

A Biogeographical Evaluation of the Vegetation Landscapes of Las Bardenas Reales in Navarre in Accordance with the LANBIOEVA Methodology

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In recent times Biogeography has become increasingly important as a consequence of its role as a discipline directed towards multiple types of research studies and analyses within the area of design and planning in territories and landscapes. In this sense, Applied Biogeography analyses the state of landscapes and vegetation with a view to their diagnosis and evaluation.

The present study is framed within the evolution of a long-term and fruitful research process which began over 25 years ago. Its principal objective or basic philosophy is oriented towards the implementation of a double system; the inventory and evaluation of the landscape vegetation of different communities on a global scale. It has, in fact, been tried out in different territorial environments within Europe (The Iberian Peninsula, The Balkans, The Scandinavian Peninsula...), within Central and South America (Nicaragua, Brasil, The Mediterranean Region of Chile, Patagonia..), and very recently in Africa (Morocco). This double method is denominated LANBIOEVA (Landscape Biogeographic Evaluation). In the case here described, it is applied to Las Bardenas Reales in Navarre.

Two large units of landscape can be differentiated in Las Bardenas Reales in Navarre: the White Bardena and the Black Bardena. In the White Bardena, arboreal or arborescent vegetation is very scant and is restricted to the dampest areas or areas with pools of water and where we find tamarisk vegetation. In the Black Bardena, on the other hand, we find arboreal or subarboreal-arborescent formations which give the landscape a much darker tone. The special geological-geomorphological, climatic, and biogeographic characteristics of this territory constitute a truly original landscape in which humans have been active and have formed a cultural landscape since early times.

The vegetation landscapes of Las Bardenas are evaluated using the LANBIOEVA methodology. In addition to this main objective we have pursued the following goals:

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- The inventory and analysis of the vegetation in accordance with its multiple attributes (phytocoenosis, territorial, mesological, structural, cultural, etc.).
- Biogeographic evaluation, not only of vegetation communities, but also taking into account different features such as: geology, geomorphology, soils, vegetation, fauna, land usage, etc. within the territory being studied.
- To obtain partial evaluations which may be of use to administrators in order to take measures regarding values or concrete criteria in planning and administering this space and the vegetation landscapes it contains.
- To experiment with the methodological framework, already applied to very diverse environments world-wide, within the specific territory of the mediterranean Iberian area which has marked semi-arid features when compared with similar areas on different scales.
- To obtain a biogeographical diagnostic which will be varied, complete and clear and which will provide administrators of this protected area with a tool which will enable them to conserve, plan and administer these landscapes in accordance with the European Convention on Landscape.

A total of 35 sites, each measuring 200 m², distributed across the two Bardenas, with a total of 122 vascular floral taxa. Though we cannot give in detail the floral list for each site (see Lozano *et al.*, 2016), 12 species have been registered in the tree and shrub category, 47 in that of bushes and climbers and 63 in that of herbs. For each site we get a figure of 0.34 trees or shrubs, a low count associated with the fact that the greater part of the White Bardena and important sectors of the Black Bardena are covered in non-arboreal and non-arborescent formations. Nevertheless, in the case of bushes (small growths of less than half a metre) and climbers we obtain 1.7 taxa per site. Herbs give a result of 1.8 species per site. Many species are repeated from one inventory to another, furze or gorse (20) being the formation with least species while the holm oak *Quercus ilex* subsp. *rotundifolia* (38) is the most diverse. The mean is situated at 30,86 taxa per site, with the mode situated at 26.

Scores relating to the phytocoenosis of the formations studied are quite high, but show notable differences between those with the highest natural grade (holm oak, pine, tamarisk-holm, kermes oak) and the lowest (spelt, furze or gorse, and rosemary-thyme).

Those categorised under territorial interest have low scores: In the 35 inventories there are only 6 endemic, none transferred y 5 wine-related taxa. In any case, with the criterion which evaluates rarity, there are important contrasts between those with the lowest score, such as furze or gorse, spelt and rosemary-thyme (all on 10 points) and those with the highest scores, tamarisk-holm (17), kermes (14) and pine (12).

Scores for mesological criteria are in general high for formations such as tamarisk-holm (56 points), holm (51) and pine (48); and medium-low for spelt (44), kermes and rosemary-thyme (40) while furze or gorse with only 27.5 points, presents one of the lowest scores registered in the Iberian peninsula.



The natural global value produces quite high scores, with the exception of 61.5 points for furze or gorse), with tamarisk-holm scoring 108. There are wide contrasts between the formations nearest the top in this region (holm oak). In any case, those most frequent, and those which show the highest grade of human transformation (spelt and furze or gorse)

Structural values produce modest scores which are very similar to those obtained for similar formations in the Iberian peninsula. They are very low for spelt, furze or gorse and rosemary-thyme, and increase with structural complexity and specific diversity. The sum of natural and structural gives rise to low registers for the three formation just mentioned and medium-high for kermes (109) pine (117) tamarisk-holm (121.5) and holm (125). These figures are very similar to, though slightly below, those obtained in similar zones but with a lesser degree of human intervention.

With respect to cultural criteria, the low values are again centered on furze or gorse, spelt and rosemary-thyme; while those with middle to high values are tamarisk-holm, holm, kermes and pine.

The sum of natural, structural and cultural values follows the same tendency. Low values are found in furze or gorse (97.5 puntos), rosemary-thyme (104) and spelt (109); the highest values go to kermes (123), pine (131), tamarisk-holm (140.5) and holm (145).

The results of the group of criteria relating to threats are notably inferior to those of other similar formations in other environments, but with less human intervention. Population density is low, accessibility-transitability and alternative threats are low or medium thanks to the protected status of Las Bardenas, and the area is safeguarded and administered with caution from a human standpoint.

The final conservation priority values range from 1,450 points for holm to 859 for kermes, results which are comparable to forest areas with greater or lesser intervention in the Iberian Peninsula.

The method shows itself to be robust and perfectly applicable in this environment. The results obtained offer administrators a considerable number of partial and global valuations which can be used to improve the administration of the vegetation landscapes of Las Bardenas Reales.

In general, there is a wide diversity of reasons which may lie behind the way in which a given formation may vary, taking into account different situations and evaluations within one and the same criterion. In general forest formations are evaluated more highly than their later stages. Forests or units at higher latitudes obtain lower scores than medium latitudes and notably lower than lower latitudes. In the mediterranean



areas of Chile, Patagonia and Brasil, the weight of territorial criteria is very high. In the case of European formations territorial criteria do count for more although, in the case of the Iberian Peninsula subcriteria such as rarity and wine-related character are also important. Las Bardenas are no exception and they obtain territorial values which are higher than those registered in the Iberian context. Mesological functions are also, in general, higher. The torrential nature of the infrequent rains, the intense processes of erosion, the hydrological and edaphic function of these formations obtains for them higher values than those allotted to mediterranean or atlantic forest formations within the Iberian Peninsula.

The highest scores, globally, were obtained in relatively well conserved forests with high natural and cultural values. Few examples are found with a valuation above 3000 points. In all our studies, up to the time of writing, only three formations have reached this score or gone beyond it: the Atlantic coastline of Brasil, the Atlantic oak/mixed forest at Urdaibai, and the Mediterranean sclerophyllous palm forest. Nevertheless, the highest absolute score was obtained by this last formation in the area of Valparaiso, given the high threat factor involved.

Las Bardenas, compared with the areas just mentioned, presents very modest scores, although the minimal threat factor involved can only be cause for congratulation. The fact that it is a protected area means that the PRICON scores are much lower than those obtained by similar environments and formations which are found in unprotected areas.

