ESPACIO, TIEMPO Y FORMA

AÑO 2020
ISSN 1130-2968
E-ISSN 2340-146X

13

SERIE VI GEOGRAFÍA
REVISTA DE LA FACULTAD DE GEOGRAFÍA E HISTORIA

UNED

ESPACIO, TIEMPO Y FORMA

AÑO 2020
ISSN 1130-2968
E-ISSN 2340-146X

13

SERIE VI GEOGRAFÍA

REVISTA DE LA FACULTAD DE GEOGRAFÍA E HISTORIA

DOI: http://dx.doi.org/10.5944/etfvi.13.2020

UNIVERSIDAD NACIONAL DE EDUCACIÓN A DISTANCIA

La revista *Espacio, Tiempo y Forma* (siglas recomendadas: ETF), de la Facultad de Geografía e Historia de la UNED, que inició su publicación el año 1988, está organizada de la siguiente forma:

SERIE I — Prehistoria y Arqueología
SERIE II — Historia Antigua
SERIE III — Historia Medieval
SERIE IV — Historia Moderna
SERIE V — Historia Contemporánea
SERIE VI — Geografía
SERIE VII — Historia del Arte

Excepcionalmente, algunos volúmenes del año 1988 atienden a la siguiente numeración:

N.º 1 — Historia Contemporánea
N.º 2 — Historia del Arte
N.º 3 — Geografía
N.º 4 — Historia Moderna

ETF no se solidariza necesariamente con las opiniones expresadas por los autores.

UNIVERSIDAD NACIONAL DE EDUCACIÓN A DISTANCIA
Madrid, 2020

SERIE VI · GEOGRAFÍA N.º 13, 2020

ISSN 1130-2968 · E-ISSN 2340-146X

DEPÓSITO LEGAL
M-21.037-1988

URL
ETF VI · GEOGRAFÍA · *http://revistas.uned.es/index.php/ETFVI*

DISEÑO Y COMPOSICIÓN
Carmen Chincoa Gallardo · *http://www.laurisilva.net/cch*

Impreso en España · Printed in Spain

ARTÍCULOS · ARTICLES

PEATLANDS EVOLUTION IN CENTRAL IBERIA (MONTES DE TOLEDO, SPAIN) AND ITS LINK TO ANTHROPOGENIC PROCESSES: A CARTOGRAPHY-BASED STUDY

EVOLUCIÓN DE LAS TURBERAS EN EL CENTRO DE LA PENÍNSULA IBÉRICA (MONTES DE TOLEDO) Y SU RELACIÓN CON LOS PROCESOS ANTRÓPICOS: ESTUDIO A PARTIR DE LA CARTOGRAFÍA

Fidalgo Hijano, C., González Martín, J. A., Corral Ribera, M.[1], García Giménez, R.,[2] and Arteaga Cardineau, C.

Recibido: 02/07/2019 · Aceptado: 27/12/2019
DOI: http://dx.doi.org/10.5944/etfvi.13.2020.25208

Abstract
The study of the peat bogs from the inner Iberian Peninsula and, specifically, those located around Puebla de D. Rodrigo (Montes de Toledo, Ciudad Real) have demonstrated how a series of anthropic alterations in the natural environment (changes in the dynamics of the slopes, the appearance of waterlogged areas in the valley bottoms due to the arrival of colluvial sediments to them …) have been jointly co-responsible for the development of numerous peat formations in this mountainous region. But also, these same actions, together with drainage works, have contributed very effectively to the disappearance of some peatlands in recent decades. These processes are verified by a diachronic study of cartographic data from the 19th and mid-20th centuries. Thus, aerial maps and photographs show the progressive advance of deforestation and agriculture towards the edges of peat areas. This paper has a double objective: on the one hand, to provide cartographic evidences of how spaces of great environmental value have been created with the concurrence of human activities; and on the other, to call attention to the need to control the impacts that threaten the disappearance of one of the southernmost peat sets of the Iberian Peninsula.

Keywords
Peatlands; anthropogenic alterations; historical land use; conservation.

---

1. Geography Department, Autonomous University of Madrid (UAM): *concepcion.fidalgo@uam.es*; *juanantonio.gonzalez@uam.es*; *mariocorral93@gmail.com*; *carlos.arteaga@uam.es*
2. Geology and Geochemistry Department, UAM: *rosario.garcia@uam.es*

Resumen

El estudio de las turberas del centro peninsular y, específicamente, las ubicadas alrededor de Puebla de D. Rodrigo (Montes de Toledo, Ciudad Real) han demostrado cómo una serie de alteraciones antrópicas en el entorno natural (cambios en la dinámica de las pendientes, la aparición de zonas anegadas en los fondos de valle debido a la llegada hasta ellos de sedimentos coluviales...) han sido conjuntamente co- responsables del desarrollo de numerosas formaciones de turba en esta región montañosa. Pero también, estas mismas acciones, junto con los trabajos de drenaje, han contribuido de manera muy efectiva a la desaparición de algunas turberas en las últimas décadas. Estos procesos se verifican mediante un estudio diacrónico de datos cartográficos de los siglos XIX y mediados del XX. Por lo tanto, los mapas y fotografías aéreas muestran el progresivo avance de la deforestación y la agricultura hacia los bordes de las zonas de acumulación de turba. Este trabajo tiene un doble objetivo: por un lado, proporcionar evidencias cartográficas de cómo se han creado espacios de gran valor ambiental con la concurrencia de actividades humanas; y por otro, llamar la atención sobre la necesidad de controlar los impactos que amenazan la desaparición de uno de los conjuntos de turba más meridionales de la Península Ibérica.

Palabras clave

Turberas; alteraciones antropogénicas; usos históricos del suelo; conservación.

....

1. INTRODUCTION

Peatlands are complex systems featuring a micro-mosaic of plant communities that can be distinguished according to ecological factors, especially those affecting the hydrological regime. They develop in very fragile and restricted habitats with unique and endemic species. For decades peat accumulations have been considered as significant pool of carbón (C) and have been used as sources of proxy climatic information and environmental reconstructions (Blackford, 1993, Franco *et al*., 2001; Torres, 2003; Lopez Merino *et al*., 2006, Musotto, 2013, Luelmo *et al*., 2019). Peat formations are very sensitive to environmental changes, both natural and anthropogenic. Thus, human activity and climate change are risks that threaten the stability of peatlands whose surfaces have been rapidly decreasing in recent decades (García del Río, 2000) due to drainage and deforestation works and fire.

Factors such as water availability and low nutrient content (and others) ensure the peat development, and thus the structure and functionality of the habitat. However, centuries of human activity have fundamentally contributed to its degradation, above all through the extraction of peat for use as domestic fuel, or through ploughing for purposes of farming, or as fertilizer for agricultural fields. Numerous specific activities have affected these habitats and among them stand out:

- excavated drainage ditches for «land and water management», which affected the continuity and depth of the water table
- peat compaction due to the passage of livestock while feeding on grass
- fertilizer use in agriculture, resulting in soil eutrophication and, combined with water drainage, accelerates soil mineralization and increases the transfer of organic matter to water flows.
- introduction of relatively vigorous species that outcompete the native species of the peatlands, thus modifying the degrees of naturalness and biological diversity.
- forest fires, which degraded the vertical structure of the peat bogs.

These impacts have motivated that many peat bogs of the European continent have been totally or partially destroyed in different countries: in Holland the bogs have almost completely disappeared, while loss of their surface in Great Britain, Ireland, Germany rises to 90%, 82% and 50%, respectively (De Miguel, 2006).

Since the peatland sites are characteristic from the Atlantic regions or from higher latitudes, in the Iberian Peninsula most of the peat bogs are located in its northern half. Especially in areas of certain oceanic influence and high mountain regions: the Pyrenees, the Central and Iberian Systems, the Cantabrian Range, or the Galician Massif (Franco, 1995 y 2001, Martínez *et al*. 2000, 2009, González-Samperiz *et al*., 2004, Pontevedra 2004, Rodriguez *et al*., 2012).

Nevertheless, peatlands are a less common habitat in the centre of the Iberian Peninsula even though can be found in certain places of the Sierra de Ayllón, the Sierra Morena, and the Montes de Toledo. The surface area of all Spanish peatlands has been estimated at about 350 km^2, which represents 0.07% of the country area (Tanneberger *et al*., 2017).

This study focuses on a set of peatlands (*Bonales*)[3] areas. They are located in the Toledo Mountains (central Spain), specifically on both banks of the Guadiana River along its middle course.

The peatlands or *bonales* of this region are small and scattered across the area. Nonetheless, they constitute a singular landscape with abundant water, peaty soil, and specific vegetation (García-Río, 2000; 2001; 2002; 2007; Martín-Herrero *et al*., Florín, 2012; Fidalgo *et al.,* 2013; López-Sáez *et al.,* 2014; and Luelmo *et al.,* 2018). Despite their small size, the presence of permanent moisture makes these peat bogs a relevant landscape element within a Mediterranean climate environment and a refuge for atlantic and boreal species with central European optimum. Decades ago, Rivas Goday (1954) referred to them as «Atlantic islands» in the Mediterranean setting in the center of Iberia. This environmental value led to the inclusion of these peatlands into Directive 92/43/CEE for priority habitats, and Law 9/1999 for Nature Conservation as «habitats with special protection». They are part of LIC Bonales ES4220019 («Place of Community Interest») in the *Comarca de Los Montes del Guadiana* and defined as a set of acid peatlands located along the banks and valley bottoms of certain tributaries of the Guadiana River. They have also been declared a Micro-Reserve, susceptible to environmental protection. In parallel, many of the species found in these peatlands are included in the *Regional Catalogue of Endangered Species* (*Catálogo Regional de Especies Amenazadas Ley 9/1999, de 26 de mayo, de Conservación de la Naturaleza* of the Castilla-La Mancha Community).

Nowadays, there are numerous works dedicated to establishing the evolution of the Holocene of Spanish peatlands (Ramil-Rego y Rodriguez, 2017, M. Abad *et al*., 2019). However, works intended to examine the recent historical degradation of these flooded areas are very scarce. And there is even less that they aim to establish specifically the main aggressions suffered by these areas, based on the analysis of documentary sources and historical cartography.

The principal aim of our study is the analysis of the current and historical dynamics around these peat bogs, considered as an excellent example of landscape modification due to anthropogenic action. At the same time, we pretend to establish proposals and / or protection measures for future conservation.

---

3. Locally, these bogs are referred to as '*bonales*', although the term '*bonal*' has several meanings. González Bernáldez (1992) defines it as moist terrain, or else vegetation (grasslands or reed beds) characteristic of such flooded terrain (González Bernáldez, 1992). Similarly, Alcázar and Azcárate (1998) consider the term to be a syncope of the word '*bodonales*', itself derived from '*bodón*' (lat. '*buda espadaña*'), referring to a natural water deposit of rounded shape (Alcázar & Azcárate, 1998). According to the *Glosario de Transhumancia*, a *bonal* can be defined as a pasture of the order Isoetetalia (winter and spring *bonales*) or Agrostietalia (winter *bonales*) made up of herbaceous (mainly grass or grass-like) plants that develop in late spring or early summer over terrain that is inundated. All consider a *bonal* to be a place of permanent or near-permanent moisture, where water swamps the terrain or flows minimally; the water found in *bonales* can proceed from springs, creeks, or the subsoil. The scarcity of oxygen and nutrients characteristic of such waterlogged zones triggers a series of processes that descompose accumulated organic matter into peat.

2. GEOGRAPHICAL SETTING

The peatlands constitute the *Micro-Reserve Bonales of Puebla de Don Rodrigo*- (Royal Decree 42/2002 of April 2, 2002) located within the municipality of this locality, in the province of Ciudad Real. In detail they are situated in the north of Sierra de Castillejos (Figure 1), belonging to the *Comarca de Montes* and integrated into the *Mancocomunidad of Cabañeros*. This set is composed of of six peatland areas covering a total surface area of 64,1 ha, plus a peripheral protection zone. These are: *Bonal (Trampal) de los Terreros* and the headwaters of *Valdelobillos* creek; *Bonal de los Jareros; Bonal del Tío Chasco; Bonal Horcajilla de los Baturros*; *Bonal de la Raña Maleta* and *Bonal del Abulagar («Observatorio»)* (Figure 1). They represent the best-preserved set of acid peatlands in Castilla-La Mancha region and belong to the so-called *Monte Valles del Término* (number 16 in the *Catálogo de Montes de Utilidad Pública).*

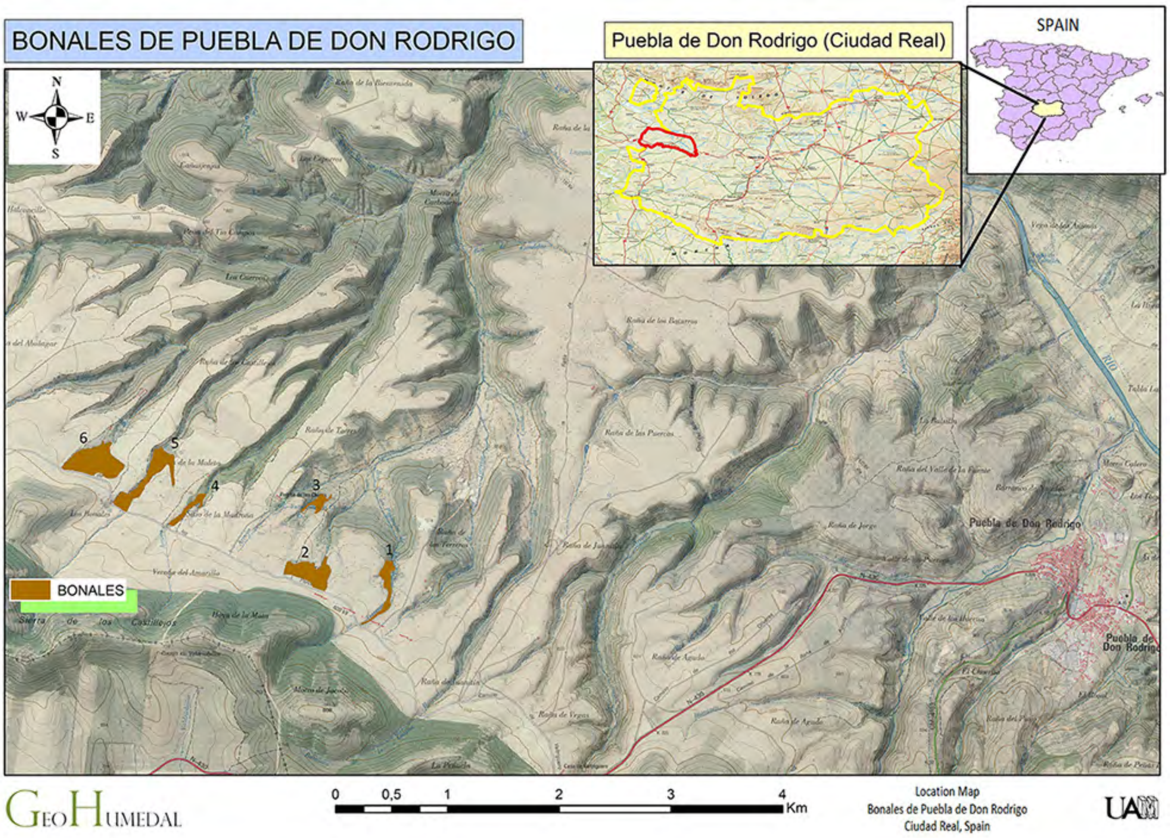


FIGURE 1. LOCATION OF PUEBLA DE DON RODRIGO WITHIN THE PROVINCE OF CIUDAD REAL, AND OF THE VARIOUS PEATLANDS THAT FORM THE OBJECT OF THIS STUDY. 1) *BONAL (TRAMPAL) DE LOS TERREROS* AND THE HEADWATERS OF VALDELOBILLOS CREEK. 2) *BONAL DE LOS JAREROS*; 3) *BONAL DEL TÍO CHASCO*; 4) *BONAL HORCAJILLA DE LOS BATURROS*; 5) *BONAL DE LA RAÑA MALETA;* 6) *BONAL DEL ABULAGAR*

They are in the southern Iberian Massif. This Paleozoic region contains different lithological units but, in the area, highlighting the extensive outcrops of rocks of low metamorphism (quartzites and slates), intensely deformed by a complex system of folds and faults, generated during various phases of the Variscan orogeny (Muñoz, 1976, García-Rayego, 1997a). The behavior of both lithologies to differential erosion is responsible for a structural framework defined by an appalachian relief characterized by quartzite ridges (800-900 m.a.s.l.) that rise above depressions (450-500 m.a.s.l.) dominated by slate outcrops (García Rayego, 1997a, Serrano Patón y Becerra Ramirez, 2017). The Guadiana River runs from southeast to northwest along one of these depressions, occasionally interrupted by some meanders. On the slopes, abundant colluvial deposits from the latest Pleistocene and the Holocene stand out. Between mountain ranges and river valleys, there are a number of ramps with concave profile (glacis); their upper segments are supported on the mountain slopes, while their final (lower and less pronounced) sections hang a few dozen meters above the riverbeds of the Guadiana River and its tributaries. These planation surfaces developed prior to the beginning of the Pleistocene, during a climate phase characterized by the disappearance of vegetation cover and that mobilized vast amounts of pebbles and gravels – the '*rañas*' that fossilized an old paleosurface (I.G.M.E., 1989).

The intricate and disorderly structural framework of mountain ranges, depressions, and valleys gives this territory mosaic-like characteristic made of multiple tiles with specific microclimatic conditions that are recognizable in highly varied vegetation with distinct atlantic influences. The climatic features of the area include a mean annual temperature of 15–15.5°C, with a mean winter temperature of 6–7°C and a mean summer temperature of 25°C. Annual rainfall is not abundant and ranging from just below 600 mm to slightly above 700 mm (García Rayego, 1997b). The presence of water in the *bonales* practically year-round can only be explained by input from springs, unlike certain ombrotrophic British bogs with similar plant communities and species (Rodwell, 1998).

Biogeographically, the area lies within the Southwestern Mediterranean floristic province, and more specifically within the warmer Portugal-Extremadura sub-province, that encompasses the areas of Montes de Toledo, Sierra Morena, and the plains of Extremadura. This sub-province stretches too much of the Tagus and Guadiana river basins, including the Montes de Toledo and the Sierra Morena, and from Portugal through the Sierra de Relumbrar (Ciudad Real) and the depressions between these massifs. (Rivas Martinez, 2011). The predominant vegetation comprises mediterranean sclerophyllous forest (Luso- Extremadurenian mesomediterranean series), with two principal species: holm oak (*Quercus ilex subsp. ballota*), and cork oak (*Quercus suber*)[4] .The holm, forest climax, corresponds to the *Pyro bourgaeanae-Querco rotundifoliae* association of the Mesomediterranean level, and to the dry-subhumid ombroclimate. The cork oak grove corresponds to the *Poterio agrimonioidis-Quercetum suberis* association (Rivas Goday, 1959) of the Mesomediterranean level, and to subhumid-humid ombroclimate. These plant formations are distributed according to the ombrotrophic climate and slope orientation. In valley bottoms with some hydromorphism, Portuguese oak groves are also present. Along riverbanks and floodplains, *Fraxinus* sp. (ash trees)

4. Currently, both these species are showing clear symptoms of the phytosanitary disease known as «oak decline», attributed to the fungus *Phytophthora cinnamoni* Rands, that is decimating the oak forests (Corral *et al*., 2018).

and *Alnus* sp. (alder) groves with occasional birches (*Betula pendula)* can be found. There is no shortage of elements typical of oceanic climate flora. The presence of cork oaks indicates a mild climate – oceanic or moderately oceanic. The hillsides of the area were likely covered more abundantly by these plant communities in the past; currently they constitute only residual formations or even isolated tree.

The principal worth of peatlands is the wealth of flora they sustain, including hygrophilous heaths of *Erica tetralix* and communities of sphagnos. Peatland vegetation is dominated by bryophytes of the *Sphagnum* genus. The excessive growth of these peat mosses over dead moss generates small peaty mounds locally known as '*vejigas*'. Groundwater and runoff waters feed these mounds. As they grow and distance themselves from the ground, they dry out and serve as settling microhabitat for less hydrophilic communities such as grasses and rushes (Figure 2).

FIGURE 2. *VEJIGA* (PEATY MOUND) OF ABULAGAR, IN JUNE OF 2013 (LEFT) AND, MUCH DRIER, IN APRIL OF 2019 (RIGHT)

With few exceptions, the *bonales* are several hundred meters long and occupy a set of small valleys characterized by their flat bottom and a low gradient. They are fed by springs with no high but perennial flow, even during years of considerable drought (Figure 1). During winter (Figure 3A), peat streams show an anastomosing pattern with very narrow channels (width <2 m and depth <0.5 m) that flow through the hydrophilicbed of the bonales (Figure 3B). The water present within them is very acidic (pH range of 5.88–6.64), with a minimum ionic charge even during the summer months, as evidenced by its low conductivity (<100 µ). Along their banks, the most recent valley fill sediments are composed of several detrital layers: abundant pebbles and coarse gravels (up to 30 cm in length) at the base and fine gravel and sand at the top separated by a layer of peaty material (Figure 3C). These detrital sediments come from two different sources: colluvial contribution of clastic material reworked from the *rañas* and alluvial contribution lugged by the water streams at high energy stages (Figure 3D).

The area offers a natural heritage of high value (Serrano Patón and Becerra Ramirez, 2017) whose rural town corresponds to the Municipality of Puebla de Don Rodrigo. This isolated town had 1826 inhabitants in the nineteenth century and today its population is 1200 inhabitants that are distributed over a territory with low population density (2.8 inhabitants/km^2). Traditionally, activities have focused on livestock and forestry practices. From the mid-twentieth century, new ploughing carried out near the *bonales* have posed a risk for the survival of these waterlogged zones.

FIGURE 3. A) WATER STREAMS IN A *BONAL* DURING THE WINTER MONTHS. B) SCATTERED STREAMS RUNNING THROUGH THE *BONAL* BED AND COVERING ITS SURFACE. C) DETRITAL LAYERS IN *BONAL DE LOS TERREROS*. D) COARSE DETRITAL SEDIMENTS COVERING THE *BONAL* BED IN *TRAMPAL DE LOS TERREROS*. THESE ARE MOSTLY REWORKED COLLUVIAL PEBBLES AND GRAVELS, WITH SOME ALLUVIAL CONTRIBUTION LUGGED BY WATER STREAMS FROM THE VALLEY HEAD.

3. MATERIAL AND METHODS

The study of the evolution of the *bonales* during the last centuries is based on fieldwork and, above all, on the analysis of maps belonging to these centuries as well as historical documentary sources. Cartography represents «... a research and study instrument ...» of the elements, the structure, and the spatial and temporal dynamics of natural systems, especially with regards to their evolution linked to human activity» (Panareda, 1992, Maldonado *et al*., 2002; Calvo *et al*., 2011). Further with the aid of written documentary sources, cartography allows a rigorous approximation to the evolution experienced (and generated by anthropogenic activity) within the region.

Past peatlands configuration was recreated using historical maps. Prior to the end of the 19th century, cartographic documents were very schematic and simple, poor in detail and with scales that do not allow the establishment of specific characteristics of these flooded sites. This is true for maps such as the following:

- Tomás López, 1765. *Provincia de La Mancha. Donde se comprehende los Partidos de Ciudad Real, Infantes y Alcaraz*. Madrid.
- Tomás López, 1785. *Mapa Geográfico del Campo de Calatrava. Comprehende el gobierno de Almagro, las Varas de Almadén, Almodóvar del Campo, Manzanares, Daymiel y las Villas enagenadas de esta orden*, Madrid.
- Tomás López, 1800. *Mapa de la provincia de Ciudad Real*.
- Anonymous, 1805. *Apuntes para el Mapa de la Provincia de Ciudad Real*, scale 1:270,000.

- Anonymous, 1830. *Carta de la Provincia de Ciudad Real*, scale 1:350,000.
- Francisco Coello, 1865. *Mapa de la Provincia de Ciudad Real*, scale 1:200,000.
- Anonymous, 1895. *Plano de la Provincia de Ciudad Real*. Sucesores de Rivadeneyra, Madrid, scale 1: 228,000.

However, detail can be found in maps produced by the National Geographic Institute (I.G.N.) from the end of the nineteenth century onward. For this study, we have consulted the following topographic maps (scale 1:50,000 and 1:25,000): Puebla de Don Rodrigo (sheet 757) from the years 1891, 1926, 1956, 1981, 1984, and 2007; Villarta de los Montes (sheet 734) from 1891, 1954, and 2007; Herrera del Duque (sheet 756) from 1953 and 2005; El Chiquero (sheet 758) from 2007; and Abenojar (sheet 783) from the years 1888, 1954, and 2007. Other cartographic materials from the municipal archive of Puebla de Don Rodrigo were also consulted. Additionally, we analyzed aerial photography of the study area, produced by the I.G.N. from 1946, 1956, 1986 and 2019. The Plan Nacional Aerial Orthophoto (PNOA), the National Centre for Geographical Information (CNIG), the National Geographical Institute (IGN) and the Cartographic Centre of Castilla-La Mancha (JCCM), provided the cartographic base used for this study. The treatment of this cartographic source has been carried out using tools provided by the ArcGIS program in its version 10.1, which generated different shapefiles depending on the purpose of the map.

The cartography produced for this study falls into two categories:

- A comparative map (scale 1:5.000) including changes experienced in the extension and morphology by certain peat bogs (*Bonal del Abulagar, Bonal de Los Terreros, Bonal de los Jarreros and Bonal de Raña Maleta*) between 1946, 1956, 1986 and 2019[5].
- Crop map and forest map. Based on the available data on land uses of detailed topographic maps (scale 1: 50,000) for the years 1891, 1953, 1984 and 2007, two shapefiles were generated: one for arboreal forest cover and other for cultivated areas. Its contrast allowed reconstructing the historical spatial evolution of forests and farmland.

In addition, data from various historical sources and with different administrative origins and varied dates were analyzed. They are kept in several national and regional archives, but mainly in the municipal archive of Puebla de Don Rodrigo. With these sources, it has been possible to reconstruct the recorded temporal dynamics, as well as the different land uses developed and how they have affected the peatlands.

The convergent analysis of both historical sources -written and cartographic documentation- has allowed us to infer the activity and recent evolution in these peat sites during the previous centuries

5. From 1986 to 2019, the changes experienced in the extension and morphology of certain peatlands are not significant, see as an example, the *Bonal del Abulagar* (Figure 8). The same is observed in the uses of the territory (extension of crops and / or reduction of forest areas) since 1984. For these reasons, orthophotos of 1986 and 2019 have been selected as well as topographic maps of 1984 and 2007, giving up incorporating intermediate years .

4. RESULTS AND DISCUSSION

The evolution of the *bonales* of Puebla de Don Rodrigo, established by means of cartographic sources and aerial photographs, has clearly shown an advance of the deforestation as well as the crop fields, reaching the margins of these peatlands. To follow this evolution, a cartographic synthesis has been carried out from the mid-twentieth century to the present. The temporal sequence of several topographic maps (scale 1: 50,000), from 1891 to 2007, shows a substantial variation in the landscape after 1953. Specifically, in the last 100 years, we can distinguish two distinct periods characterized by antagonistic morphogenetic scenarios in petlands edges:

A first period, in which plant cover (with greater or lesser degradation) dominated the landscape and stabilized the perimeter of these peatlands, with variable effectiveness depending on their state of conservation. This period lasted until the years 1950–1956 (Figures 4 and 5).

A second period, where the main features were deforestation and the agricultural intensification of large areas around the peatlands (Figures 6 and 7).

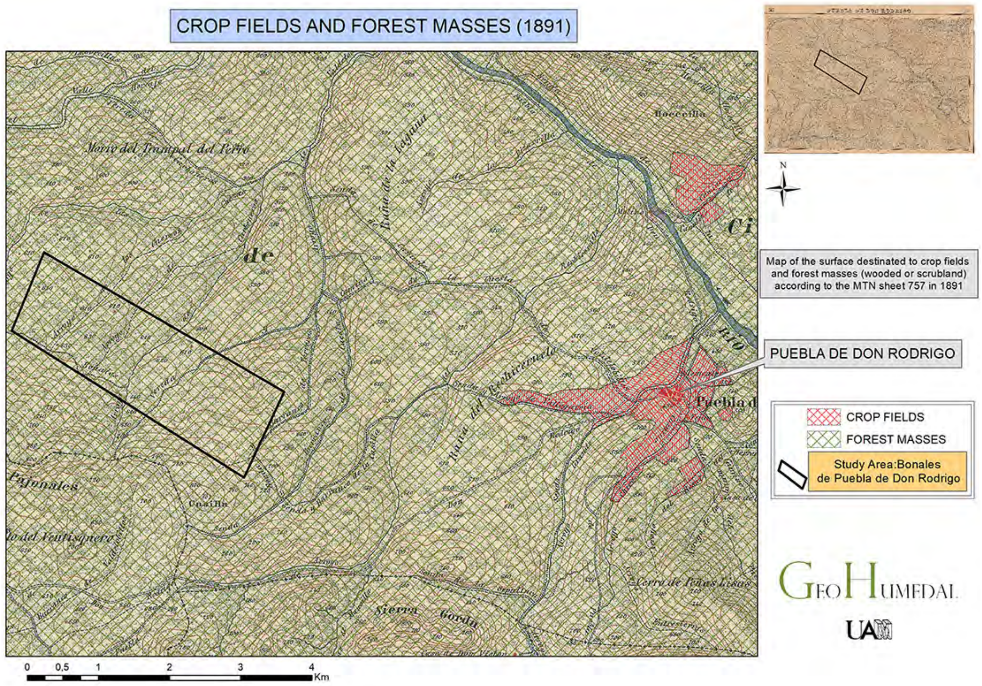


FIGURE 4. TOPOGRAPHIC MAP FROM 1891 SHOWING THE SURROUNDING AREA OF THE *BONALES* COVERED BY VEGETATION, GENERALLY OAK SCRUBLANDS

Aerial photography clearly reveals the process that had taken place. The transformation of the rural landscape has been significant since the mid-1950s, as previously noted. In this case, we consider four *bonales* within the *Bonales* Micro-Reserve: *Abulagar, Raña Maleta, Terreros, and Jareros.*

In the *Bonal del Abulagar* **(Figure 8),** we identified a perimeter area that was larger in the aerial photograph of 1946. However, in 1956, a sharp decrease of this area in its western sector is noted, with a net limit formed by a straight and clearly anthropic line.

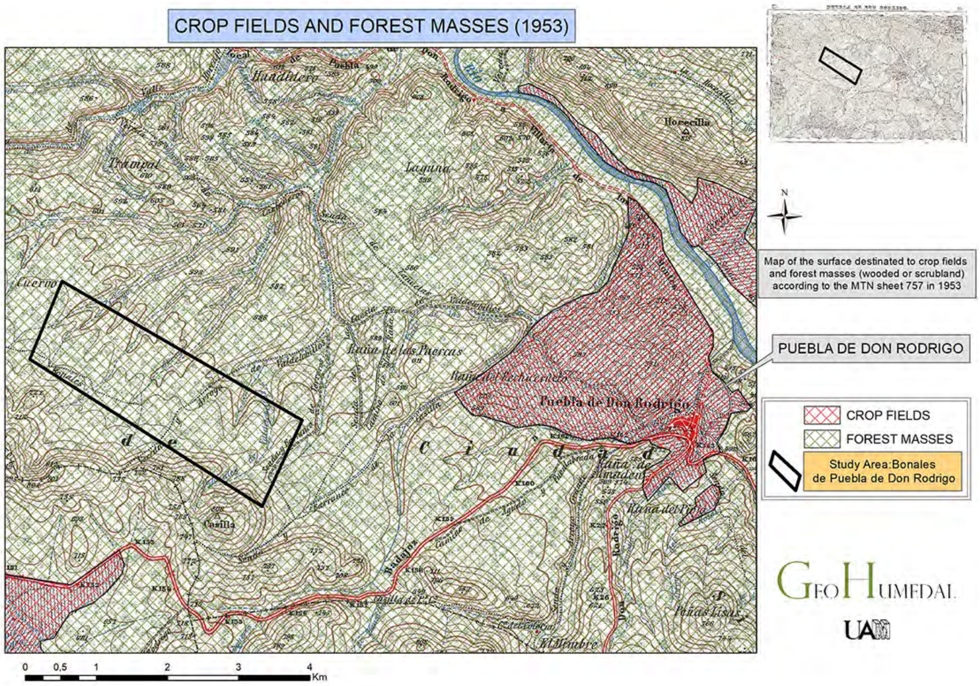


Figure 5. In 1953, forestland surrounds the urban centre of Puebla de Don Rodrigo, reaching *the Raña del Rechiceruelo.* To the south, the advance of crop fields is noticeable

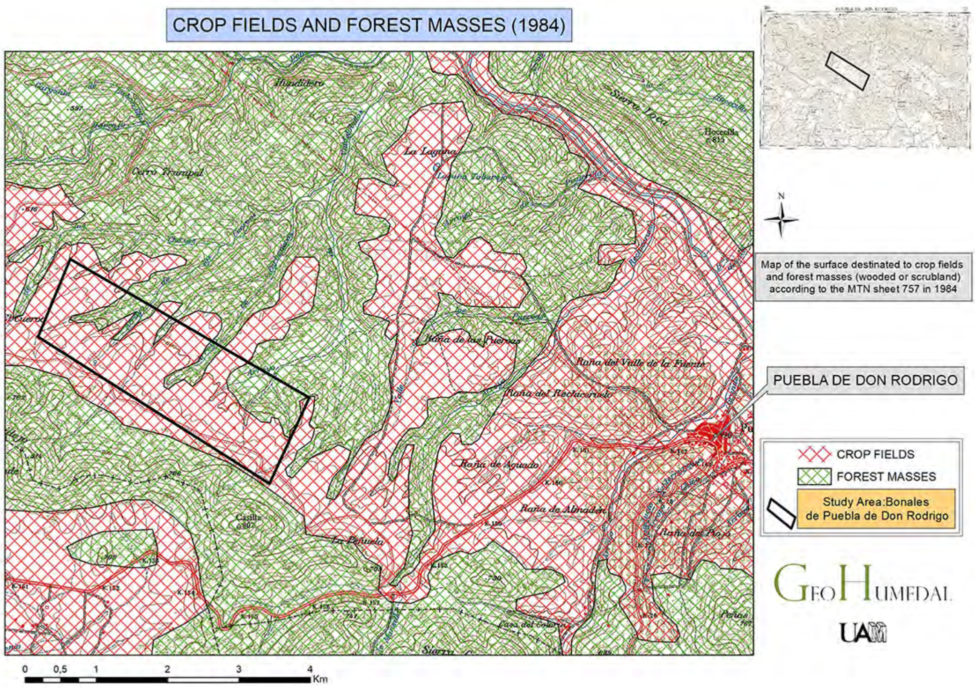


Figure 6. In this topographic map of 1984, it is clear how the lands surrounding the streams that house the *bonales* have been transformed into crop fields extending to the edge of the peat bogs. All plain surfaces of *rañas* were dedicated to cereal crops

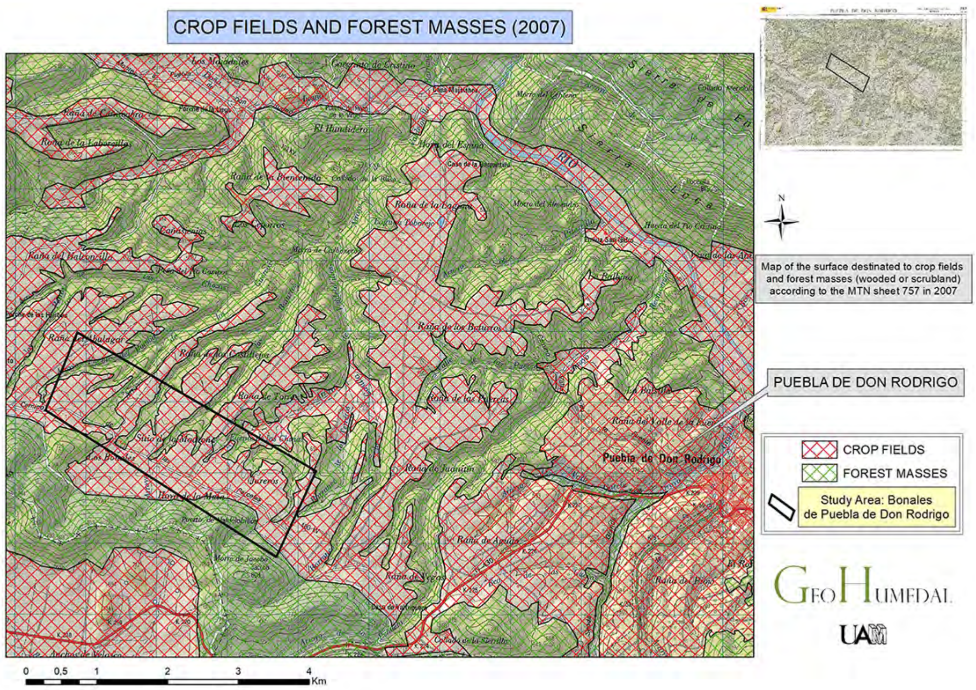


FIGURE 7. IN 2007, THE ADVANCE OF CROP FIELDS IS WIDESPREAD. IN ADDITION, THE TOPONYM *VEREDA DE LOS BONALES* HAS CHANGED TO *CAMINO DE LAS PARCELAS* (PATH OF THE PLOTS), SUGGESTING THE DEGRADATION OF THESE WATERLOGGED AREAS

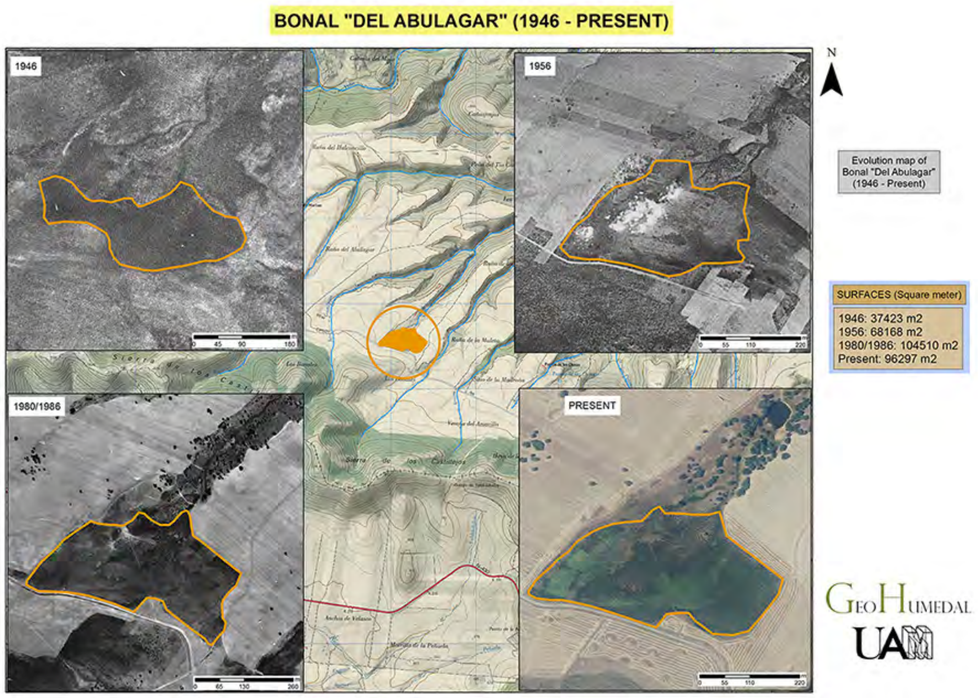


FIGURE 8. AERIAL PHOTOGRAPHY OF THE ***BONAL DEL ABULAGAR***, FROM 1946 TO PRESENT DAY, SHOWING THE SPATIAL EVOLUTION RECORDED DURING THIS PERIOD

This epoch reflects a critical situation, since the previous waterlogged surfaces of the valley botton are now completely dry. The situation improves in the 1980s (during that decade, the surface area of all the *bonales* expands). The current photograph shows a well-defined flow and a progressive advance of the crop fields. It is worth noting that in the last aerial image (1980/86), the darker colors (evidence of waterlogging) are limited to the vicinity of the riverbed, while in the surroundings the color is noticeably lighter. The fieldwork confirmed this fact, as well as the advance of the rockrose that borders the peaty mound in this *bonal,* known as «*Observatorio*» (Figure 9).

FIGURE 9. THE ROCK ROSE IN THE SURROUNDING THE PEATY MOUND OF BONAL DEL ABULAGAR (OBSERVATORIO). AT THE FAR LEFT, A *QUERCUS* AFFECTED BY «OAK-DECLINE» CAN BE SEEN

In both the *Bonal de los Terreros* (Figure 10) and the *Bonal de los Jareros*, the evolution is similar to that of the *Bonal del Abulagar*. In 1956, the boundaries of both *bonales* have net borders that are lineal and clearly anthropogenic in origin, in comparison to those recorded in 1946. The present-day situation shows a sharp and clear decrease of the surface occupied by the *bonales,* especially in the case of the *Bonal de los Terreros* (Figure 10).

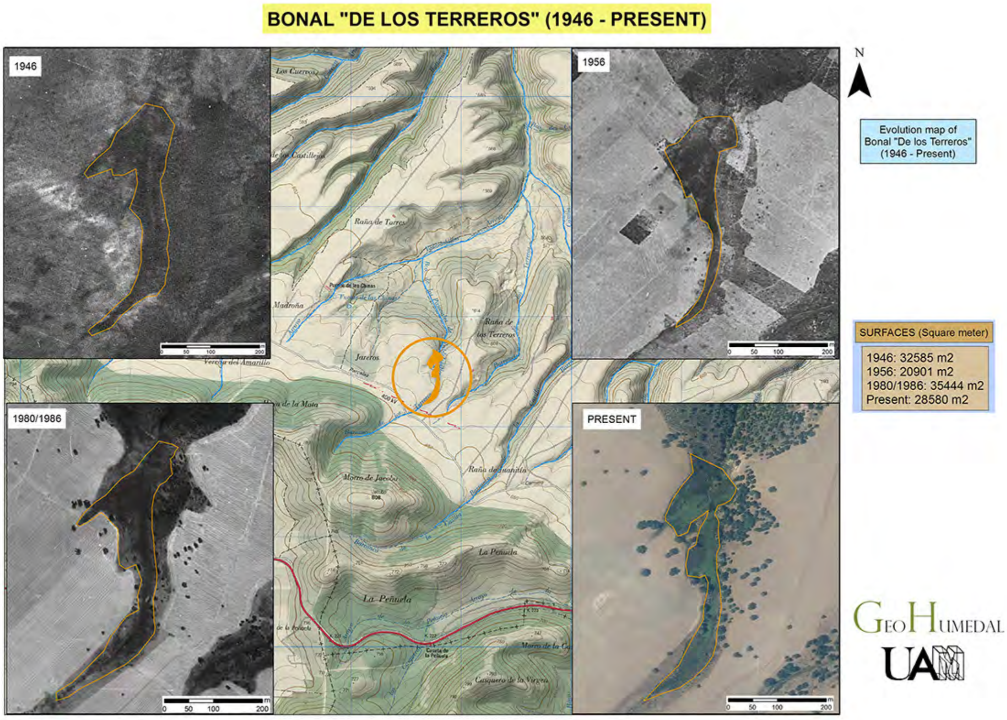
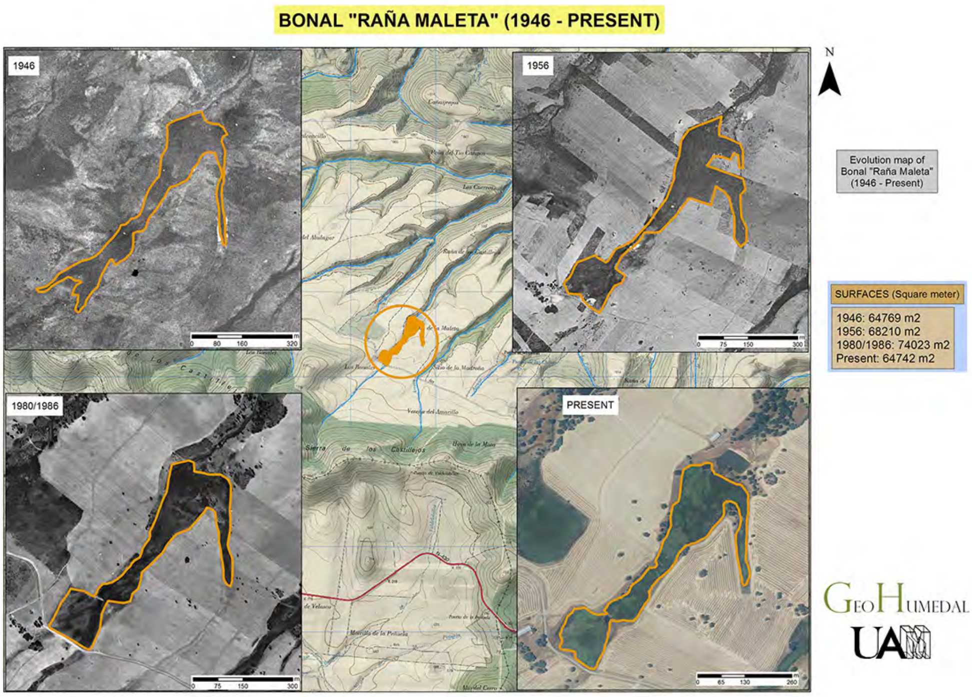


FIGURE 10. EVOLUTION OF THE *BONAL DE LOS TERREROS*, FROM 1946 TO PRESENT DAY



FIGURES 11 AND 12. *BONAL DE RAÑA MALETA*. EVOLUTION AND DETAILS OF THE EXISTING WATER RESERVOIR THAT DEPLETES WATER RESOURCES FROM THE *BONAL*. *HTTPS://SATELLITES.PRO/MAPA_DE_ESPANA#39.103523,-4.711418,13*

The *Bonal* de Raña Maleta (Figure 11) constitutes a key site of anthropogenic evolution. Comparison between the situation in 1946 and in 1956 shows a large advance in crop fields that were not initially present. In 1956, the limits of the bonal are perfectly outlined by these fields. In the last image (nowadays), a small water reservoir appears, linked to water resource management (Infante and Heras, 2012).

The evolution experienced is not reflected in the greater or lesser area occupied by the peat, but in the changes generated in the flooded areas, which are today fully controlled by the crop fields that delimit them. Recently, anthropogenic activity has been remarkable in the case of Bonal de Raña Maleta, where the presence of a small dam has caused a retention of the watercourse and an environmental modification in the flooded ecosystem (Figure 12).

In relation to the anthropic uses of the environment, the consultation of the textual documentary sources of the municipal archive has been of enormous importance. It is established how the economy of the municipality is based and has been over time, in livestock and essentially in agriculture, to which we must add the hunting activities.

Documentary sources show that several anthropogenic processes have taken place and continue to alter the landscape around the peatlands. These include:

a. Deforestation processes: in the 1950s, the study area showed a remarkable deforestation from prior centuries (Fidalgo *et al*., 2018). There are numerous data attesting to this lack of forest cover. In a request demanding[6] the possibility of carrying out a afforestation in the northern area of *Mount Valles del Término,* some 1900 ha are described as «lacking forest cover», and other 50 ha were listed as» degenerated *Quercus* mass «. In another document dated March of 1962, it asserted that the plant species located in *Mount Valles del Término* include, in descending order of abundance: rock rose (*Cistus* sp.), heather (*Erica* sp.), mastic (*Pistacia lentiscus*), narrow-leaved mock privet (*Phillyrea angustifolia*), rosemary (*Rosmarinus officinalis*), gall oak (*Quercus faginea*), holm oak (*Quercus ballota*), ash tree (*Fraxinus* sp.) and cork oak (*Quercus suber*). The dominant tree is the gall oak that grows in some ravines.

In a later municipal document (1965)[7], it was stated that at present, paid for by the state budget, work have been carried out consisting of clearing over 100 ha and the rest of the surface of this Mount remaining fully covered by various plant species forming the so-called low mount. That year, the local Puebla de Don Rodrigo government was given received permission to grub up 30.000 kg of heather strains from *Mount Valles del Término*, increasing the degradation of its territory.

b. Progress of plowing and drainage actions. The documents examined include many demands (for example, in 1957) to plow and to cultivate land in areas of *rañas* without vegetation cover and belonging to the local government. These fields were declared as lacking plant cover. The authorization for these activities in the plains

6. *Documento de Solicitud de Consorcio entre el Patrimonio Forestal del Estado y el Ayuntamiento de Puebla de Don Rodrigo (1957)*. Municipal Archive of Puebla de Don Rodrigo (File box 99).

7. Municipal Archive of Puebla de Don Rodrigo: File box 99 «actualmente con cargo a los Presupuestos de Estado se han realizado trabajos de roza y descuaje en 1000 has, quedando el resto del monte totalmente cubierto por distintas especies vegetales de las que constituyen el llamado monte bajo»

of *raña* entailed the obligation to establish an elementary drainage system: «with trenches 30 cm wide by 30 cm deep and a longitudinal profile of 1.5 to 2% ... to drain the waters in the upper segments of the slopes and thus prevent erosion at the edges of the *rañas*».

In another document (nº 6171), also from 1957[8], permission was requested to «continue farming activities in 366 ha of land ... the patches in question are located in areas called *Raña del Madroñal, Raña del Alconcillo and Raña del Abulagar.*» It is stated that these fields are not covered by vegetation and are suitable for crop farming». It is important to point out that, by the end 1950s, the lands in the area known as *Raña del Abulagar* lacked plant cover.The lands of the *Dehesa Boyal* were used illegally for agriculture (October 30, 1956), generating a lawsuit that was the origin of abundant documentation[9]

In 1965 «... near these parceled lands, the local government annually provided land to plow in cleared zones in previous years, at very low prices, since the tillage of these fields is very beneficial, as it prevents it from growing again».

All the modifications were described in the documents consulted and were inherent in the increase of the ploughings intended to cultivate the fields and prevent the vegetation from growing back in them. Among these impacts, the following stand out: the removal of the vegetation cover that persisted, the construction of drains, the stacking of stones (called *majano*) at the edges of the *bonales*, etc.

As of July 7, 1967, the agricultural use of 727 ha from *Mount Valles del Término* (number 16 in the Catalogue of State-Owned/Public Woodlands classified as public utility) is extended in time[10].

c. Livestock use. A third aspect relates to livestock and the vast extension of pasturelands belonging to the municipality. Those grasslands partly coincided with land occupied by the bonales, while the plains known as *rañas* were destined for crops. In the report presented by the local government on December 21, 1965, with regards to the situation derived from the existence of two big game hunting reserves in the mountains belonging to the local government, it is stated that a large area of *Mount Valles del Término*, where the *bonales* are located, «... is dedicated to cattle and sheep, under prior auction that always gives preference to local residents of this valley». The number of head of cattle grazing in the zone was considerable (Fidalgo *et al*., 2018).

d. Finally, the impact generated by the big game hunting. The existence of two two hunting reserves in the *Mount Valles del Término* has long posed difficulties and disputes with the farmers. On April 10, 1957, the Ciudad Real Forest District Authority agreed to authorize land clearing to hunt «as in previous years» on this *Mount.*

According to the report mentioned by the local government on December 21, 1965, «... in the area of the mountain, and distributed in two separate areas, there are

8. «continuar el cultivo agrícola de 366 has de terreno...las parcelas cuya continuación se pretende se hallan situadas en los lugares denominados Raña del Madroñal, Raña del Alconcillo y Raña del Abulagar...no están cubiertos de vegetación siendo aptos para el cultivo agrícola».

9. Municipal Archive of Puebla de Don Rodrigo (File box 99)

10. Municipal Archive of Puebla de Don Rodrigo (File box 99).

two reserves for hunting deer and wild boars». In this document, there is mention of the existence of a conflict that, later, would motivate the abandonment of the fields in *Valles del Termino* and derived from the damages caused by the cattle. The local government requested the closure of these reserves to dedicate the upper areas to livestock, while the lower areas would be used for crop fields.

On March 8, 1968[11], a budget is prepared for a construction work on a metal fence designed to reduce the damage caused by big game. The fence would have a perimeter of 5 km in length of 5,000 m and would protect a cultivated area of 200 ha from possible harm to the hunting reserve of the *Sierra de Bueyes*.

All these activities have had a logical effect on the peatland habitats, as well as on the entire hydrographical basin where they are located.

In peatland areas, the water factor is one of the natural components most modified by anthropogenic actions and, among them, those dedicated to the cultivation of new lands. This is suggested by the spatial and temporal distribution of water flows, before with perennial streams but currently appear as discontinuous streams (Figure 13). In a written source, in March 1962, and with respect to a proposal from the local government for the improvement of the pastures of Puebla de Don Rodrigo, it is mentioned how in the *Monte Valles del Termino* «...the most important ravines, the *Valdelobillos* stream, *Doña Juana* or *Espinar* stream, and *Vallehorcajo* stream are the only ones with continuous water flow».

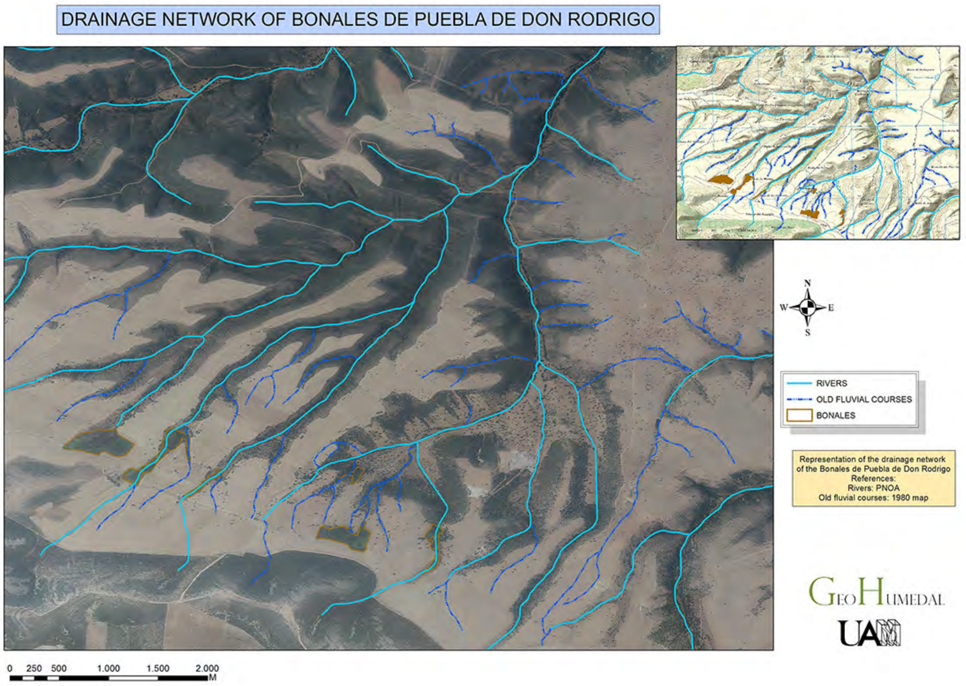


FIGURE 13. SOME WATER STREAMS HAVE DISAPPEARED BECAUSE OF THE DRAINAGE WORKS AND VEGETATION CLEARING OF LANDS DESTINED MAINLY FOR FURTHER CROPS

11. Municipal Archive of Puebla de Don Rodrigo (File box 136).

The landscape transformation was controlled by changes in the geomorphological behavior of the processes that had been functional until that time. The deforestation of the vegetation covers motivated that the colluvial materials of the slopes were transported by surface runoff to the valley bottoms. The efficacy of this process was favoured by the considerable availability of loose detrital material offered by the *rañas* that surround the *bonales*. The arrival of these sediments at valley bottoms had several effects on them by modifying their hydrological conditions:

a. they affected the drainage by decreasing the speed of river flows;
b. they modified their anastomosed pattern, increasing both the number of small channels and the the sinuosity of their paths.
c. the longitudinal profiles of the fluvial beds also decreased, due to the inability to transport all detritic material downstream. The convergence of these phenomena favored the initial waterlogging at the valley bottoms and the colonization of sphagnum with permanent hydromorphism, greatly favored by the impermeable conditions of paleozoic bedrock.

In summary, the peatluands of the study area, as well as those of the Montes de Toledo in general, were formed by «terrestrialization in waterlogged areas» (García-Río 2001, Martín-Herrero *et al*., 2003, López-Sáez *et al*., 2014/2015).

5. CONCLUSIONS

The essential conclusion of this study is that the *bonales* of the Micro Reserve of Puebla de Don Rodrigo are the result of a long process of evolution of the landscape that, in the last 50-70 years, has registered numerous impacts. This evolutionary process of decline is clearly depicted in aerial photographs and cartographic data. Meanwhile, written documentation specifically establishes the genesis of the impacts recorded in this environment. Three factors have most influenced the development of these peatlands: the time of permanence of water on the soil surface, topography and inadequate human management. About the latter, agricultural activities have been widely developed in areas occupied by hydrophilic vegetation and crops have frequently occupied the edges of the *bonales.* Nor is it uncommon for *bonales* to be used, in part or in full, for vegetable gardens, dry farming, or planting of non-native species such as pine trees, poplars, etc. Linked to these anthropic activities can also highlight the construction of infrastructures: firewalls, roads, roads that allow access to crop fields, water tanks, drains, water channels and others.

Intensive grazing has generated substantial damage: (i) Under these conditions, the ground hardens so much that it hinders the regeneration and expansion capacity of numerous plant species, typical of the *bonales*. (ii) The processes of putrefaction of organic matter slow down or stop. (iii) Water storage capacity decreases and evaporation water loss increases. (iv) The increase of nutrients in soil and water. (v) The peripheral vegetation fringes lose their protective capacity. (vi) Concomitantly, the presence of nitrophilic species (toxic and unappealing to herbivores) is increased while the rockrose expands.

Similar processes are linked to hunting activities.

All these impacts identified since the mid-twentieth century are still ongoing. The construction of ponds or small water tanks poses an obstacle to river streams. Also notable is the construction of drainage or water extraction systems to feed canals, such as those located in the surroundings of the *Observatorio* mound in the *Bonal del Abulagar*

Given the great sensitivity of peatland ecosystems to any type of impact, these modifications may jeopardize their conservation and survival. Presently, and following a dry winter such as 2019 has been, the *bonales* appear much deteriorated with a surrounding vegetation starring scrubs where Ericaceae vegetation has been replaced, in some zones, by rockrose, thus indicating a high degree of xericity.

A good state of conservation of the *bonales* is incompatible with the activities of artificial drainage of waterlogged sites or high intensity livestock activity. Furthermore, here should be a decrease in crop fields on their margins and a demanding control of fertilizers.

BIBLIOGRAPHY

Abad, M., Muñoz, A.F., González-Regalado, M.L., Ruiz, F., Rodríguez-Vidal, J., Cáceres, L.M., ... Romero, V. (2019). Evolución paleoambiental de una turbera finiholocena en el sector suroccidental del Parque Nacional de Doñana (S.O. España). *Estudios Geológicos*, 75(1), p. e087. Retrieved from https://doi.org/10.3989/egeol.43417.514.

Alcázar González, A. and Azcarate Luxán, M. (1998). Aproximación a la toponimia del repertorio de caminos de Guadalajara*, Actas del IV Congreso de Caminería Hispánica I*, pp. 223-242.

Calvo Iglesias, M.S., Méndez Martínez, G. and Díaz Varela, R. (2011). Los paisajes culturales de agras en Galicia y su dinámica evolutiva. *Ager*. *Revista de Estudios sobre Despoblación y Desarrollo Rural*, 10, pp. 7-38.

Centro Nacional de Información Geográfica (CNIG). Retrieved april 24, 2019, from http://centrodedescargas.cnig.es/CentroDescargas/index.jsp#.

Corral Ribera, M., Fidalgo Hijano, C. and Peco Vázquez, B. (2018). Environmental variables in the distribution of la seca disease in the holm oak (*Quercus ilex* subsp. *ballota*). *Espacio, Tiempo y Forma, serie VI Geografía*, 11, pp. 107-120.

De Miguel, E. (2006). *Manuales de Desarrollo Sostenible 2. Conservación y restauración de turbera*. Fundación Santander Central-Hispano, p. 57.

Fidalgo Hijano, C., González Martín, J. A., García Giménez, R. and Arteaga Cardineau, C. (2013). *Estudio Paleobotánico, Paleogeográfico dinámica y amenazas de la Microrreserva de los Bonales en el término municipal de Puebla de Don Rodrigo,* Informe/contrato de investigación, Junta de Comunidades de Castilla La Mancha (unpublished).

Fidalgo Hijano, C., González Martín, J. A., García Giménez, R., Arteaga Cardineau, C. and Colmenarejo M.ªL. (2018). Turberas y deforestación. La evolución del paisaje a través de las fuentes documentales (Bonales de Puebla de Don Rodrigo, Ciudad Real). *Anales de Geografía de la Universidad Complutense,* 38 (1), pp. 11-34.

Florín Beltrán, M. (2012). Los bonales de Montes Norte: máquina del tiempo y puerta a otro mundo. In (pp. 111-) Gosálvez Rey, R.U. (ed.) *Montes Norte. Patrimonio natural y divulgación ambiental de un territorio singular*. Ciudad Real: Asociación de Desarrollo Montes Norte.

Franco Múgica, F., García Antón, M., Maldonado Ruiz, J., Morla Juaristi, C. and Sainz Ollero, H. (2001). Evolución de la vegetación en el sector septentrional del Macizo de Ayllón (Sistema Central). Análisis polínico de la turbera de Pelagallinas. *Anales Jardín Botánico de Madrid*, 59(1), pp. 113-124.

García Rayego J.L. (1997a). El Medio Natural y sus unidades en el Sur de la Meseta Meridional. In García Rayego, J.L. and González Cárdenas, E. (eds.), in *Elementos del Medio Natural en la Provincia de Ciudad Real* (pp. 11-19). Cuenca: Colección Estudios. Ediciones de la Universidad de Castilla La Mancha.

García Rayego, J.L. (1997b). El Medio Físico de Los Montes, in García Rayego, J.L. and González Cárdenas, E. (Eds.). *Elementos del Medio Natural en la Provincia de Ciudad Real* (pp. 21-81). Colección Estudios. Cuenca: Colección Estudios. Ediciones de la Universidad de Castilla La Mancha.

García Río, R. (2000). *Caracterización Florística y Ecológica de los Bonales de Ciudad Real y Planes Para su Conservación como Microrreservas de Flora Amenazada*. Ciudad Real: Junta de Comunidades de Castilla-La Mancha.

García Río, R. (2001). Una ojeada a los bonales de Montes Norte (Ciudad Real). *Medio Ambiente Castilla-La Mancha,* 6, pp. 10–15.

García Río, R. (2002). Flora protegida regional existente en las turberas de Ciudad Real. *Conservación Vegetal*, 7, p. 8.

García Río, R. (2007). Flora y vegetación de interés conservacionista de Sierra Madrona y su entorno (Ciudad Real, Sierra Morena, Spain). *Ecosistemas* 16(1), pp. 97-111.

González Bernáldez, F. (1992). *Los paisajes del agua. Terminología popular de los humedales*. Madrid: Ed. Reyero.

González-Sampériz, P., García-Ruiz, J.M., Valero-Garcés, B. and Martí-Bono, C. (2004). La Turbera de El Portalet y su significado en la deglaciación del Pirineo, in Peña, J.L., Longares, L.A. and Sánchez, M. (eds.). *Geografía Física de Aragón. Aspectos generales y temáticos* (pp. 85-94). Zaragoza: Universidad de Zaragoza e Institución Fernando el Católico, Instituto Pirenáico de Ecología, CSIC, Campus de Aula Dei.

Hernandez Bermejo, J.E. y Herranz Sanz, J.M.ª (eds) (2011). Protección de la diversidad vegetal y de los recursos fitogenéticos de Castilla La Mancha. Inst. de Estudios Albacetenses *Serie I, Estudios,* 197.

Infante, M. and Heras, P. (2012). Red Preliminar de áreas importantes para los Briófitos. IBRA 35: Raña Maleta. In Garilleti, R. and Albertos, B. (coord.) *Atlas y Libro Rojo de los Briófitos Amenazados de España*. Madrid: Organismo Autónomo Parques Nacionales.

ITGE (1989). *Mapa Geológico de España 1/50.000 Hoja 757. Puebla de Don Rodrigo*.

Ley 9/1999, de 26 de mayo, de Conservación de la Naturaleza. Published in: «DOCM» núm. 40, de 12/06/1999, «BOE» núm. 179, de 28/07/1999. Referencia: BOE-A-1999-16378. Comunidad Autónoma de Castilla-La Mancha (1999).

López Buendía, A.M., Bastida, J., Querol, X. and Fernández Turiel, J.L. (1995). Geoquímica comparada de depósitos de turberas altas (tremedales de los Montes Universales, Teruel) y de turberas bajas (Marjales de la depresión Valencia-Castellón). *Cuadernos Laboratorio Xeológico de Laxe,* 20, pp. 99-116.

López-Merino, L., López-Sáez. J.A. and López García, P. (2006). Estudio palinológico de la turbera litoral holocena de Las Dueñas (Cudillero, Asturias, España). *Revista Española de Micropaleontología* 38(2-3), pp. 299-308.

López Sáez J. A., García Río F., Alba Sanchez E., García Gómez E. and Pérez Diaz, S. (2014). Peatlands in the Toledo Mountains (Central Spain)». *Mires and Peat*, 15(04), pp. 1–23. Retrieved from http://www.mires-and-peat.net.

Luelmo Lautenschlaeger R., Pérez-Díaz, S., Alba-Sánchez F., Abel-Schaad, D. and López-Sáez J. A. (2018). Vegetation History in the Toledo Mountains (Central Iberia): Human Impact during the Last 1300 Years. *Sustainability*, 10(7), pp. 25-75.

Maldonado Ruiz, J., Benito Garzón, M., Sánchez Dios, R., and Sainz Ollero, H. (2002). Evolución reciente de las áreas de los bosques esclerófilos ibéricos. Cambios deducidos a partir de la cartografía forestal. In (pp. 217-236) Charco García, J. (aut.) *La regeneración natural del bosque mediterráneo en la Península Ibérica: Evaluación de problemas y propuesta de soluciones*.

Martín-Herrero, J., Frontaura, M.C. and Plaza, M. (2003). Bonales, bohonales o trampales. Humedales poco conocidos. *Medio Ambiente Castilla-La Mancha*, 11, pp. 4-13.

Martínez Cortizas, A., Pontevedra Pombal, X., Novóa Muñoz, J.C. and García-Rodeja, E. (2000). Turberas de montaña del Noroeste de la Península Ibérica, *Edafología*, 7(1), pp. 1-29.

Martínez, A., Pontevedra Z., Nóvoa, J. C., Rodríguez, R., López, J. A., Ferrín, C., Ferro, C., Costa, M. and Rodríguez, J. (2009). 7110 Turberas elevadas activas, in VV.AA., *Bases* *ecológicas preliminares para la conservación de los tipos de hábitat de interés comunitario en España.* Madrid: Dirección General de Medio Natural y Política Forestal, Ministerio de Medio Ambiente, y Medio Rural y Marino.

Martínez, A., Pontevedra, X., Nóvoa, J. C., Rodríguez, R. and López, J. A. (2009). Bases ecológicas para la gestión de turberas ácidas de esfagnos (71 Sphagnum acid bogs), in VV.AA., *Bases ecológicas preliminares para la conservación de los tipos de hábitat de interés comunitario en España.* Madrid: Dirección General de Medio Natural y Política Forestal, Ministerio de Medio Ambiente, y Medio Rural y Marino.

Ministerio de Medio Agricultura, Alimentación y Medio Ambiente (2019). *Cartografía y SIG. Visores Geográficos*. Retrieved april 24, 2019, from http://www.magrama.gob.es/es/cartografia-y-sig/visores/default.aspx.

Municipal archive of Puebla de Don Rodrigo. Various documents. 1956, 1957, 1965, 1967. File box 99.

Municipal archive of Puebla de Don Rodrigo (1968). *Construction of a defensive metal fence*. Document of March 8, 1968. File box 136.

Muñoz Jiménez, J. (1974). *Los Montes de Toledo: Estudio de Geografía Física* (Tesis doctoral, Universidad Complutense de Madrid).

Musotto, L.L. (2013). *Paleoambientes y paleoclimas del Cuaternario Tardío en turberas del centro de la Isla Grande de Tierra del Fuego en base al análisis palinológico* (Tesis Doctoral, Universidad Nacional del Sur, Argentina). Retrieved from http://repositoriodigital.uns.edu.ar/handle/123456789/3126.

Panareda Clopés J.M.ª (1992). La cartografía en la didáctica del medio ambiente. *Boletín de la A.G.E*. 12, pp. 95-110.

Plan Nacional de Observación del Territorio (2019). *Plan Nacional de Ortofotografía Aérea*. (PNOA). Retrieved april 24, 2019, from http://pnoa.ign.es/.

Pontevedra Pombal, X. and Martínez Cortizas, A. (2004). Turberas de Galicia: procesos formativos, distribución y valor medioambiental. El caso particular de las «Serras Septentrionais». *Chioglossa* 2, pp. 103-121.

Ramil-Rego, P. and Rodríguez Guitián M.A. (eds.) (2017). *Hábitats de turbera en la Red Natura 2000. Diagnosis y criterios para su conservación y gestión en la Región Biogeográfica Atlántica*. Lugo: Horreum-Ibader.

Rivas Goday, S. (1954). Islas atlánticas en pleno dominio de flora mediterránea*. Anales Real Academia Farmacia*, 20, pp. 405-412.

Rivas Goday, S. & col. (1959). Contribución al estudio de la *Quercetea ilicis* hispánica. *Anales del Instituto Botánico Cavanilles*, 17(2), pp. 285-406.

Rivas-Martínez, S. (2011). Mapa de series, geoseries y geopermaseries de vegetación de España). *Itinera Geobotanica* 18(2), pp. 425-800.

Rodwell, John. S. (Editor) (1998). *British Plant Communities. Volume 2. Mires and heaths*. Cambridge University Press.

Serrano Patón, M. and Becerra Ramírez, R. (2017). Valoración del Patrimonio Geomorfológico y la Geovidersidad en el Municipio de Puebla de Don Rodrigo, in *Patrimonio geológico, gestionando la parte abiótica del Patrimonio Natural* (pp. 95-101). Carcavilla, L., Duque Macias, J., Giménez, J., Hilario, A., Monge, M., Vegas, J. and Rodriguez, A. (Eds). *Cuadernos del Museo Geo-Minero*, 21.

Tanneberger, F., Tegetmeyer C., Busse, S., Barthelmes, A., Shumka, S., Moles Mariné, A.,... Joosten, H. (2017). The peatland map of Europe. *Mires and Peat,* 19, pp. 1-17.

Torres Pérez-Hidalgo, T.J. (2003). Interpretación paleoecológica y paleoclimática del tramo superior de la turbera de Padul (Granada, España), *Polen* 13, pp. 85-95.

AÑO 2020
ISSN: 1130-2968
E-ISSN 2340-146X
13

ESPACIO, TIEMPO Y FORMA

SERIE VI GEOGRAFÍA
REVISTA DE LA FACULTAD DE GEOGRAFÍA E HISTORIA

UNED

ISSN 1130-2968
13
9 771130 296007