RGSA – Revista de Gestão Social e Ambiental
ISSN: 1981-982X
Submission date: 08/01/2024
Acceptance date: 10/04/2024
DOI: https://doi.org/10.24857/rgsa.v18n11-038
Organization: Interinstitutional Scientific Committee
Chief Editor: Ana Carolina Messias de Souza Ferreira da Costa
Assessment: Double Blind Review pelo SEER/OJS

DEPOPULATION AND CHANGES IN HABITAT TYPE IN RURAL AREAS IN ARAGÓN (SPAIN)

Samuel Esteban Rodríguez[1]
Liu Zhaoyang[2]
María Zúñiga Antón[3]

ABSTRACT

Objective: The study aims to examine recent transformations in rural habitats undergoing depopulation in Aragón, Spain, between 2010 and 2018. It seeks to verify changes in habitat concentration patterns and identify the underlying factors.

Theoretical Framework: Drawing upon theories of rural exodus and demographic shifts, the research employs the Colas Index (Colas, 1945) to analyze habitat types—dispersed or concentrated. It recognizes the influence of agricultural changes, service provision challenges, and territorial dynamics on rural settlement patterns (Escolano and de la Riva, 2003; Nuninger *et al*., 2021).

Method: The investigation focuses on depopulated municipalities in Aragón, utilizing a comparative analysis of the Colas Index from 2010 to 2018. Administrative boundaries define the study's territorial units, enabling the quantification of habitat changes and an assessment of their direction. The analysis integrates demographic and settlement dynamics to understand habitat evolution.

Results and Discussion: Findings indicate varied habitat transformation processes across municipalities, confirming the heterogeneity of the rural landscape (Pinilla and Sáez, 2017). While transformations are not universal, they challenge the traditional link between depopulation and habitat concentration. The Colas Index proves valuable for characterizing habitat dispersion levels, yet its limitations in concentrated areas are acknowledged. Methodological constraints related to administrative boundaries and the complexity of rural-urban continua are also discussed.

Research Implications: This study contributes to a nuanced understanding of depopulation impacts on rural habitats, informing territorial planning and demographic policies. It underscores the need for tailored strategies that consider local habitat variability and the potential for revitalization efforts in select areas.

Originality/Value: By highlighting the diversity of habitat transitions amidst depopulation, the research offers fresh insights into rural settlement dynamics. Its value lies in demonstrating that depopulation no longer universally leads to habitat concentration, thus updating the scholarly discourse on rural transformation in Spain.

Keywords: Depopulation, Habitat Transformation, Colas Index, Rural Settlements, Aragón.

[1] Universidad de Zaragoza, Ministerio de Geografía y Ordenación del Territorio, Grupo de Investigación en Ordenación del Territorio GEOT, Instituto de Ciencias Ambientales de la Universidad de Aragón IUCA. Zaragoza, Espanha. E-mail: sestebanr@unizar.es Orcid: https://orcid.org/0000-0002-5282-1930
[2] Universidad de Zaragoza, Zaragoza, Espanha. E-mail: 867767@unizar.es
Orcid: https://orcid.org/0009-0005-2387-3773
[3] Universidad de Zaragoza, España, Instituto Universitario de Ciencias Ambientales (IUCA), Grupo de Estudios en Ordenación del Territorio (GEOT). E-mail: mz@unizar.es Orcid: https://orcid.org/0000-0002-9541-5609

DESPOVOAMENTO E ALTERAÇÕES DO TIPO DE HABITAT NAS ZONAS RURAIS DE ARAGÃO (ESPANHA)

RESUMO

Objetivo: O estudo visa examinar as transformações recentes em habitats rurais em processo de despovoamento em Aragão, Espanha, entre 2010 e 2018. Procura verificar alterações nos padrões de concentração de habitats e identificar os fatores subjacentes.

Referencial Teórico: Baseando-se em teorias de êxodo rural e mudanças demográficas, a pesquisa emprega o Índice de Colas (Colas, 1945) para analisar tipos de habitat – dispersos ou concentrados. Reconhece a influência das mudanças agrícolas, dos desafios da prestação de serviços e das dinâmicas territoriais nos padrões de assentamento rural (Escolano e de la Riva, 2003; Nuninger *et al*., 2021).

Método: A investigação centra-se em municípios despovoados de Aragão, utilizando uma análise comparativa do Índice de Colas de 2010 a 2018. Os limites administrativos definem as unidades territoriais do estudo, permitindo a quantificação das alterações dos habitats e a avaliação da sua direção. A análise integra dinâmicas demográficas e de povoamento para compreender a evolução do habitat.

Resultados e Discussão: Os resultados indicam processos variados de transformação de habitat entre municípios, confirmando a heterogeneidade da paisagem rural (Pinilla e Sáez, 2017). Embora as transformações não sejam universais, desafiam a ligação tradicional entre o despovoamento e a concentração do habitat. O Índice de Colas revela-se valioso para caracterizar os níveis de dispersão do habitat, mas suas limitações em áreas concentradas são reconhecidas. Constrangimentos metodológicos relacionados às fronteiras administrativas e à complexidade da continuidade rural-urbana também são discutidos.

Implicações da Investigação: Este estudo contribui para uma compreensão matizada dos impactos do despovoamento nos habitats rurais, informando o planeamento territorial e as políticas demográficas. Sublinha a necessidade de estratégias adaptadas que considerem a variabilidade do habitat local e o potencial para esforços de revitalização em áreas selecionadas.

Originalidade/Valor: Ao destacar a diversidade de transições de habitat em meio ao despovoamento, a pesquisa oferece novas perceções sobre a dinâmica dos assentamentos rurais. O seu valor reside em demonstrar que o despovoamento já não conduz universalmente à concentração de habitats, atualizando assim o discurso académico sobre a transformação rural em Espanha.

Palavras-chave: Despovoamento, Transformação de Habitat, Índice de Colas, Assentamentos Rurais, Aragão

DESPOBLACIÓN Y CAMBIOS EN EL TIPO DE HÁBITAT EN ZONAS RURALES DE ARAGÓN (ESPAÑA)

RESUMEN

Objetivo: El estudio tiene como objetivo examinar las transformaciones recientes en hábitats rurales en despoblación en Aragón, España, entre 2010 y 2018. Su objetivo es verificar los cambios en los patrones de concentración del hábitat e identificar los factores subyacentes.

Marco teórico: Basándose en las teorías del éxodo rural y los cambios demográficos, la investigación emplea el Índice Colas (Colas, 1945) para analizar los tipos de hábitat, dispersos o concentrados. Reconoce la influencia de los cambios agrícolas, los desafíos de la prestación de servicios y las dinámicas territoriales en los patrones de asentamiento rural (Escolano y de la Riva, 2003; Nuninger *et al*., 2021).

Método: La investigación se centra en los municipios despoblados de Aragón, utilizando un análisis comparativo del Índice Colas de 2010 a 2018. Los límites administrativos definen las unidades territoriales del estudio, lo que permite cuantificar los cambios en el hábitat y evaluar su dirección. El análisis integra la dinámica demográfica y de asentamientos para comprender la evolución del hábitat.

Resultados y Discusión: Los hallazgos indican procesos variados de transformación del hábitat en los municipios, lo que confirma la heterogeneidad del paisaje rural (Pinilla y Sáez, 2017). Si bien las transformaciones no son

universales, desafían el vínculo tradicional entre la despoblación y la concentración del hábitat. El Índice Colas demuestra ser valioso para caracterizar los niveles de dispersión del hábitat, sin embargo, se reconocen sus limitaciones en áreas concentradas. También se discuten las limitaciones metodológicas relacionadas con los límites administrativos y la complejidad del continuo rural-urbano.

Implicaciones de la investigación: Este estudio contribuye a una comprensión matizada de los impactos de la despoblación en los hábitats rurales, informando la planificación territorial y las políticas demográficas. Subraya la necesidad de estrategias adaptadas que tengan en cuenta la variabilidad del hábitat local y el potencial de los esfuerzos de revitalización en determinadas zonas.

Originalidad/Valor: Al destacar la diversidad de las transiciones de hábitat en medio de la despoblación, la investigación ofrece nuevas perspectivas sobre la dinámica de los asentamientos rurales. Su valor radica en demostrar que la despoblación ya no conduce universalmente a la concentración del hábitat, actualizando así el discurso académico sobre la transformación rural en España.

Palabras clave: Despoblación, Transformación del Hábitat, Índice de Colas, Asentamientos Rurales, Aragón.

1 INTRODUCTION

1.1 THE DEPOPULATION PROCESS

Depopulation is related to a decline in population (Pinilla and Sáez, 2017) and to the abandonment of population units that, over time, have become deserted (Frutos-Mejías *et al.* 1994; Ruiz-Budría and Frutos-Mejías, 2014). In Spain, this process particularly affects rural, inland municipalities (Jurado and Pazos, 2022). This problem has been addressed extensively in academic spheres (Camarero *et al.*, 2009), and has spread to public opinion and political debates in recent years (Paniagua, 2016; García and Espe-jo, 2019); however, it is still far from being solved: 'very few rural municipalities on the Iberian Peninsula will manage to reverse their current, regressive demographic trends, with all the consequences for territorial sustainability that this involves' (Ju-rado and Pazos (2022, 81).

The speed of the changes in the way land is occupied may vary depending on the characteristics of each historical period (George, 1973). Currently, 'rural areas in Spain are undergoing a long, profound, silent revolution with unsuspected dimensions' (García and Espejo, 2019, 1). The root of the problem lies in relatively recent processes (Paniagua, 2016), such as the transition from a traditional to a more modern economy (Thompson, 2002). In Spain, the process essentially began in the 1960s, although 'the major demographic imbalances caused by the rural exodus in the second half of the last century still determine the rural population

structures to this day' (Camarero *et al.*, 2009, 167).

Clout (1976) emphasised that biological depletion after prolonged stages of rural exodus can reduce the pace of depopulation. This occurred in Spain after the period from 1950 to 1975 (Pinilla and Sáez, 2017). As a consequence, much of the country's rural areas have not only seen a reduction in their population, their demographic structure has also been substantially modified. Male rates have increased, birth rates have fallen and the population has aged noticeably (Camarero *et al.*, 2009).

At the beginning of the 21st century, territorial trends in the rural environment were heterogenous (Pinilla and Sáez, 2017). At the same time as the depopulation process was underway, there were movements from urban to rural areas, thereby generating 'new, more decentralised settlement patterns' (Arroyo, 2001, online). On occasions, this 'rural renaissance' (Thompson, 2002), led to phenomena such as the rehabilitation of abandoned villages (Marín, 2014) or the construction of new housing developments in tourist areas. All this, however, particularly affects the areas that are most attractive to the urban population (Arroyo, 2001).

1.2 THE NOTION OF HABITAT

The word habitat was 'adopted by geographers in 1928 (the Cairo Congress) to refer to the way human settlements are arranged' (George, 1991, 311); in other words, the way housing and population are distributed across the territory: when spatially grouped together, the term is concentrated habitat; otherwise, it is dispersed habitat (Aguilera *et al.*, 1991). Most dispersed localities respond to pre-industrialisation production logics and their location is consistent with subsistence agriculture (Ruiz-Budría and Frutos-Mejías, 2014). In Spain, this model was abandoned due to the changes in agri-culture, as new location logics and problems related to the supply of goods and ser-vices in the rural environment have arisen. In this sense, 'high dispersion of settle-ments and population raises the price of provision of and access to services, more so if the settlement is small' (Escolano and de la Riva, 2003, 10).

In relation to the action of settling, Puyol (1995, 74) emphasises the study of 'population settlements, taking into account their number, size and distribution within a spe-cific territory.' Therefore, habitat is a characteristic element of the territory, which, in turn—and due to its specific geographical nature—is influenced by aspects such as surfaces area (Colas, 1945) or distance between settlements (Garner,1971). Demograph-ic dynamics can be used in combination with the above-mentioned aspects to analyse the transition between different ways of settlement. (Nuninger *et al.*, 2021). In this sense, the spatio-temporal colonisation models

link changes in settlement structure with issues such as migration and natural population growth (Baños *et al.*, 2021).

1.3 HYPOTHESES AND GOALS OF THE STUDY

During the period of most intense rural exodus, a significant number of small population centres were abandoned, particularly in areas of dispersed habitat (Ruiz-Budría and Frutos Mejías, 2014). Frutos-Mejías *et al.* (1994) demonstrated that, from 1900 to 1981, the degree of population concentration in the province of Teruel had increased and that a considerable number of disperse units had disappeared; therefore, the de-population process had been capable of modifying the rural habitat.

The initial hypothesis for this study is that, despite the decrease in the rate of depopulation, the habitat continues to change. Currently, as has already been noted, some population centres in several rural areas are undergoing processes of creation and re-habilitation (Marín, 2014). At the same time, a decrease in the pace of depopulation may have curbed the disappearance of settlements and affected the population distri-bution in them. This may have lead to the reversal of the tendency towards a greater concentration of the habitat, which is associated with periods of intense rural exodus. This is the second hypothesis of the study.

To shed light on the questions raised, the study analyses recent changes (2010–2018) in the type of habitat in the municipalities undergoing depopulation in the rural areas within the Autonomous Community of Aragón (Spain)—a region where depopulation is at a stage that is both advanced (Pinilla and Sáez, 2017) and alarming (Rodríguez-Rejas and Díez-Gutiérrez, 2021). As regards the first hypothesis, and based on the Co-las Index, used by Frutos-Mejías *et al.* (1994), this study quanitifies the number of municipalities showing changes. As for the second hypothesis, the study analyses the sign of these changes. Furthermore, in order to explain these modifications, the study examines the elements of the habitat that may have influenced them, namely, the dy-namics of the settlements and their demographic dynamics. Next, the study area is defined and the methodology used is described. The results relating to the first hypoth-esis are presented first and, later, those relating to the second. Subsequently, the fac-tors that conditioned the evolution described in the previous sections are stated. The following section focuses on discussing the results and the last one summarises the main conclusions of the study.

2 THEORETICAL FRAMEWORK

2.1 CASE STUDY: RURAL MUNICIPALITIES IN ARAGÓN UNDERGOING DEPOPULATION

2.1.1 Territorial frame of reference

As suggested by Pinilla and Sáez (2017), Aragón has been historically characterised by models of extensive agriculture and a low population density; however, during the period of developmentalism, the the region was near the growth poles, which led to a massive rural exodus. At present, except for a few enclaves such as the city of Zaragoza, most municipalities in the region are part of Spain's demographic desert (Jurado and Pazos, 2022, 73), including some highly significant cases, such as the province of Teruel (García and Espejo, 2019). In relation to this problem, in 2017 Aragón passed a special directive on land planning of demographic policy and against depopulation (Government of Aragón, 2017a).

The community has traditionally been characterised by different models of land occupation, with areas of both concentrated and dispersed settlements. Some of these models are based on forms of settlement that emerged after the *Reconquista* (Ruiz-Budría, 1994). However, habitat concentration, which is associated with the rural exodus, homogenised the territory considerably (Frutos-Mejías *et al.*, 1994). One of the main factors in this loss of diversity was the disappearance of population units, as demonstrated by Ruiz-Brudía and Frutos-Mejías (2014) in their study on the '*mases*' (traditional farm or smallholding in Aragón) in the *comarca* (region) of Bajo Aragón. Nevertheless, in 2003, several areas had a high concentration of settlements despite the low population density, particularly in the north of the autonomous community and in the south of the province of Teruel (Escolano and de la Riva, 2003).

According to the data from the nomenclator, in 1940 in Aragón, there were 2,652 population units and 398,181 people living in settlements of 1,000 inhabitants or fewer; at the end of the 20th century, in 1991, only 1,543 units remained with 202,160 people living in this kind of settlement (Aragonese Statistics Institute – IAEST, 2001). In the 21st century, this figure has fallen even further, to 1,491 inhabited units in 2010 (Spanish National Statistics Institute - INE, 2010). However, as happens in other places (Thompson, 2002), there are several processes underway aimed to rehabilitate the rural environment; on occasions, these processes involve the rehabilitation of disappeared old population centres (Marín, 2014). In addition, rural

tourism has gained prominence, thereby creating new economic activities in the region's rural areas. The CAP (Common Agricultural Policy) and other public policies in support of the rural environment should also be considered (Rubio, 2010). Therefore, the present situation differs from the previous, hasty exodus in the 1980s and the depopulation process has slowed (Pinilla and Sáez, 2017). However, it has not stopped: in 2010 in Aragón a total of 392,602 people lived in municipalities with a population density below 100 inhabitants per km^2 whereas in 2018 this figure had fallen to 352,641 (INE, 2010-2018).

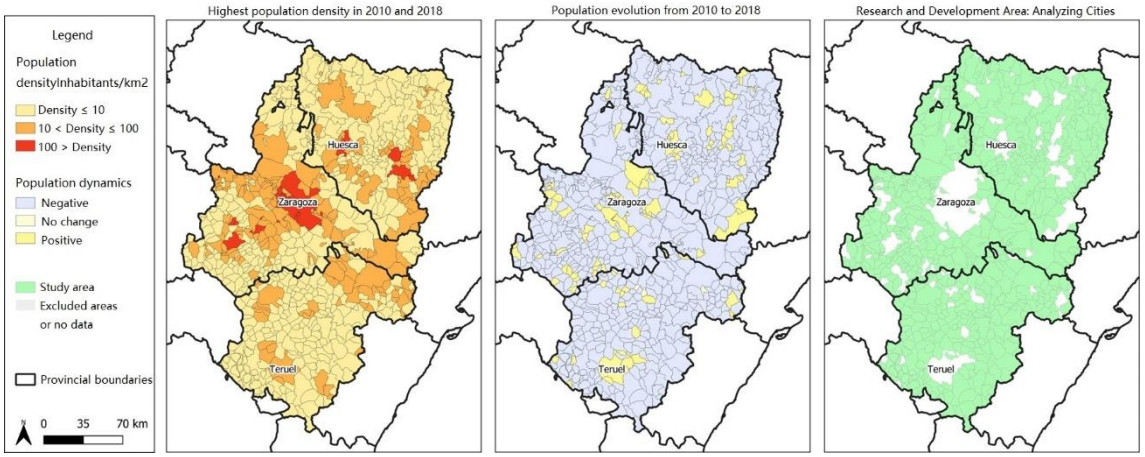
2.1.2 Delimitation of the study area

In Spain, the analysis of habitat type is frequently conducted at municipality level (del Canto *et al.*, 1988). This study analyses the rural municipalities experiencing depopulation in the Autonomous Community of Aragón (Spain).

There are several definitions for the concept of rural environment. In terms of effectiveness, the definition outlined by the Organisation for Economic Co-operation and Development (OECD) in 2006 is worth noting, as well as that described in the Spanish Law 45/2007 of 13 December, on sustainable development of the rural environment (Head of State, 2007). Both link low population density to rurality, a criterion that has been also applied in this study. A municipality is defined as rural if its population density is lower than 100 inhabitants per km^2 in any of the periods analysed. This threshold has been taken from the definition of rural area contained in Law 45/2007. Regarding demographic dynamics, municipalities are deemed to be undergoing the depopulation process if they have lost population between 2010 and 2018. In total, 619 municipalities in Aragón simultaneously meet both criteria—rurality and depopulation (Figure 1)— which represents 84.68% of the municipalities in the autonomous community and 86.17% of its surface area; in other words, most of the region's territory.

Figure 1

Area of study



Compiled by the author based on data from INE (2010 and 2018) and IGN (Spanish National Geographic Institute) (2019)
Fuente: Esteban,2022

2.2 AN INDEX VALUE OF 0 CORRESPONDS TO A CO CHARACTERISATION OF THE RURAL HABITAT: ELEMENTS STUDIED AND SOURCES

In the first half of the 20th century, several indices were formulated to characterise habitat types. In this regard, Colas (1945) and, subsequently, Chiffre (1969) systematically compiled—together with their own contributions—the main indices proposed. Among these indices, Demangeon's dispersion index (1933) and Colas' index are of particular interest. Although both can be used as the basis for developmental analysis (Frutos-Mejías *et al.*, 1994; Antunes and Esteban, 2021), this study uses the Colas Index, as it had been previously applied by Frutos-Mejías *et al.* (1994) to identify habitat changes in the province of Teruel, which is located within the study area.

The formulation [1] of the Colas Index (C) considers the surface of the area analysed (A), the number of dispersed population units (E) and the inhabitants living in dispersed population centres. The difference between the total population of the area of study (T) and the dispersed population (D) is also considered. An index value of 0 corresponds to a totally concentrated habitat and higher values indicate greater dispersion (del Canto *et al.*, 1988).

$$C = \frac{A * E}{T - D} \qquad [1]$$

The Colas Index has been calculated at municipal level, using as a basis the population units from the nomenclator (del Canto *et al*., 1988). The INE defines a singular population unit as 'any inhabitable area within the municipal boundaries—whether inhabited or, exceptionally, uninhabited—clearly differentiated within that territory, and known by a specific name that identifies it with no room for misunderstanding' (INE, 2020, online).

The units have been classified into two groups: 1) if the unit is the one with the most inhabitants in the municipality, it has been classified as the '*cabecera*' (main population centre); 2) the units that were not included in the previous group have been classified as dispersed. The source of information for units and population are nomenclators from 2010 and 2018 (INE, 2010–2018). Surface area data have been drawn from the cartographic databases at the Spanish National Geographic Institute (IGN) for administrative boundaries for 2019. Alterations in municipal boundaries are not frequent (Albet i Mas, 2019) and during the period analysed they were deemed to be constant. As regards the population on any specific date, a population unit has been considered uninhabited when its population is equal to 0 inhabitants or when it appears in one nomenclator but not in the other.

After calculating the dispersion indicators for each municipality's habitat, the analysis focuses on their evolution. Subsequently, they have been linked to the elements used in their determination. The work uses the evolution of the total population, dispersed population, population living in the *cabecera*, the ratio between the last two and also the relationship between population and surface area. This has been complemented with an analysis of the processes of creation and disappearance of units. The former is related to the appearance of new population units or inhabitation of previously uninhabited units; the latter is related to population decline.

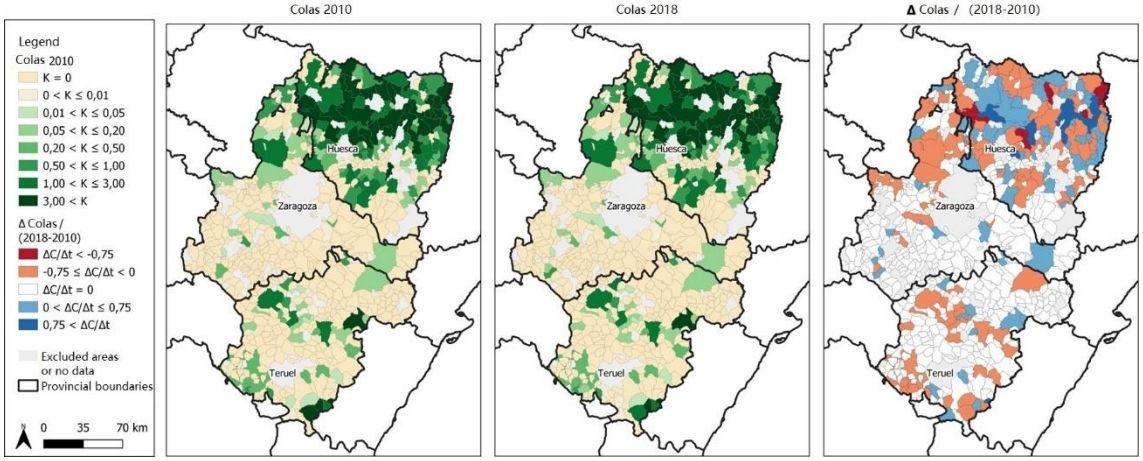
3 METHODOLOGY

3.1 HABITAT EVOLUTION IN RURAL MUNICIPALITIES UNDERGOING DEPOPULATION

In Aragón, the rural municipalities with dispersed habitats and in the process of depopulation are concentrated in the province of Huesca, in the north of the province of Zaragoza and in the centre and south of the province of Teruel. The habitat in the rest of the community is totally concentrated (Figure 2).

Figura 2

Changes in the Colas Index between 2010 and 2018



ΔC = Colas $_{2018}$ – Colas $_{2010}$; Δt = 2018 – 2010
Compiled by the author based on information from the INE (2010 and 2018) and the IGN (2019)
Fuente: Esteban,2022

The mean of the Colas Index has increased from 0.92 in 2010 to 0.94 in 2018. This figure represents a small variation, which is consistent with the fact that its distribution is very similar on both dates (Figure 3). Between 2018 and 2010, in most of the municipalities analysed, no changes in the indicators for habitat type have been observed (Table 1). The percentage of municipalities with a totally concentrated habitat is 72.5% in 2010 and 72.2% in 2018. However, it is paradoxical that, although the mean value of the index has increased slightly, the proportion of municipalities with a completely concentrated habitat has also increased. The proportion of municipalities that have not experienced any changes is 72.05%. Of the 27.95% municipalities that have experienced changes, around 16% have shown a reduction in dispersion and fewer than 12% have shown an increase. The municipalities where dispersion has increased are particularly concentrated in the province of Huesca; those with the opposite trend show a greater spatial fragmentation, although they are mainly located in the provinces of Teruel and Zaragoza.

Figure 3

Colas Index in the area of study. Histograms from 2010 and 2018.

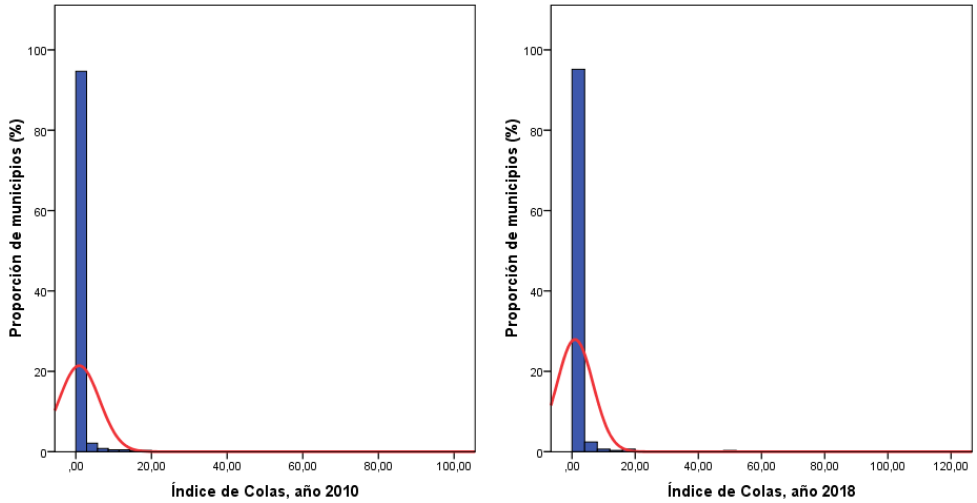


Table 1

Evolution of habitat type between 2010 and 2018.

Evolution of habitat type	Number of municipalities	Percentage
Increase in dispersion	73	11.79
No change	446	72.05
Decrease in dispersion	100	16.16
Total	619	

3.2 CHANGES IN POPULATION DISTRIBUTION

3.2.1 Population distribution according to type of settlement

Most of the variations detected in the type of habitat are linked to changes in population distribution across different types of settlement. However, in the municipalities as a whole, in line with previous observations, the ratio between dispersed and concentrated population is very similar in 2010 and 2018 (R^2 = 0.9802). Although the differences are not large, the similarity between the two dates is slightly greater in municipalities with increased dispersion (R^2 = 0.9836) than in those with increased concentration (R^2 = 0.9770).

These results are consistent with a depopulation scenario. Regarding the approach taken by the Colas Index, when the ratio and other elements remain constant, if the number of inhabitants in the territorial unit decreases, dispersion increases; in other words, as settlements lose population proportionally, the denominator of the formula decreases and the value of the index increases. Conversely, an increase in concentration is linked to an increase in the size of

the *cabecera* and, as has been noted, with modifications to population distribution that are essentially associated with a more dramatic reduction in the dispersed population than in the *cabecera*; therefore, in this case, the ratio between disperse and concentrated population shows a slightly lower correlation coefficient between both dates.

The municipal *cabecera* had an average population of 588.69 inhabitants in 2010 and 529.16 in 2018; in other words, expressed as a decimal, an annual growth of -0.013. The average number of inhabitants in the dispersed units was 42.93 in 2010 and 37.67 in 2018; this represents an annual growth of -0.015. Therefore, although the rate of growth is negative in dispersed units and in the *cabeceras*, in keeping with the current trend, a possible demographic depletion would affect the former before the latter as dispersed units are smaller in size and, furthermore, their rate of decline is slightly higher.

3.2.2 Relationship between surface area and population

As indicated above, the Colas Index sets the value as 0 if the habitat is totally concentrated. Therefore, in this type of municipalities, there is no variation in the habitat indicators, although some of the other elements involved may have varied. In this sense, in addttion to aspects relating to the size of the *cabecera*, the relationship between population and surface area may also have varied. As the latter has been deemed constant and the focus is on rural municipalities undergoing depopulation, in all of the municipalities with a totally concentrated habitat on the dates analysed, population density has decreased. As a whole, in the municipalities with a totally concentrated habitat, population has decreased from 8.63 inhabitants/km^2 in 2010 to 7.52 in 2018. This represents a growth rate of -0.016 and an increase in surface area per inhabitant of the *cabecera* of 1.11 km^2. This fact, even though the municipality has a totally concentrated habitat, implies a modification of its components and, therefore, represents changes in land occupation.

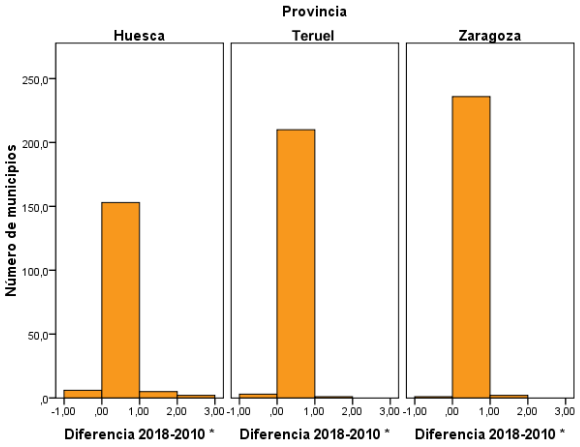
3.3 EVOLUTION OF POPULATION UNITS

Approximately half of the population units in Aragón have a dispersed nature. In 2010, they represented 51.26% of the total, and 51.34% in 2018. In the period analysed, the number of these population units has risen from 651 to 653. This variation represents an increase of only 0.08%; even so, it has a positive sign. This figure involves two distinct processes: on one hand, the disappearance of units and, on the other, the creation and rehabilitation of settlements.

In total, 13 population units that were inhabited in 2010 had become uninhabited by 2018; of these, 8 are in the province of Huesca, 4 in Teruel and 1 in Zaragoza. At the same time, 15 units that did not appear in the 2010 nomenclator or did not have any inhabitants are now inhabited. Of these 15 units, 11 are in the province of Huesca and the remaining 4 are divided equally between Teruel and Zaragoza. The processes of creation and disappearance of units are not mutually incompatible. There are 3 municipalities (2 in Huesca and 1 in Teruel) where both processes have occurred simultaneously. In the province of Huesca, as regards the number of units, the balance is positive (Figure 4); the same is also true for the province of Zaragoza. However, in the province of Teruel, the disappearance of settlements outweighs the processes of creation.

Figure 4

Evolution of number of population units between 2010 and 2018.



Number of dispersed units in 2018 - Number of dispersed units in 2010.

3.3.1 Process of unit creation and rehabilitation

Units that were uninhabited in 2010 and inhabited in 2018 are mainly located in the region of the Pyrenees and the Pre-Pyrenees—in the province of Huesca—in tourist areas (Figure 5). All the units that have been created or rehabilitated are dispersed and have low population, which oscillates between 1 and 14 residents, with an average of 4.53 inhabitants per unit and a mode of 1. Therefore, these are small settlements, even in comparison to the unit average of the municipalities analysed, which, excluding the uninhabited settlements, was 309.37 inhabitants in 2010 and 277.23 in 2018.

In the rural areas analysed, the processes of settlement creation and rehabilitation are directly linked to a pre-existing dispersed settlement and a high number of units in 2010. That

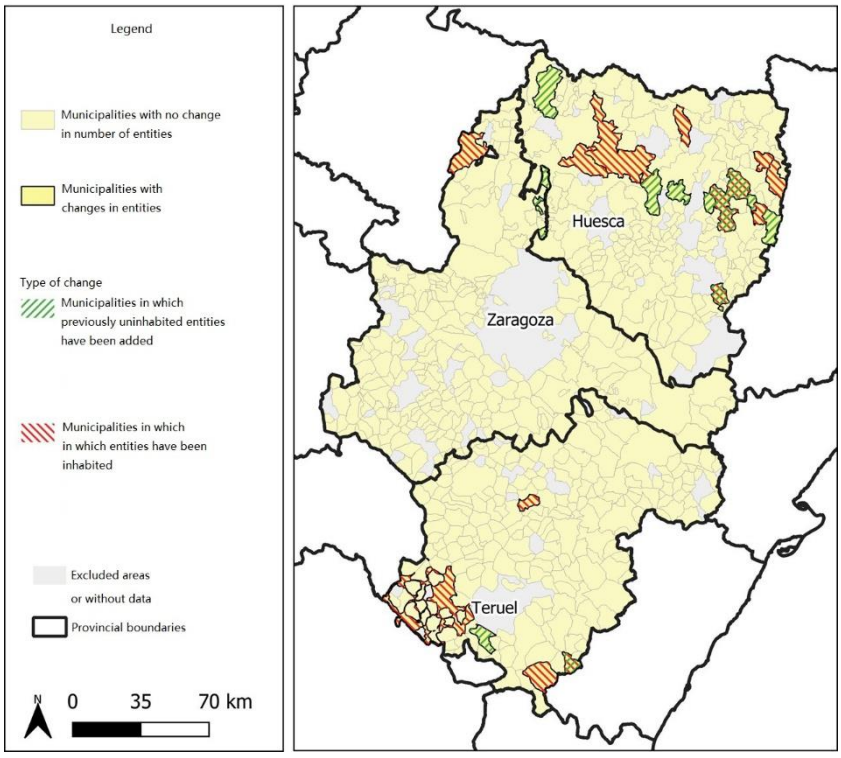
year, the average number of inhabited units in municipalities where new units had been inhabited was 4.5. This data contrasts with the figure of 0.98 municipalities where no units had been created. The difference between the two values is significant (significance lower than 0.001). When the same test was conducted regarding the population in the municipality in 2010, there were no differences either between the two types of municipalities or in relation to their demographic dynamics (significance 0.889).

3.3.2 The process of unit depopulation

As in the previous case, the depopulation-disappearance of settlements is linked to a pre-existing dispersed habitat. The average number of dispersed units in 2010 in municipalities where settlements had been deserted was 10.69, in contrast to the figure of 0.84 for the others. The differences are statistically significant. However, unlike the processes of unit creation and rehabilitation, the disappearance is, in fact, closely connected with negative demographic dynamics: firstly, from an ontological point of view, with the dynamics of the settlement itself; and, secondly, with the dynamics of the municipality. In the municipalities where population units have disappeared, depopulation occurs at an average rate of -20.04 people per year; in contrast, in the remaining municipalities, the average is -7.87. In this case, the difference noted is also significant.

Figure 5

Creation and disappearance of units: changes between 2010 and 2018.



Compiled by the author based on data from the INE (2010 and 2018) and IGN (2019)
Fuente: Esteban,2022

The risk of a unit becoming deserted is greater if it is small in size. All the units that are now deserted had 5 inhabitants or fewer: the average is 1.69. The total number of inhabited units with 5 inhabitants or fewer in 2010 was 101. Operation with these figures, [13/ (101-13)], results in an odds ratio of 0.15; this means that the probability of a unit being deserted is 0.17. In 2010, there were 1,270 units in total in the municipalities analysed. Considering this data, both the odds and the probability of becoming deserted are 0.01 for the whole group. In other words, the probability of a unit becoming deserted is 16.59 times higher if it has 5 inhabitants or fewer; crossing this threshold increases the risk of this happening.

In 2018, the number of units inhabited by 5 people or fewer was 123, out of a total of 1,272. This number has increased by 21.78%, due to the depopulation process. Therefore, in view of the above, depopulation increases the risk of population decline; and, when this effectively occurs, if the other elements remain constant, the level of habitat concentration rises.

4 RESULTS AND DISCUSSIONS

This analysis has revealed that, as regards habitat, there are different situations, even within a group of municipalities that share similar problems. Pinilla and Sáez (2017) suggested that, currently, heterogeneity is one of the characteristic features of the rural environment in Spain. The results obtained from analysing the changes in the Colas Index support this statement. This index continues to be useful in characterising habitat type—dispersed or concentrated— to establish a scale for the level of dispersion and to analyse its evolution. However, in areas of totally concentrated habitat, it only serves to identify changes when they fall into the category of ascription. In addition, from a methodological point of view, the use of administrative boundaries as the benchmark unit in calculating the index may conceal transitional situations and gradients between forms of land occupation but, still, enables to identify homogeneous areas on a regional scale and to assign a level of dispersion to each municipality, which is relevant as regards planning.

Using administrative boundaries favours the possibility of focusing the analysis on municipalities with certain characteristics. However, in the case of a rural-urban continuum and multiple interrelations between settlements on different levels, doing so could limit knowledge of the territorial processes affecting the subject of study when these processes are organised thorugh central locations. Colas himself (1945) emphasised that equating the largest unit with the cabecera is an arbitrary—albeit operational—criterion in the same lines, the role of the 'chef-lieu' (Demangeon, 1933) held by many of the small cabeceras included is questionable. In any case, the methodology used enables the identification of the main changes and the detection of trends regarding habitat using public sources.

Most of the municipalities in the study area have not experienced variations in dispersion coefficients between 2010 and 2018. Therefore, unlike in the past (Frutos-Mejías *et al.*, 1994), the changes in habitat type that are currently occurring are not generalised. In addition, population distribution according to type of settlement in 2018 and 2010 is very similar. There have not been substantial variations either in the regional distribution of settlements, nor in the distribution of habitat types in the region. In any case, when making comparisons, it should be noted that the period analysed by Frutos-Mejías *et al*. (1994) was 81 years, while this study has considered an 8-year period; still, almost 30% of the municipalities exhibited changes in the Colas Index. Therefore, there is not a completely stable model of rural habitat, although the change experienced is moderate and no substantial modifications have been observed in the distribution of the categories of dispersed and concentrated habitat.

In contrast to the generalised tendency towards concentration reported by Frutos-Mejías *et al*. (1994), changes in the municipalities where the habitat indicators have varied—despite all of them being immersed in the process of depopulation—have not always had the same sign. In 42.93 of the municipalities showing some sort of change, dispersion has increased, but many of the municipalities presenting changes show a tendency towards concentration that—in contrast to what was observed between 1900 and the beginning of the 1980s—is essentially linked to variations in population distribution according to settlement type, as the rate of unit disappearance is now lower (1.63 per year, excluding newly populated units). In the area and period analysed by Frutos-Mejías *et al*. (1994), the annual reduction in the number of population centres was 7.13; in contrast, the total number of inhabited units between 2010 and 2018 has increased.

Traditionally, the main effect which has been linked to depopulation has been the rise in habitat concentration (George, 1973; Frutos-Mejías *et al.*, 1994). The results obtained suggest the existence of a new stage in the depopulation process as regards habitat type. This may be characterised by the existence of heterogeneous dynamics and different types of behaviour.

In other contexts, such as England from 1951 to 1961, settlements with fewer than 100 inhabitants were those most prone to depopulation (Johnston, 1965); in Teruel from 1900 to 1981, however, the settlements most affected had fewer than 50 inhabitants (Frutos-Mejías *et al.*, 1994). The analysis in the area and period analysed in this study has revealed that short-term risk of becoming deserted is greater in dispersed settlements, particularly if the unit has 5 inhabitants or fewer. As a result of the depopulation process, the number of units below this population threshold increased between 2010 and 2018. This element may suggest that the hypothetical stage outlined is transitory, as the disappearance of units is linked to a dicrease in dispersion and a renewal of the process of habitat concentration, which is a characteristic of depopulation processes.

The disappearance of traditional settlements represents a loss of heritage (Rodríguez-Rejas and Díez-Gutiérrez, 2021) that may be a source of economic activity, particularly regarding rural tourism (Ruiz-Budría and Frutos Mejías, 2014). Concentrated habitats favour economies of scale (Garner, 1971). The provision of services in areas with dispersed habitat and sparse population is more costly than in areas with concentrated habitat, especially in small population centres (Escolano and de la Riva, 2003). At one point, some of the criteria used to rationalise the settlement system recommended centralising the concentration of services; the underlying philosophy was, after numerous experiments in this respect, prevention of the loss of public resources (Clout, 1976). However, as Clout himself suggests (1976, 228), causing

unviable settlements to disappear 'is a difficult exercise from a political point of view.' In this respect, the focus is currently on the need to ensure quality of life for the population, regardless of the area inhabited (Paniagua, 2016).

5 CONCLUSION

The system of settlements and population distribution has undergone changes over time in a fairly constant way (Nuninger *et al.*, 2021). As this study emphasises, this process is still underway in the rural environment in Aragón. This confirms the first hypothesis outlined. However, the reduction in the rate at which population is lost has not reversed the trend towards concentration in all cases; therefore, the second hypothesis can only be partially confirmed. Dispersion has increased in some municipalities without a simultaneous increase in the number of dispersed units, but this is not the only pattern detected; at the same time as this process is underway, a trend towards concentration has been observed in other municipalities.

Regarding the factors responsible for the changes, role of the demographic dynamics of the municipal *cabeceras* in relation to the dispersed units is worth noting. To a large extent, this relationship determines habitat evolution when the number of dispersed settlements remains constant. The role of the processes of unit creation and disappearance should also be mentioned. While infrequent, these processes condition the evolution of indicators and may even cause variations in the category to which the habitat type of a spatial/territorial unit is ascribed.

ACKNOWLEDGEMENTS

Opcional section, where the author can thank the funding agencies, or other applicable thank you.

REFERENCES

Aguilera, M.J., Borderías, M.P., González, M.P. y Santos, J.M. (1991). *Geografía general II (Geografía Humana)*. Madrid: Ed. Uned.

Albet i Mas, A. (2019). El mapa municipal en España: estructura, evolución y problemáticas. Geopolítica(s). *Revista de estudios sobre espacio y poder*, 10(1), 11-40. https://doi.org/10.5209/GEOP.63834

Antunes, M.V.M.; Esteban Rodríguez, S. (2021) Reforma agraria, conflictos por la tierra y cambios en el poblamiento: caso de estudio de la mesorregión de Presidente Prudente en

el Estado de São Paulo (Brasil). *Investigaciones Geográficas*, n. 75, p. 249-265. https://doi.org/10.14198/INGEO.17334.

Arroyo, M. (2001). La contraurbanización: un debate metodológico y conceptual sobre la dinámica de las áreas metropolitanas. *Scripta Nova. Revista electrónica de geografía y ciencias sociales*. Núm. 97. http://www.ub.edu/geocrit/sn-97.htm

Baños, A.; Le Néchet, F.; Ouriachi, M.J.; Franc, A. (2021) Chapter 3: Simulating transition: an introduction to spatio-temporel models. En: *Settleting the World: From Prehistory to the Metropolis Era*. Giras: François-Rabelais University Press, 2021 http://books.openedition.org/pufr/19752.

Camarero, L. (coord.); Cruz, F.; González, M.; del Pino, J.A.; Oliva, J.; Sampedro, R. (2009). *La población rural de España, de los desequilibrios a la sostenibilidad social.* Barcelona: Fundación 'la Caixa'.

Del Canto, C.; Gutierrez, J.; Pérez, M.C. (1988) Asentamientos y transportes. En Carrera et al. *Trabajos prácticos de Geografía Humana*. Madrid: Ed. Síntesis.

Chiffre, J. (1969) Une nouvelle formule de dispersion de l'habitat rural : son application au Nivernais. *Revue Géographique de l'Est*, núm. 9-1-2, pp. 149-175. https://www.persee.fr/doc/rgest_0035-3213_1969_num_9_1_2168.

Clout, H.D. (1976). *Geografía Rural*. Barcelona: Oikos-Tau. 307p.

Colas, R. (1945) Répartition de l'habitat rural. *Bulletin de l'Association de géographes français*, 22, 169-170.

Delgado Urrecho, J.M.; Martínez Fernández, L.C. (2017) Evolución, situación actual y perspectivas de la población en los pequeños municipios españoles. *Documentación social*, Nº 185, 37-66.

Demangeon, A. (1933). Une carte de l'habitat. *Annales de Géographie*, t.42, n°237, 225-232. https://doi.org/10.3406/geo.1933.10517.

Escolano Utrilla, S.; de la Riva Fernández, J.R. (2003). Marco conceptual y metodológico del estudio de los procesos de despoblación. En Escolano Utrilla, S.; de la Riva Fernández, J.R. (Coords.). *Despoblación y ordenación del territorio*. Diputación de Zaragoza, Institución 'Fernando el Católico'. 7-14.

Frutos Mejías, L.M.; Solans Castro, M.; Chueca Diago, M.C. (1994) Cambios en el sistema de asentamientos rurales: la provincia de Teruel. *Geographicalia*, 31, 83-94. https://doi.org/10.26754/ojs_geoph/geoph.1994311770

García Marín, R., & Espejo Marín, C. (2019). El círculo vicioso de la despoblación en el medio rural español: Teruel como caso de estudio. *Estudios Geográficos*, 80, 286.

Garner, B.J. (1971) Modelos de geografía urbana y de localización de asentamientos. En Chorley, R.J.; Haggett, P. *La geografía y los modelos socio-económicos*. Madrid: Instituto de estudios de administración local. p. 211-296

George, P. (1973) *Población y poblamiento*. Barcelona: Edicions 62, S.A. 209p.

George, P. (1991). *Diccionario Akal de Geografía*. Torrejón de Ardoz (Madrid): Ediciones Akal. p. 622.

Gobierno de Aragón (2017a). *Decreto 165/2017, de 31 de octubre, del Gobierno de Aragón, por el que se aprueba la Directriz Especial de Ordenación Territorial de Política Demográfica y contra la Despoblación*. Departamento de Vertebración del Territorio, Movilidad y Vivienda.

Instituto Aragonés de Estadística (2001). *Entidades de población de Aragón y sus habitantes en los censos de 1857 a 2001*.

Instituto Geográfico Nacional (2019). *Delimitación Territorial: líneas límite municipales.* Madrid: Instituto Geográfico Nacional – Centro Nacional de Información Geográfica. http://centrodedescargas.cnig.es/CentroDescargas/catalogo.do?Serie=CAANE

Instituto Nacional de Estadística (2010) *Nomenclátor: Población del Padrón Continuo por unidad poblacional*. https://www.ine.es/uc/N5BnhqgL

Instituto Nacional de Estadística (2018) *Nomenclátor: Población del Padrón Continuo por unidad poblacional*. https://www.ine.es/uc/N5BnhqgL

Instituto Nacional de Estadística (2020). *Nomenclátor. Relación de unidades poblacionales (Metodología*). https://www.ine.es/nomen2/Metodologia.do

Jefatura del Estado (2007). *Ley 45/2007, de 13 de diciembre, para el desarrollo sostenible del medio rural*. https://www.boe.es/eli/es/l/2007/12/13/45/con

Johnston, R. J. (1965) Components of rural population change. *Town Planning Review*, núm. 36, p. 279-293.

Jurado Almonte, J. M., & Pazos García, F. J. (2022). Población y sostenibilidad territorial de los espacios rurales en España y Portugal. *Cuadernos Geográficos*, 61(2), 61-87. https://doi.org/10.30827/cuadgeo.v61i2.23878

Marín Gavín, S. (2014). Construir sobre lo construido. Rehabilitación de pueblos abandonados en el Altoaragón. *ZARCH: Journal of interdisciplinary studies in Architecture and Urbanism*, 3.

Martín Roda, E. M. (2014). Territorial imbalances in the chinese economic boom. *Boletín de la Asociación de Geógrafos Españoles*, (66). https://bage.age-geografia.es/ojs/index.php/bage/article/view/1804

Nuninger, L.; et al. (2021). A generic conceptual framework for describing transitions in settlement systems: Application to a corpus of twelve transitions between 70 000 BP and 2050 In: *Settling the World: From Prehistory to the Metropolis Era*. Tours: Presses universitaires François-Rabelais. http://books.openedition.org/pufr/19740.

OCDE (2006) *The New Rural Paradigm, Policies and Governance*. Paris: OECD Rural Policy Reviews.

Paniagua Mazorra, Á. (2016) Despoblación, sostenibilidad social y espacio rural. Algunas consideraciones para el debate. Ambienta, 116:58-67.

Pinilla, V.; Sáez, L.A. (2017) *La despoblación rural en España: génesis de un problema y políticas innovadoras*. Informes CEDDAR.

Puyol, R. (1995) La Población. En Puyol, R.; Estébanez, J.; Méndez, R. *Geografía Humana*. Madrid: Cátedra. 51-238.

Rodríguez-Rejas, M. J., & Díez-Gutiérrez, E. J. (2021). Territorios en disputa: un estudio de caso en la España vaciada. *Ciudad y Territorio, Estudios Territoriales*, 53(208), 371–390. https://doi.org/10.37230/CyTET.2021.208.05

Rubio Terrado, P. (2010). Modelización de los cambios y evolución reciente del sistema rural español. *Boletín de la Asociación de Geógrafos Españoles*, (54). https://bage.age-geografia.es/ojs/index.php/bage/article/view/1286

Ruiz-Budría (1994) *Análisis geográfico del 'mas' turolense: pervivencia y viabilidad de una explotación agraria tradicional*. Tesis doctoral. Departamento de Geografía y Ordenación del Territorio de la Universidad de Zaragoza.

Ruiz Budría, E.; Frutos Mejías, L.M. (2014) Los 'Mases', elementos fundamentales en la estructura del paisaje turolense oriental. En Arnáez Vadillo, J. et. al (eds.) *Geoecología, cambio ambiental y paisaje: homenaje al profesor José María García Ruiz*. 471-479. https://dialnet.unirioja.es/descarga/articulo/4854204.pdf

Thompson, I. (2002). Innovation and re-ruralisation in Haute Maurienne, France. En *Innovations in rural areas*, 4e colloque franco-britannique de Géographie rurale. Worcester. P. 107-126.

Vinuesa, J.; Puga, D. (2007). *Técnicas y Ejercicios de Demografía*. Madrid: INE.