

NATURAL AND ANTHROPIC DYNAMICS OF THE VEGETATIVE LANDSCAPE OF THE INNER VALLEYS OF WESTERN CANTABRIA (NORTH OF SPAIN)

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I. INTRODUCTION

The interactions among geomorphological dynamics, vegetation evolution and land uses have led to significant changes in the mountain landscapes of the Northern Iberian Peninsula during the last millennia. The aim of this paper is to emphasize these connections, pointing out the milestones that mark the historical configuration processes of these mountain landscapes. We focused our research in a Northern Iberian valley, the Lamasón valley in the Cantabrian Nansa basin (Cantabria). This is an exemplary area to explain all the occupation processes and the related changes in the vegetative landscapes of the Cantabrian Mountains. In these medium-high mountains, the extensive livestock farming associated with seasonal livestock settlements was the principal system for a long period of time up to last century and still remains quite important as an economic activity nowadays.

The interpretation of the genesis of these landscapes has been carried out from the viewpoint of the first intention being to obtain more grazing area and pasture space, which deter-

mined, from the beginning of the processes, the necessity to set consecutive, quick and effective fires to transform the land use. Here, we have analyzed those elements that have allowed us to obtain the effective threshold in the reconstruction of the exploitation systems. Moreover, we attempt to explain how and what man-provoked dynamics occur in these areas over time. To this end we developed a multidisciplinary and integrated view which allows us to set out an occupation sequence of these territories and the land use changes involved.

In this work, we have opted to consider the wide rotational slide that has occurred in the last millennia in the hills of Bustarredondo-Culazón (Lamasón valley) as the starting point for the landscape changes. The slide shaped the slopes into an irregular topography with a complex framework of small peat bog depressions. We drilled a borehole into one of them for palynological and sedimentological study and then analyzed historical documentation. This permitted us to reconstruct the vegetative development and the sedimentary mode changes of the peat bog and surrounding area. The sources have different characteristics and also the accuracy of the information varies according to the time it was registered. In relatively recent periods, we were able to make a comparative study among palynological records and historical documents and available sources found in local and regional archives. Furthermore, we attempt to understand the evolution of this medium-high mountain landscape by deepening knowledge about its plant communities and dynamics.

The analyzed area is affected by the Prevailing westerly winds and it is swept by many mass-air fronts and mid-latitude low-pressure areas, which generate mild climatic conditions with a marked oceanic influence. According to the AEMET data from the station nearest Lamasón, Rozadío (210 m), the mean annual temperatures reach 13.1° C, with a low thermal range (10°C between the coldest and warmest month of the year). The annual rainfall is substantial (1126.2 mm), and there is no drought period (minimum precipitation of 48.7 mm in July). The dominant rock type in the Lamasón valley consists of a set of continental siliciclastic sediments (Upper Jurassic-Barremian Wealdian Complex), which are typical of the Basque-Cantabrian Basin surrounded by the western Paleozoic massif (Asturian massif). The syn-orogenic and post-orogenic fluvial and torrential dissection has created the landforms and the shape of the valley, with few, little floodplains, very steep slopes and smoothed culmination. The erosive dynamics continued during the Holocene with the mobilization of materials through many fluvial incision processes, filling of the river beds and mass movements on the slopes.

The dominant vegetation cover on these valley slopes in the medium-high Cantabrian mountains has been intensely modified by humans. This intervention has been associated with fires in order to obtain pastures. Nowadays there is a predominance of subshrubs of successional plants. Around Bustarredondo, Pyrenean oak (*Quercus pyrenaica*) woods are growing just inside the water courses and bare rock areas less affected by fires. These copses are accompanied by *Betula alba* var. *alba* in the sectors most exposed to the fires. The frequent plant communities growing on burnt soils are heaths, dense plurispecific formations composed predominantly of *Calluna vulgaris*, *Erica mackaiana*, *Daboecia cantabrica* and *Erica cinerea*. *Ulex gallii* ssp *gallii* heath is also common in these areas, but it is related to older burn off and so it has become more consolidated. Along with these plant communities, we can find a grid of scythed meadowland associated with winter shelters and small marshy areas on shelf slopes. Nowadays, meadowlands are sometimes being replaced by foreign conifer plantations (*Pinus radiata*).

II. METHOD

The fieldwork carried out was focused on three ways of deepening knowledge. Firstly, we established the positioning and interpretation of the geomorphological features. Secondly, we found and interpreted the plant communities and processes of vegetative dynamics. Finally, we choose an accumulation peat bog in order to collect sedimentary and palynological samples.

The hygro-peaty deposit chosen (Culazón peatbog, 592 m.a.s.l.) has an extension of nearly 1Ha, and it is dominated by *Rhynchospora alba* in the most damp areas. It is surrounded by extensive serial formations of *Ulex* ssp. and *Erica* ssp. We collected a drill core sample, which was specifically assessed every two centimeters. The sequence was divided into two pollen zones (A and B) with their own subzones. Twelve radiocarbon absolute datings were carried out by AMS on two different groups of samples; ten from the Culazón peat column analyzed, and two more datings from two palaeosoils located in the latero-frontal lobe area of the landslide. Some interesting transects were also chosen for floral plant sampling, by collecting those data necessary for the characterization and analysis of the most representative plant dynamics. Four community types were also defined which made it possible to assess current vegetation features and processes: Grassland over peatbog hollows, Gorse scrub over solifluidal slopes, siliceous multi-specific Heather, pseudo-rupicolous Oakwoods (*Quercus pyrenaica*).

All the point, linear and polygonal information captured through GPS was totally integrated and considered for the study. To make it possible, it was firstly converted into a layer file by using GIS software (ArcGis 9.x)

III. VEGETATION, GEOMORPHOLOGICAL PROCESSES AND RELATED DYNAMICS

The Lamason valley is characterized by the scarce material consistency of its rocks, which has led to slope mobilization and sliding. The valley's central sector (Bustarredondo-Culazón), has asymmetric slopes because of the rotational landslide that affected them. It has formed a thick toe, which is complex, irregular and has several fronts, steps and intermediate hollows which are often closed. The runoff waters in these closed depressions flow more slowly and are occasionally retained. This situation leads to the formation of stagnant areas, wetlands and peatbogs. One of them located at the head of the landslide lobe has provided the sampling material for the pollen analysis that we have done. This sample allowed us to date the bottom part of the accumulation (3589 ± 60 BP), which indicates the minimum age when the mass movement and the material slide took place.

Other erosive periods took place subsequently, which can be seen as there were little mass movements on these slopes (ca. 2.000 BP). More recently, during the documented period, we have been able to establish that intense rainfalls and consecutive floods have led to a series of mass movements and debris flows, although not as bulky as the oldest one. The information we have at our disposal for the modern period has enabled us to deduce the intensity of the rainfall in the second half of the XVIIIth century.

The great landform diversity existing on a large scale and the varied water situations occurring in short time periods that can be found here have favoured different strategies of

vegetative evolution over time. This is reflected in different dynamics that have provoked the following plant communities: *Peatbog hollows*, topogenous and ombrotrophic mires where *Rhynchospora alba* is dominant. *Successional scrubs*, constituted mainly by gorse and heather formations (*Ulex gallii* and *Erica mackaiana*). The natural phases following a vegetative cover degradation period are also present, especially caused by fire. Lastly, we can also find stony outcrops covered by *Oakwoods* (*Quercus pyrenaica*), which demonstrate previous intense burning periods which converted the other woods into meadows.

Taking into account pollen analysis results and all the documental information archives analyzed, it is possible to deduce advance-and-retreat evolutionary dynamics of certain plants in this area. This is mainly related to ground burnings in order to create new grazing areas from previously wooded areas, or in order to maintain the previously created pastures.

The current plant communities and their behaviour are simply representative of a former landscape, which was the main landscape during many historical epochs. We have interpreted the pollen sequence age, based on many C14 AMS datings of the Culazón peat core, and we have linked them with the documental information we have for more recent times. From the analysis of all these results, we have tried to deduce all the construction-deconstruction landscape processes during the last millennia.

The bottom of the core (subzone A1a, 140-117 cm), only 23 cm thick, occurred over an extensive time period (ca. 2215 cal BC-1030 cal AD), demonstrating a varied advance-and-retreat dynamic on the medium height land pastures. This sequence was followed by a second one (Subzone A1b, 117-107 cm), characterized by intensification and diversification activities, which took place between the XIth and the XVth centuries cal AD. Associated with these activities, we can find the first rye (*Secale cereale*) crop samples in this livestock area. Above this level there is a more recent one (Subzone A2a -107-93 cm), which represents a new land use change corresponding to XV-XVIth centuries cal AD. In this case, we have determined that a process of disuse of the livestock areas took place with the consequent post-fire occupation by trees.

The next levels above (Subzone B1 -79-69 cm) show that later, in the XVII-XVIIIth centuries cal AD, there was an increase in cattle-related activities and a diversification in the winter cabin farming activities. As a consequence, there was an increase in temporary crops (*Cerealía* and *Secale*). Over this level, the Subzone B2a (69-41 cm) reflects that the medium-high pastures were slightly neglected between the XVIIth and the XIXth centuries cal AD. Moreover, these two reflect a fall in both kinds of cereal crops and worsening of weather conditions. The level sequence ends with the most recent and current scrubland growth processes, taking place after burning periods on the pastures, and with a forest area advance. We must point out three different facts which are reflected in these levels: The introduction of woody plants like *Pinus*, the reduction in the pasture use intensity in these medium-high pastures and the *Secale cereale* disappearance (XIXth to XXIth century cal AD).

IV. LANDSCAPE CHANGES

The Lamasón valley evolution illustrates very well how natural and socioeconomic dynamics in medium-high siliceous northern mountains have been combined. To start with, we considered the erosive slope destabilization processes, which led to the mass movement

of Bustarredondo-Culazón. This landslide process started in 3589 ± 60 BP (2133-1760 *cal* BC, mid-Holocene). These processes formed an irregular space, with hollows, small closed depressions with stagnant waters and wetlands, in different steps. Around 2215-1950 *cal* BC this sector was covered by hazel wood formations. These types of plants were typical of colonisation after burning areas, so they represented the pioneer formation after that kind of events. A large quantity of tree pollen was found, so it is easy to associate it with temporary pasture structures, opened after quick ground burnings. In any case, there were consecutive advance-and-retreat dynamics in the pastures, associated with two different kinds of processes. Sometimes, it was associated with an increase or a reduction in fire actions and, at the same time, to erosive processes and little landslides over *ranker* soils.

Between 1920 ± 40 BP (*ca.* 82 *cal* AD, 122 cm) and 060 ± 40 BP (*ca.* 980 *cal* AD, 119 cm) there is no information concerning the core. This could be related to erosive processes and sedimentary material loss, and the human factor could have had a critical influence on that. It has been found that for that period (320 *cal* AD) in Lamasón valley there were Romanized indigenous settlements. Thus this might have determined an alternation between pastures with a reduced number of cattle, and a small number of grazing areas opened thanks to specific burnings.

In the centuries XIth-XVth *cal* AD, the occupation of meadows and productive diversification was related to social development processes, through collective land use conversion carried out by small village communities. Moreover, this social development occurred with fair weather conditions, which determined the pressure on grazing areas and consequently, an increase in them. From the XVth century *cal* AD, new weather conditions occurred, whose coldest pulses provoked a new different land use. This meant a temporary disuse of this area for cattle grazing and the spread of *Quercus* plants, like at the present time. Related with colder weather (at the end of the XVI century *cal* AD.), these pastures gradually became neglected. In spite of that, a reduced function was maintained; moor plant communities increased, and the number of fires and nitration levels reduced.

Burnings started up again in the middle of XVII century *cal* AD., in association with better climate conditions and with pasture reoccupation. In this case, moor formations retreat because of the burning frequency increase. Considering these aspects, it is easy to imagine some of the sunny stony hills occupied by cereal crops.

Agricultural and livestock activity expansion and intensification continued during the XVIIIth century *cal* AD, although the wooded areas conserve similar characteristics to the previous century. These wooded areas are used as a source of energy for houses and nearby foundries, so these woods and copses became adapted to this type of economic activities. Moreover, the Navy required wood from these forests too, so any plants suitable for that use were always reserved for shipbuilding.

In the early XIXth century *cal* AD, the exploitation cycles of these areas became reduced and they were occupied during less time due to the worsening weather conditions. All the spaces previously occupied by cereal crops, became transformed into pastures. The tendency was maintained during the XXth century *cal* AD and the first decade of the XXIth century *cal* AD. Some taxons indicative of pasture and farming activities have disappeared or become reduced in number. This means that this area has become a peripheral pasture space and it has been gradually transformed into a post-burning scrubland. Cattle activities and use of

firewood have been reduced in these areas so scrubland and wooded areas have increased. As a result of the decrease in cattle-related activities, a new process has occurred, namely, reforestation. There are a limited number of reforestation examples which have mainly occurred inside the ancient fenced fields.