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A HALF-CENTURY OF LANDSCAPE EVOLUTION IN THE SIERRA NEVADA (SPAIN)

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I. INTRODUCTION

Landscape is a complex concept that can be approached from many perspectives. Many authors, and indeed the European Landscape Convention,view landscape as a result of the characteristics of the territory and its historical evolution together with public perceptions and representations of it over time (Bertrand, 2008; Gómez, 1999; Mata et al., 2003; Molinero et al., 2011; Zoido, 2012). This paper focuses on the evolutionary aspect of landscape, analysing the succession of socio-territorial models and their effects on the structure of the territory by studying the changes that have taken place in land uses and vegetation covers.

History is clearly of key importance for understanding the genesis of current landscape structures. We have therefore conducted a diachronic study to analyse land uses and covers and identify and quantify the dynamics of landscape change. The evolution of landscape in the Spanish mountains is the result of the social, economic, demographic and cultural changes which, since the 1950s, have resulted in depopulation, abandonment of traditional activities and impoverishment of rural lifestyles. All these aspects, combined with the absence or ineffectiveness of public management of mountain territory, have had negative effects on the stability of the slopes and on biodiversity and have resulted in an increasing homogenization of landscapes so reducing their quality (Arnáez et al., 2010; Jiménez, 2010; Swihart and Moure, 2004).

The aim of this paper is to analyze how the economic and social crisis that began in the 1950s has affected the regions of Sierra Nevada and how changes in the socio-territorial model have led to such a strong landscape change dynamic that the area is threatened with the loss of its environmental, cultural and aesthetic values.

II. METHODOLOGY

This evolutionary study is based on an analysis of the four major types of landscape in Sierra Nevada (Jiménez, 1991), differentiated by grouping together the geosystems that have similar patterns of spatial organization. We conducted diachronic analysis based on the study of the transformation of land cover between 1956 and 2006 through photo-interpretation of orthophotos from the first and the final year of this period, fieldwork and analysis of various cartographic documents.

In this way we drew up two separate land cover maps which were then used to design a flowchart and to obtain statistics regarding land cover in the study area. Likewise, tables and maps depicting the dynamics of change between the two dates have been obtained to show both the scope of the transformations and the new categories that have emerged to replace previously existing ones and the extent to which this has taken place.

III. THE TRADITIONAL LANDSCAPES OF THE SIERRA NEVADA IN THE MIDDLE OF THE 20THCENTURY

III.1. Ecological and cultural bases

The geo-environmental conditions of these mountains gave rise to a model of human organization based traditionally on agriculture but with little potential to sustain large numbers of livestock. Organizational systems of agriculture, forestry and livestock grazing were based on important human intervention in the natural balance, forming a mosaic of mixed uses and spaces (Rodríguez, 1981). The region of the Alpujarra on the southern side of the Sierra is especially large and complex, and is marked by altitudinal succession of land uses with a combination of agriculture, grazing and forestry. This is made possible by large irrigated areas composed of small terraced fields and an extensive network of irrigation channels, in which they cultivate herbaceous species and some trees that diversify production and help reduce soil erosion. In the high areas summer pastures predominate, although there are also cultivated fields as high as 2200 m.

The north side of Sierra Nevada, by contrast, has hardly been used for agriculture, and instead is predominately forest and livestock grazing land, while the western side had a rural subsistence economy in which small holdings with irrigated and dry land crops alternate with species from the original forest such as holm oaks, oaks and riverside maples.

III.2. The state of the landscape in the 1950s

The socio-economic and cultural context of the 1950s combined with various historical legacies to shape landscapes dominated by grassland and scrub (62% of its surface), above allin areas above the tree line. In the middle and lower sections cultivated space was mixed with the remains of broad-leaved copses. Wooded areas occupied only 15% of the massif.

We will now discuss the state of the landscape by analysing the situation of each of the four major types to which we referred above.

The *natural landscapes of the high mountains*, situated above 2200 m, were dominated by xeric grasslands developed on land of active periglacial geomorphology and relatively

gentle topography. These were spaces in which there had been little human intervention and where grazing did not alter the natural character of the climax scrub, which was cold and dry, with low land coverage and rich flora.

In the *forest landscapes on north-facing slopes*, descending from 2200 m to the foothills, at about 850 m, there were large areas of scrub and grassland, the predominant land cover due to degradation of the original supra-mediterranean and meso-mediterranean forest of oaks and holm oaks. Extensively farmed fields of non-irrigated cereals diversified these landscapes.

The *limestone and agro-forestry landscapes in the western valleys*, extending between 2200 m and the depression of Granada, are grouped into two major types according to the nature of the dominant rocks. The limestone-dolomitic rock on which few crops would grow meant there were almost no permanent human settlements. The active morphogenesis of these lands and deforestation processes resulted in the prevalence of low and scattered scrub. On schistose materials large spaces of scrubland covered the highest areas where cattle were reared. At lower levels agro-forestry landscapes alternated small copses with irrigated arboreal fields, so creating almost uninterrupted tree-covered space.

The *agro-forestry landscapes of the south-facing slopes of Sierra Nevada* are the most complex and have the greatest historical, patrimonial and symbolic values. They are the result of the traditional system of working the land that includes large tracts of land covered by small fields and wooded areas for three main uses: agriculture, forestry and livestock. The crops, reaching up to high altitudes, are the result of a socioeconomic model that puts maximum pressure on natural resources and is based on the terracing of hillsides, in mixed crop fields irrigated by an extensive network of water-channels, and the use of characteristic agro-forestry species, such as chestnut or walnut (Rodríguez, 1981; García, 1999).

IV. LANDSCAPES AFTER HALF A CENTURY OF CHANGE IN RURAL LIFE IN THE MOUNTAINS

IV.1. Crisis of the traditional economy and new functions of mountain areas

Profound changes have taken place in Spain since the 1950s, with the overdue industrialization process and the new general situation of the country. The rural exodus caused a widespread abandonment of traditional activities, leaving many fields untended. This also led to a deterioration of the material bases of the traditional system, such as terracing and water-channels due to a lack of maintenance. At the same time the emergence of new uses such as intensive agriculture and tourism put pressure on mountain resources (Rodríguez, 2000), leading to the dismantling of the previous model and to a slow but steady transformation of agro-forestry landscapes.

Partially linked to the disappearance of traditional farming activities, new forestry policies were implemented provoking a dramatic transformation of Sierra Nevada's landscapes. The ambitious reforestation campaigns of the national hydrological-forestry plan led to a radical transformation of the northern slopes and also to profound changes in the western and southern valleys, where new pine forest covered the highest regions and part of what had once been cultivated fields.

The 1980s saw a shift in national policy enabling village communities to survive thanks to increased social care and special support for mountain agriculture. Apart from agriculture, there were also plans for economic development based on the area's potential for tourism, both sports-related and for rural holidays. Public intervention was reinforced by the Special Plan for the Protection of the Physical Environment and by the Law establishing an Inventory of Natural Areas passed by the Government of Andalusia thanks to which, in 1989, Sierra Nevada was declared a Natural Park. In 1999 it achieved the highest protection status when it was declared a National Park. However, only isolated, poorly planned attempts were made to ensure that rural development was compatible with conservation and traditional uses and local demands were often ignored giving rise to a variety of conflicts (Rodríguez, 2000).

In the 1990s European policies aimed at promoting mountain development were based on a much broader set of potential local resources, not only on agriculture, as well as on raising environmental awareness and on growing demand for nature and leisure from an advanced urban society (Mulero, 1995). With this new approach to rural development based on the multifunctionality of rural areas, the service sector has benefitted most from the stimulus provided by tourism, which has done little foragriculture, agro-industry or local crafts.

Today the foundations of the local economy seem detached from the traditional agro-pastoral activities and rural tourism is not sufficiently connected to the other economic sectors, wasting marketing synergies such as the sale of high-quality local products.

Society is gradually coming to view the mountains as a reserve for nature and resources, as a place to enjoy leisure time and as a space for a diversified economy and this has brought profound changes in the spatial model and in the management of resources.

IV.2. Transformations and current state of the landscapesin Sierra Nevada

The current distribution of land cover in the mountains is the result ofthe socio-economic and political changes described above. Public reforestation policies have led to a notable increase in the coniferous forest, which has extended into agricultural areas and, occasionally, beyond the existing tree limit. The advance of forested land is attributable also to spontaneous processes of ecological succession, that enable the expansion or maturation of oaks or holm oaks forests in parallel to a decrease in human pressure on land. Agricultural uses have been reduced to 7.4%. The increase in the number of abandoned fields represents a major mutation of the landscapes whose contours are blurred anticipating a process of landscape trivialization.

If we analyse the current state of the four major types of landscape we could draw the following picture.

The *natural landscapes of high mountains*have enjoyed greater stability, maintaining the same land cover over 76% of their surface. The dynamics of geosystems have been closely linked to morphoclimatic processes that have reduced the extension of the cryoromediterranean area and increased the dominance of grassland in the oromediterranean area to the detriment of the climax brushwood, causing a loss of environmental quality. However the decrease in the area of scrub is the result of reforestation processes. In these landscapes, high-mountain crops have been abandoned and natural vegetation has recovered.

The introduction of winter sports requires special attention. The ski resort, developed since the 1960s, now covers 82.5 ha. It poses a strong threat to the ecosystems and is a continuous source of conflict between economic and conservationist interests.

The level of transformation of *forestry landscapes on the north-facing slopes* has been extraordinary. The scrub and grassland, which originated from the degradation of the meso and supramediterranean holm oaks and oaks, have been replaced by woodlands. Although, as a result of government reforestation plans most of the forests are conifers, some large masses of native forest have consolidated in the wettest geosystem at the western end. The predominant land use model in these valleys, focused on the extensive cattle breeding of fighting bulls, has been decisive. In addition, ecological succession processes on slopes that were previously covered by scrub and grasslands have in some cases led to broadleaved forests and lowland forest bodies. The third dynamic of change is linked to the abandonment of agricultural land and its replacement with pioneering communities of scrub and grassland with the frequent presence of scattered holm oaks, a clear symptom of the recuperation of the potential vegetation. In agricultural landscapes, some traditionally irrigated areas have now been replanted with olive and almond trees, which are not irrigated and require less dedication. In some areas we found evidence of agricultural expansion into what were previously lowland forest areas.

The *limestone and agro-forestry landscapes in the western valleys*have undergone intense transformation with 72.7% of their area affected. Highly tectonized limestone-dolomite formations have meant that denudative processes have triumphed over edaphological processes and plant colonization. Furthermore extensive reforestation work has produced vast masses of conifers that have completely encompassed relict woods. The presence of forestry elements in the agro-forestry landscapes has increased due to the spontaneous growth of broadleaved trees after the space used for agriculture fell by 75% and livestock pressure also decreased. Finally, we must emphasize the importance of urban development in this sector due to its proximity to the city of Granada. Although the area occupied by these new developments is relatively insignificant, they have a substantial impact on the landscape.

In the *agro-forestry landscapes of the south-facing slopes of Sierra Nevada* land use has changed in 67.5% of its area. These changes are mainly linked to the evolution of scrub and grassland into woodland formations through a process of ecological succession towards mature states. These changes are mainly due to the rapid abandonment of agricultural activity, as demonstrated by that fact that the cultivated area has shrunk by 55%. Within the remaining agricultural area, crops that can be tended on a part-time basis now predominate. Herbaceous, cereal and horticultural crops have mostly been replaced by tree plantations, mainly olives and almonds and, to a lesser extent, by walnuts, cherries and other fruit trees. In conclusion, today's landscapes are composed of larger extensions of reforested conifers and growing masses of holm oaks and oaks. The agricultural areas have declined due to the breakdown of the small holding system, the deterioration of the terraces and the neglect and cementation of the irrigation channels. All this together with the advance of scrubland in what were once farmed fields has blurred the organized mosaic of a landscape with great historical, ethnographic and ecological value that is an integral part of the image of the area and a hallmark of local identity.

V. CONCLUSIONS

The five decades studied have brought major transformations to the landscapes of the Sierra Nevada through very powerful change dynamics that have affected 42.8% of the Protected Area. The most important change has been the substantial increase in the forested area. This is firstly the result of reforestation policies, which have not only had a strong morphological impact but have also caused significant alterations in the ecological base, and secondly of the natural dynamics of ecological succession favoured by the abandonment of traditional agriculture and livestock activities, which have led to the deterioration of cultural landscapes with high heritage values.

The new rural development model promoted by European, national and regional policies, pays insufficient attention to the need to support the agricultural practices that have helped form these century-old cultural landscapes and are essential for maintaining them, a question that is doubly vital at a time when tourism is becoming increasingly important for the local economy and depends to a large extent on the picturesque qualities of the agricultural landscape. An additional problem is that tourism is largely detached from a parallel enhancement of high quality, local agro-forestry-pastoral resources. The high mountain areas meanwhile show the high levels of stability characteristic of peaceful landscapes.

All these changes are the result of a profound transformation of the role of the mountains in the current economic and sociocultural paradigm. Sierra Nevada does not just provide a livelihood for the people who live there but also plays an important role as a source of water resources, a biodiversity area, aspace for recreation and a refuge for an exceptional cultural heritage. The increasing demands placed on Sierra Nevada are multiplying the interests and functions that come together in it.

The change in the management model has transformed the landscape, and will continue to do so in the future. Public authorities must perform tasks as varied as fire prevention, control of public and tourism-related use, the naturalization of reforested areas, the maintenance of irrigation channels and terraces, the control of wildlife and the promotion of sustainable economic activities amongst the population of this Protected Area.

Therefore, greater coordination is required between administrations, local development agents and the mountain population to ensure the promotion of a truly sustainable development model which would improve the landscape and environmental quality of the natural spaces and guarantee the survival of valuable cultural landscapes.