A New Methodology for Low-density Definition and Its Effect on Tourism Development Analysis: The Case of Portugal

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1 Introduction

The rise of an urban-industrial society since the eighteenth century triggered the loss of economic, social, and symbolic centrality of the rural world (Ferrão 2000). This transformation established a diachronic understanding of rural areas as archaic environments, contrasting to a progressive setting developed within urban-industrial agglomerations (Ferrão 2000). Urban areas have increasingly developed into places of economic growth and service provision, leading to power asymmetries between rural and urban environments. Both spaces have manifested conflicting territorial dynamics based on disparities, namely in population, economic activity, quality of life, access to public goods and services, technological infrastructure, and political control synthesized by dual interactions between high and low-density areas (Carvalho 2018).

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Overall, the underlying territorial imbalance is an outcome of low-density economies' dependence on the extraction and 'first stage processing of local natural resources' that are then exported elsewhere (OECD 2016, p. 141), often to urban areas. The challenge arising from such asymmetry is how to preclude a trend of territorial polarization (Salvatore et al. 2018) to allow the future existence of society as a whole (Ribeiro and Marques 2002). As a result, rural tourism has been approached as an economic alternative for rural restructuring and described as a "potential development vehicle," particularly since 1987 when the OECD's 24 members began discussing this issue (Lane and Kastenholz 2015, p. 1134).

Addressing the Portuguese case, after its accession to the European Community, the Structural Funds have constituted the central assistance mechanism for regional development. An important part of this financial aid has been directed to the tourism sector by supporting investments in low-density regions through rural tourism (Costa 2012). The evaluation of these funds' impact on rural area's development is measured and compared under a scalar rationale, namely at the NUTS3 level, a territorial scale introduced by EUROSTAT in 1970, which presently includes a minimum population of 150,000 and a maximum population of 800,000 people. Consequently, regional economic changes have been assessed under a rationale of geographical continuity which has implications on the classification of low-density regions as well as on the evaluation of the European Union's funds contribution toward regional development.

Though it may seem intuitive to define low-density areas as rural territories with low human occupation, the current degree of urbanization that allows distinguishing between urban and rural areas (European Commission 2014) relies mostly on population density, inhibiting a full interpretation of low-density's multidimensionality. This is particularly relevant considering that the current funding instruments in Portugal which originate from the National Program for Territorial Cohesion (*Programa Nacional para a Coesão Territorial*) aim to endorse tourism development in interior regions[1] and support economic, social, and territorial cohesion.

Despite identifying the spatial scope of interest, as well as defining a set of holistic intervention programs,[2] the National Program for Territorial Cohesion fails to define "interior territories," acknowledging that an inclusive and clear idea of what can be described as the «*Interior of Portugal*» is missing. So, given the undefined and somewhat fluid conceptual and methodological scope of low-density territories, as well as its implications concerning the effective use of structural funds meant to promote territorial cohesion, what are the implications in terms of tourism development analysis? This is critical if the definition of low-density extends its scope to a wider set of dimensions beyond population density which the National Program for Territorial Cohesion requires.

[1]Linha de Apoio à Valorização Turística do Interior.

[2]Aging with quality; Innovation of the Economic Base; Territorial Capital; Cross-border cooperation; Rural-Urban relationship; Digital accessibility; Territorial attractiveness; Approaches, networks, and participation.

Therefore, this chapter first proposes a new methodology that allows classifying low-density territories by including physical, demographic, and socioeconomic characteristics but also considers other factors according to a multi-dimensional approach. The methodology that will be presented and discussed here produces a composite index (low-density indicator) that can be deployed and used regardless of the territorial scope and scale of approach. The identification of low-density territories is based on an index that results from the combination and weighting of the individual indicators organized in sub-indexes (profiles) related to the lowest administrative unit (civil parishes) in mainland Portugal. These are subject to an algorithm that computes partial indexes (profiles) corresponding to an intermediate step toward the construction of a global index that is further computed at the municipality and NUTS3 level. Next, this study applies bivariate linear regression models at the municipality and NUTS3 level to determine the low-density indicator's (LDI) impact on the analysis of tourism development, using as response and proxy variables a set of quantitative tourism non-financial and financial tourism lodging variables published by Statistics Portugal (INE). To operationalize this investigation, this study looks at mainland Portugal.

The purpose of this chapter is twofold. First, to discuss a new methodology that defines the spatial outline of low-density areas at different contexts and territorial scales (parish, municipality, and NUTS3), which expands on the traditional population density dimension. Second, to assess the implications of the proposed methodology, which captures a new low-density outline and spatial context, on the analysis of tourism development.

2 Literature Review

The following section is divided into two parts. The first part reviews and discusses the issue of the low-density spatial outline, considering its conceptual ambiguity and dependence on population density, lacking a more comprehensive approach that incorporates other factors (e.g. settlement and accessibility). The second part analyses tourism in peripheral and low-density rural areas, and particularly on how it has affected agricultural land use transition toward a multifunctional economy. This section further debates the problem of peripherality as a geographical matter imbued of social, political, and economic implications. The literature review concludes by discussing the fragmented benefits sought of rural tourism, resonating the ongoing transformation and transition of peripheral rural areas.

2.1 Low-density Spatial Outline

As Hopkins and Copus (2018, pp. 1-2) have observed, "Unlike sectoral (agricultural) rural development policy—which targets beneficiaries on the basis that they

are farmers, or other primary producers, in a «spatially-blind» way—place-based approaches seek to address the needs of specific rural areas holistically, with beneficiaries identified according to their location. Thus, a key precondition for place-based rural policies is a definition of the rural area, and some understanding of rural diversity, perhaps captured by some kind of typology." This constitutes the same perspective that we address in this chapter when referring to the typological definition of low-density territories in the context of this work.

Studies covering low-density delimitation are, as a general rule, part of a broader issue that includes the conceptual definition and mapping of territorial typologies. This covers a wide spectrum, ranging from operational territorial typologies determined mainly to ensure coherence within data collections for statistical purposes (Eurostat 2019) to the classical urban-rural dichotomy (Stewart 1958) which has become increasingly blurred (Hugo 2004; Cloke 2006; Woods 2009), with new concepts like "rurban," "peri-urban" or "exurban" emerging to somewhat remedy this fuzziness (Antrop 2000; Theobald 2001; Meeus and Gulinck 2008; Qviström 2013).

The definition of low-density territories might come across as straightforward and intuitive, referring to a rural territory with a population density below a previously fixed threshold. In practice, however, its application gives rise to numerous questions and difficulties: from the fixing of the quantity to be attributed to the referred threshold to the set of other components and problems that go far beyond demographic and population characteristics that should be included. This challenge raises the recurring criticism of the lack of objectivity or scientific foundation of the adopted values, given the distinct realities and specificities that mark the territories.

Particularly in Europe, several studies incorporating multiple dimensions have been developed in the last decades and applied in different national and international contexts and under different perspectives, to classify geographical areas of distinct sizes, giving rise to a great diversity and heterogeneity of typologies, mostly associated with rural spaces, that may be assumed as low-density. Most of the identified typologies in previous works attend to specific purposes, ranging from the characterization, diagnosis, and delimitation of relatively homogeneous areas to the identification of areas with common and specific problems and for targeting sectoral or territorial interventions and policies. The latter is of particular importance and, to some extent, an indispensable requirement in the current context of policy design within the framework of the European Union aimed at rural areas. In this study, we compiled and analyzed several of the recognized classifications (Table 1) to allow the definition of a new standard framework for the categorization of low-density territories in Portugal that can support place-based policies.

Low-density is a notion associated with the most disadvantaged rural space, and it is defined, at first, through the demographic component. This notion has negative connotations and is approached as a problem: low-density is synonymous with agricultural abandonment and rural depopulation, social and economic dependence, "decline," "emptiness," and "desert" (Simard 2005). Low-density territories are characterized by a broader set of negative attributes, classified as such in the light of urban norms: scarcity/absence of population, especially young people, services,

Table 1 Synthesis of studies regarding low-density or rural typologies definition

Study	Low-density corresponding typology	Main classification criteria
EC Regulation 1257/1999	Less-favored areas	Topography, altitude, and land-use
Baptista et al. (2003)	Rural fragile with fragile agriculture	Population density, demography, agricultural economy, and socioeconomic dynamics
Nordregio-Nordic Centre for Spatial Development (2004)	Mountain areas	Topography, altitude, and temperature
Resolução do Conselho de Ministros n.° 11/2004	Less-favored municipalities	Purchasing power per capita index
Bengs et al. (2004)	Low urban influence, low human intervention	Population density and accessibility to populated centers
Marques (2004)	Classes with references to "low-density context"	Population density, demography, socioeconomic performance, agricultural population, land use, and accessibility to populated centers
EUROSTAT (2005)	Thinly populated areas	Population density
MADRP (2006)	Significantly rural areas	Population density and agricultural population
MiPAAF (2007)	Rural areas with comprehensive development problems	Population density, elevation, and agricultural economy
Dijkstra and Poelman (2008)	Predominantly rural remote	Population density and accessibility to populated centers
Martín et al. (2008)	Dominantly rural	Population size, settlement structure, population density, demography, socioeconomic performance, and accessibility to public services
MAGRAMA (2009)	Rural area to be revitalized	Population density, agricultural population, income levels and accessibility to populated centers
Öğdül (2010)	Dominantly rural	Employment structure, population density, population size, rate of urbanization, settlement structure, educational level, accessibility to main transport infrastructures, budget income per capita, and the number of branch banks.
OECD (2011)	Predominantly rural	Population density and size of the urban centers
IGE (2011)	Sparsely populated areas	Population density
Barthe and Milian (2011)	Low-density and desertified	Population density
Brezzi et al. (2011)	Predominantly rural remote	Population density, size of the urban centers, and accessibility to populated centers

(continued)

Table 1 (continued)

Study	Low-density corresponding typology	Main classification criteria
Copus (2011)	Predominantly rural remote, agrarian and in depletion	The EDORA Cube multi-dimensional analysis framework comprises three typologies: Dijkstra/Poelman, economic restructuring, and socioeconomic performance
Hilal et al. (2011)	Aged rural at very low density	Population density, demography, socio-economic performance, and accessibility to populated centers
Bibby and Brindley (2013).	Rural village and dispersed in a sparse setting	Settlement structure
INE (2014)	Predominant rural areas	Population density and land use
INSEE (2015)	Very low-density communes	Population density
Quintá and Arce (2018)	Very rural	Population density and evolution, demography, settlement structure, agricultural population, accessibility to populated centers

and activities. Territories that appear in this context, as residual spaces, have been labeled as "deep rural," "fragile rural" (Azevedo 2013), or "space of crisis and abandonment" (Figueiredo 2018).

There are very different typologies at the territorial level (European, national, regional, and local) and with distinct scales (regional and local), giving rise to a huge diversity of approaches used to define different categories of territories. The conceptual framework itself varies between a theoretical nature and a relatively rational application. However, most cases are based on empirical references, more precisely on indicators. All of this, considering the typologies presented, leads to the establishment of different guiding dimensions, namely: 1) the territorial dimension that refers to the region or location and its geomorphological characteristics and/or economic, social, and political performances; 2) the temporal dimension that refers not only to the time frame of the analyzed dynamics but also to the historical evolution of technical options, economic and/or behavioral nature; 3) the development dimension, namely rural development, understood as a multi-sectoral concept that encompasses multiple aspects of different nature and which underlies the majority of the presented typologies; and 4) the important issue related with the scope of application since it implies the consideration of multiple factors, namely in cases where their elaboration is aimed at implementing place-based policies.

The typologies and classifications presented are diverse according to the stated objectives. The definitions are so varied that a common standard is elusive: they change based on the purpose of the study and the institutions and actions demanding them. These approaches present relevant aspects of the delimitation of rural spaces. However, they tend to be defined by operational objectives or integrated into sectoral

logic (agricultural sector) limiting, in most cases, differentiation of rural spaces by the diverse components that characterize them. Most studies suggest that there could be differentiated low-density territorial outlines according to each sectoral viewpoint.

Furthermore, recent studies have been referring that multiple factor approaches are more suitable to classify low-density areas in the context of policy-making, although the thresholds in each variable differ both in time and in space, adjusting to the context and objective of the respective research. In most of the examined investigations, the perspectives adopted favor the population density indicator serving, simultaneously, as the main criterion for defining geographic units. These perspectives assume the establishment of a threshold below which it is pertinent to speak of low-density territories, which is based on the observation of the distribution of the population, varying according to the author, country, or geographical scope. From our point of view, this approach reveals some shortcomings and limitations, namely in terms of its struggle to accurately establish a value for the threshold to be widely adopted. Furthermore, it reveals a challenge related to the heterogeneity of the territorial units (municipalities, parishes, NUTS3), which necessarily alters the results. In this sense, the population density threshold to be adopted should be understood as an order of magnitude and not a strict criterion.

Besides population density, we have identified five other main dimensions as essential components for the identification of low-density territories: a) physical-geographic; b) demographic; c) settlement; d) socioeconomic; and e) accessibility. Based on these factors we have developed profile indexes and a global composite index computed at the smallest possible administrative unit (parishes) level, depending on the available statistical data (Table 2). Each profile integrates variables that correspond to the defined conceptual delimitation. The physical-geographic characteristics integrate the components of altitude, climate, and artificial land use. As altitude and thermal amplitude increase, a strong rural landscape is usually associated with the dominance of agricultural, forestry, or natural associated land uses. The demographic profile classifies parishes by their recent population growth, but also by their long-term sustainability, integrating the share of youth and elderly population. The settlement profile considers the weight of the population living in settlements classified by their population size. This allows us to differentiate urban and denser areas from low-density territories and to distinguish, among the latter, those that have a more nucleated, dispersed, or isolated settlement pattern. The socioeconomic profile intends to characterize each parish in terms of the available active population, income level, social dependence of the State, and economic dependence on agriculture. The accessibility profile considers the access, measured in terms of travel time by car from each parish to its subsequent hierarchical metropolitan hubs and reference points (municipal major city or town, the district capital and regional capital) as described in the Central Place Theory (Christaller 1933) as a measure of social inclusion and effectiveness of public policies in ensuring the quality of life and the reduction of territorial inequalities in access to public services.

Table 2 Variables and data sources used in each profile

Profile	Variables	Sources
Population density (P_d)	Population density (persons per sq. km)	Population census 2011 (INE)
Physical-geographic (P_1)	Elevation (m) Temperature annual range (°C) Share of artificial land (%)	ASTER GDEM v2 (METI and NASA) BIO7—Global Climate Data (Hijmans et al. 2005) COS 2007 (DGT)
Demographic (P_2)	Population growth rate (%)	Population census 2001 and 2011 (INE)
	Share of the elderly population (%)	Population census 2011 (INE)
	Share of young population (%)	Population census 2011 (INE)
Settlement (P_3)	Share population living in large urban settlements ($\geq$ 2000 inhabitants) (%)	Population census 2011 (INE)
	Share of population living in small urban settlements ($\leq$100 inhabitants) (%)	Population census 2011 (INE)
Socioeconomic (P_4)	The average monthly wage of employees (€)	Earnings and working hours survey 2009 (GEP/MTSSS)
	Share of agricultural family population in total population (%)	Agricultural census 2009 (INE)
	Share of population with lower secondary education 3rd. cycle completed or higher (%)	Population census 2011 (INE)
Accessibility (P_5)	Travel time by car to third-tier/municipal urban center (min.) Travel time by car to second-tier/district capital (min.) Travel time by car to first-tier/regional capital (min.)	Google Maps batch routing

2.2 *Tourism in Peripheral and Low-density Rural Areas*

Tourism is an asymmetric phenomenon that polarizes flows, facilities, and services (Salvatore et al. 2018), developing imbalanced and binary relationships that have been widely interpreted under the postindustrial dependency theory (Britton 1981; Chaperon and Bramwell 2013) as hierarchical core-periphery relations. Among these, the structural biased relationship between urban and rural areas is one of the most conspicuous due to the control of "urban cores" (Smith and Still 2009, p. 52) over rural resource-based communities, which enacted mainly production and supply roles, rather than places to be consumed. The inherent deterministic resource extraction paradigm between urban (the core) and rural (the periphery) areas has amplified asymmetry. And so, peripherality is not only a geographical issue but is also imbued of social, political, and economic implications, frequently meaning "economic disadvantage, lack of technological infrastructure, and political weakness" (Salvatore et al. 2018, p. 42).

Due to changes in food production (Salvatore et al. 2018) at the beginning of the 1970s in parts of Europe, agriculture started to decline (Lane and Kastenholz 2015). The arising crisis affecting rural areas, and rural land base traditional production functions—mainly agriculture—progressively modified rural's economy towards a multifunctional model (Gerowitt et al. 2003; Marsden and Sonnino 2008). In this context, tourism was perceived as an easily accessible tool to deal with the economic decline (Lane and Kastenholz 2015), by providing employment and a means to promote rural economic diversification (Ribeiro and Marques 2002; Williams and Shaw 1998). These changes gave rise to a post-productivist paradigm whereby rural areas came to be regarded "as consumption spaces to be exploited not only by industrial capital but by the growing urban and exurban populations" (Marsden and Sonnino 2008, p. 423). Rural areas have since begun to be targeted as consumption subjects "based on establishing new commodities or in reimaging and rediscovering places for recreation and tourism" (Hall and Page 1999, p. 180).

The first approach to diversify agricultural land use through tourism was based on the notion of agritourism, or farm tourism. The word agritourism was first used to designate what later became known as rural tourism which acquired a holistic and sectoral meaning by framing a variety of activities. In various countries, tourism in rural areas was first developed by adapting "rooms in village houses or in converted, often historic buildings" (Lane and Kastenholz 2015, p. 1136). This was the case in Portugal, with the introduction in 1978 of what was then named "*Turismo de Habitação*" (Programa do IV Governo Constitucional 1978), through the renewal of manor houses in four pilot areas[3] (Silva 2007). In 1986, rural tourism was formally introduced and since then subject until recently (2017) to numerous legislation changes that have included further forms of accommodation and activities.

Since joining the European Economic Community (EEC), in 1986, Portugal has been benefiting from European funding programs to support the development of rural tourism under the assumption that rural area's economic diversification can mitigate regional asymmetries (*Programa do X Governo Constitucional*). The amount of political and financial engagement to develop rural tourism has therefore resulted in many positive outcomes, particularly in terms of infrastructural and amenity supply. However, it seems to have been less capable to address social and demographic constraints. The fact that only a small number of rural tourism businesses remain in a family when the owner retires (Lane and Kastenholz 2015), frequently due to rural exodus factors, is a clear illustration of these challenges. Hence, the strategy that has been pursued in Portugal, and other European countries, has been more successful in addressing tangible factors rather than intangible and more fluid issues.

The Portuguese case indicates that the government's strategy, at least at an early stage, mirrored in the published legislation, was more concerned with tourism rather than with rural area's economic regeneration and development (Ribeiro and Marques

[3]Ponte de Lima, Vouzela, Castelo de Vide and Vila Viçosa.

2002). This strategy favored mainly affluent families rather than ordinary farmers due to the high level of requirements that were imposed to authorize new accommodation units (Ribeiro and Marques 2002). Despite this issue and the unevenly geographic distribution of rural tourism accommodation units, mostly concentrated in northern Portugal, the regional development agenda established an important framework toward rural regeneration and conservation of existing properties and heritage resources. By allowing the recovery of built heritage, rural tourism has contributed to the maintenance of a landscape full of symbolic value (Silva 2007). The downside of rural tourism's development policy though has to do with its inability to justify the infrastructural investment effort, namely through job creation and local trade and services development, and so failing to reduce population decline and low density in rural areas (Silva 2007).

Along with the discussed transformations affecting the economic fabric of rural areas resulting from the reconfiguration of regional development policies, there has also been a profound change in the tourism consumption paradigm, which was addressed by Poon (1989) as a "Post-Fordist" trend, defined as a shift from an "old tourism" to a "new tourism" and described by individual consumption patterns with greater volatility in preferences as well as tailored and adaptable in both time and space (Poon 1989, p. 181). Demand for rural areas is also believed to attract a post-modern market pursuing exclusive experiences (Kastenholz et al. 2012). Hummelbrunner and Miglbauer (1994) referred to a new "new rural tourism" (p. 41), based on the tourist's re-orienting choices namely toward an "increasing environmental awareness" (p. 42), escaping from polluted areas and searching for an undamaged environment. Also, rural areas are deemed to represent a nostalgic return to the past and the origins, as well as authenticity (Chen and Kerstetter 1999; Kastenholz et al. 2012). So, the commonly labeled "rural tourists" are far from being a homogenous market (Kastenholz et al. 2012; Silva 2007) and several authors have shown its fragmented structure (Frochot 2005; Kastenholz et al. 1999). Rural tourism is a complex activity and rurality has many manifestations (Lane 1994) suggesting "that consumers can consume this world in many ways" (Frochot 2005, p. 336).

Given the fragmented benefits sought of rural tourism and the fact that "the multiplier effect is often more impacting in rural areas" (Kastenholz et al. 1999, p. 353), it highlights the significance of planning and managing the ongoing process of "tourism transition" (Salvatore et al. 2018). The sustainability of rural areas is dependent on tackling fluid issues, namely demographic, social, and economic factors, along with tangible and physical concerns. These are vital in guaranteeing local genuine products to respond to a new consumer trend which is more sensitive to local qualities and "sense of place" (Jepson and Sharpley 2015, p.1).

Thus, the literature review echoes an ongoing transformation and transition of peripheral rural areas, suggesting a development tendency that looks at the same characteristics and qualities that were formerly deemed to be detrimental as new opportunities (Brown and Hall 2000; Salvatore et al. 2018). Moreover, the literature indicates the importance of tourism as a tool for regional local development to manage the decline of peripheral rural areas and tackle problems related to

low-density resulting from demographic decline as well as physical, social, and economic disruptions.

3 Methodology

3.1 Research Setting

To fulfill this study's goals, a new methodology that calculates a low-density index (LDI) and defines the spatial outline of low-density areas in mainland Portugal at different territorial scales (parish, municipality, and NUTS3) is presented. Additionally, to evaluate the implications of the proposed index on tourism development analysis, bivariate regression models were applied to estimate the explanatory significance of the LDI on 10 demand and supply tourism lodging statistical indicators in 2018, as proxy variables, as well as on each variable's percentage change for the period of 2013 to 2018 at both the municipality and NUTS3 levels.

3.2 Research Data and Methods

3.2.1 LDI and Spatial Outline

The statistical variables were obtained from the most currently available statistical datasets at the lowest level administrative division in mainland Portugal (civil parishes) from the population and agricultural censuses. Elevation values were extracted, for each civil parish main urban central point coordinates, from the Advanced Spaceborne Thermal Emission and Reflection Radiometer Digital Elevation Model (ASTER GDEM v2) at 30m resolution. Temperature data was extracted from the Annual Thermal Amplitude (BIO7) data provided by WorldClim – Global Climate Data, which is based on the annual averages between 1950 and 2000. The share of the artificial area was estimated from COS land cover maps produced by the Portuguese General Directorate for the Territory. These are land cover maps at the 1:25.000 scale, with a minimal cartographic unit of 1ha, based on orthophoto maps with four spectral bands (blue, green, red, and near infra-red). These datasets were photo-interpreted with an average interpretative accuracy of 95%. Land cover was divided into hierarchical levels, from level one containing five primary types (artificial areas, agricultural areas, and agroforestry, forests and natural and semi-natural areas, wetlands, and water bodies) to level five containing up to 190 classes (Abrantes et al. 2016). In this study, the first level was used to adequately estimate the total artificial area. Access times were estimated using Google Maps routing capabilities, where the circulation time in each road section considers both the characteristics of the road network such as hierarchy, crossings, intersections, and

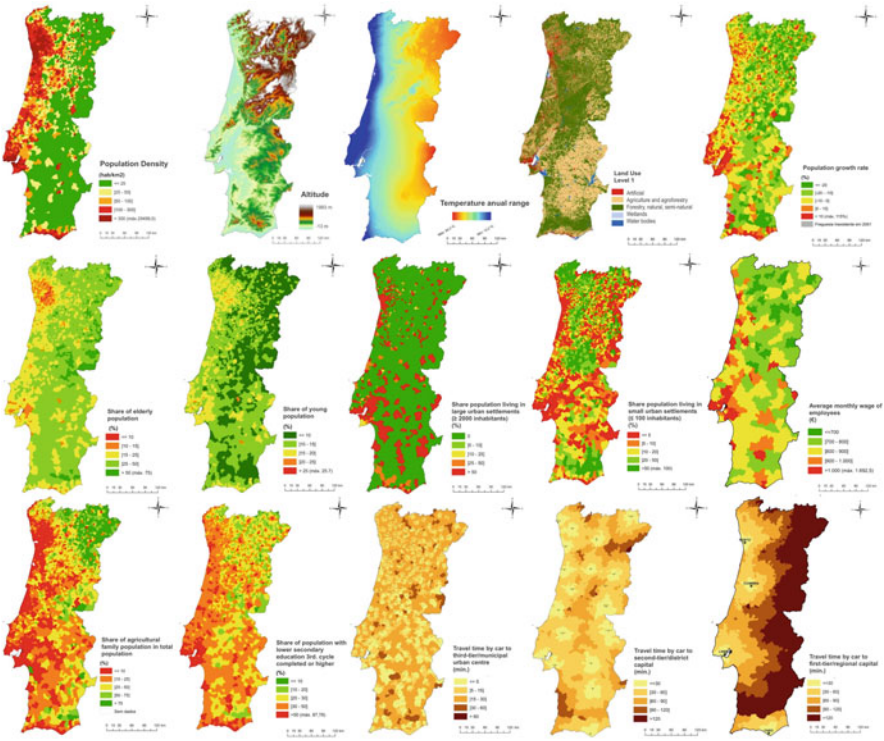

Fig. 1 Maps for continental Portugal of each of the variables used in each profile

the average speed of driving a light vehicle. Table 2 and Fig. 1 present all the variables used in the low-density index calculation.

Individual profile indexes were based on standardized (Z-scores) variables by applying Eq. 1:

$$X' = \frac{X - \mu}{\sigma} \tag{1}$$

where X' is the standardized data value, μ is the mean of the data set, and σ is the standard deviation of the data set.

Statistical standardization ensures the removal of issues related to the unit of measurement and scale, generating indicators with zero mean and unitary standard deviation. Zero averages avoid bias in the aggregation resulting from mean differences. Dividing the means by the standard deviations allows the variables to be rescaled but does not prevent indicators with extreme values to have a greater impact on each profile index since the range of effective variation of these indicators will be greater. This approach has a positive effect, given that the objective of the global composite indicator is exactly to highlight the differences between statistical units and to identify the specific subset of low-density civil parishes. In the second phase,

a normalization procedure was carried out by applying a min-max rescaling to eliminate the analytical inconveniences resulting from the inevitable negative performances in the z-score method and to ensure the incorporation of dispersion between extreme values present in the resulting indexes. This process was performed using Eq. 2:

$$X' = \frac{X - \min(x)}{\max(x) - \min(x)} \tag{2}$$

where X' is the normalized data value and X is the input data value.

Each profile index was transformed by division with the respective mainland Portugal's average, thus obtaining relative values referenced to the national average, allowing a measure of the distance of each parish concerning the national reference value. Where no such average existed, it was estimated through the parishes' average weighted by its population. After the application of the standardization and normalization procedures, the value of each profile index was drawn from the average value of the corresponding individual variables. The global index was calculated from the weighted average of the population density (with a weight of 50%) and each of the profile indexes (with a weighting equal to 10% each, meaning, therefore, that the results reflect a view where the same importance of the various profiles is assumed in the identification of low-density territories), as expressed in Eq. 3.

$$LDI = P_d * 0,5 + \sum_{1}^{n} 0,1 * P_n \tag{3}$$

where *LDI* is the low-density index value, P_d is the population density index, and P_n represents each one of the other profile indexes.

More recent estimates regarding some of the demographic variables do exist but only at the municipal level. So, in this study, the most recent data available at the civil parishes level was used. It is expected that the economic crisis that occurred in the past decade may have altered the population structure and distribution which could eventually increase the number of parishes being classified as low-density territories. We cannot effectively determine its current impacts, so *LDI* calculation should be periodically revised (preferably every decade, with every new Census) and the resulting maps changed accordingly.

3.2.2 Bivariate Regression Models

In total, 20 bivariate regression models were built to provide a precise analysis of the relationship between the *LDI*, the regressor, each tourism lodging demand and supply indicator in 2018, and the respective percentage change for the period of 2013 to 2018, as dependent variables (Table 3).

Table 3 Bivariate linear regression model's predictor and dependent variables

Predictor variable	Dependent variables (Y)	
Low-density index (LDI)	Tourism indicators (TI):	Overnight stays – total (OS)
		Overnight stays – Portuguese residents (OSP)
		Overnight stays – foreign residents (OSF)
		Lodging revenue (euro) (LR)
		Lodging capacity (units) – total (LC)
		Lodging capacity (units) – hotels (LCH)
		Lodging capacity (units) – local accommodation (LCLA)
		Lodging capacity (units) – rural tourism (LCRT)
		Bed occupancy rate (%) (BR)
		Length of stay (nights) (LS)
		OS percentage change: 2013–2018
		OSP percentage change: 2013–-2018
		OSF percentage change: 2013–2018
		LR percentage change: 2013–2018
		LC percentage change: 2013–2018
		LCH percentage change: 2013–2018
		LCLA percentage change: 2013–2018
		LCRT percentage change: 2013–2018
		BR percentage change: 2013–2018
		LS percentage change: 2013–2018

Bivariate regression models allow for the assessment of individual regression coefficient signs and the measurement of the proportion of the variation (R-squared) in each dependent tourism indicator that is expected to be affected by the *LDI*. Each bivariate linear regression model was specified as follows:

$$TI = \beta_0 + \beta_1 LDI + \varepsilon \tag{4}$$

where *TI* represents the predicted value for a given tourism indicator (dependent variable), *LDI* is the Low-density index value (independent variable or regressor), β_0 and β_1 are constants describing the functional relationship between *LDI* and each considered criterion (the y-intercept and the slope respectively), and ε is the error term (residuals).

4 Results and Discussion

4.1 LDI Index and Spatial Outline

The main objective for the delimitation of low-density territories is to allow the development of specific place-based public policies to tackle the vulnerabilities caused by the vicious cycle of depopulation/aging/socioeconomic decline normally associated with these areas, aiming at fostering territorial cohesion and economic development. The resulting geographical distribution of the LDI indicates that this reality is not exclusively associated with the most inland regions of mainland Portugal (Fig. 2).

The LDI adjusts very well to the national urban system, with both metropolitan areas presenting the higher LDI values, followed by second-tier cities outside metropolitan regions like Aveiro, Braga, Coimbra, and Faro. Most of the civil parishes with lower LDI values are located in the north and central regions, mainly in the interior areas, where only major municipal urban centers present somewhat higher LDI values. Exceptions occur, namely in coastal regions such as *Alto Minho* located in the northwest and *Alentejo Litoral* situated in the southwest of Portugal, which exhibits significant areas with low LDI values that be explained by the presence of relevant natural protected areas.

The operationalization of place-based policies raises the question of how the results obtained should be used to define a low-density map. Parishes are an adequate territorial scale for some specific programs like the LEADER community program, but bearing in mind the principles of coherence, functionality, and effectiveness of public policies, other administrative levels, namely the municipalities and NUTS3, need to be taken into account. For these levels, LDI was determined by the average of the total corresponding lower administrative units (Fig. 3).

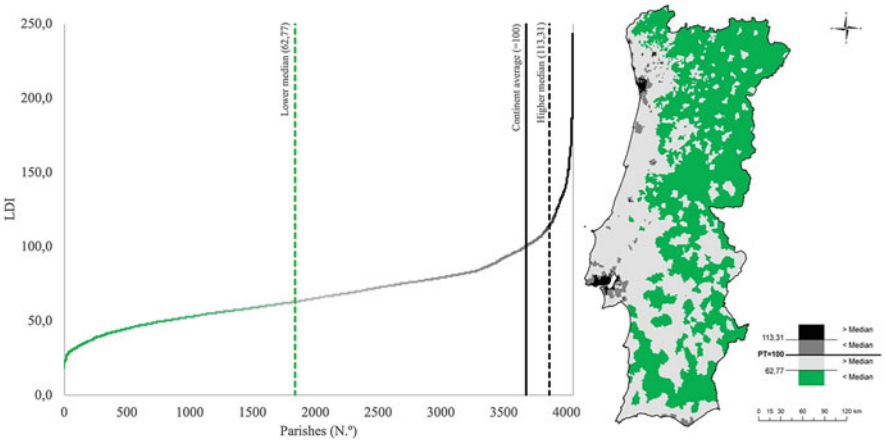

Fig. 2 LDI of continental Portugal parishes (lowest LID values correspond to low-density areas)

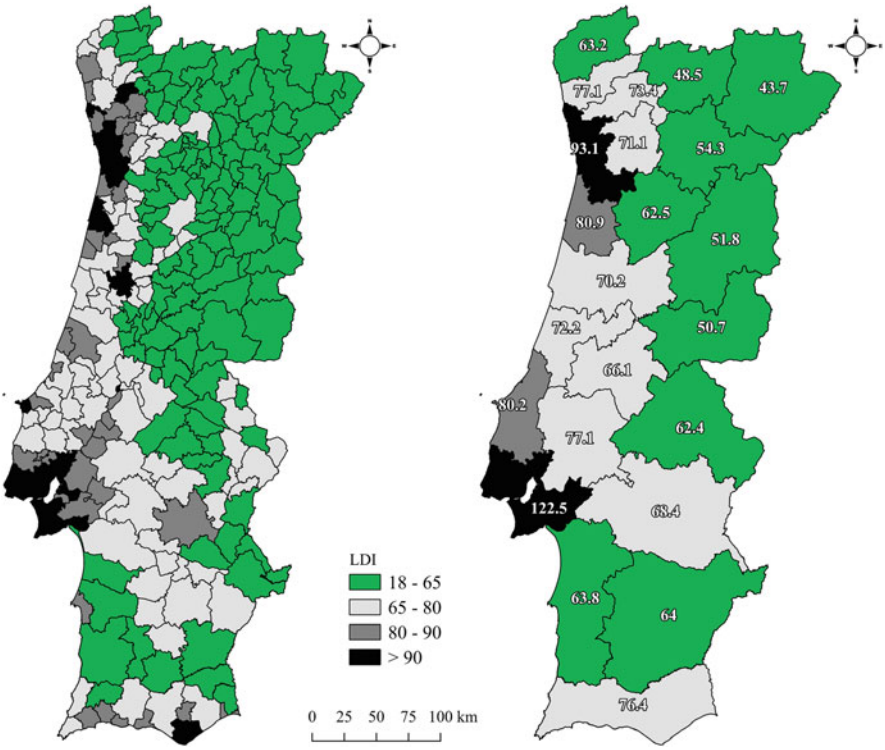

Fig. 3 LDI average values at municipal (left) and NUTS3 (right) administrative levels

The LDI mapping (Fig. 3) provides an overview of the effect that occurs following a process of aggregation of multiple constructs when shifting from the municipal to the NUTS3 level, helping to circumstantiate local policy measures within a sub-regional context (NUTS3). This is particularly important when sectoral policy and supra-municipal action are required to articulate the territory comprehensively. One of the most evident effects of tourism is its contribution to regional development (Fazenda et al. 2008), and so anchoring tourism planning action at a meso level, i.e., the NUTS3, is particularly appropriate.

4.2 Level of Influence of the LDI on Each Tourism Indicator in 2018 and the Respective Percentage Change for the Period of 2013 to 2018

The bivariate linear regression models were first applied at the municipality level, exhibiting either a non-significant effect of the predictor variable (LDI) on most response variables (tourism indicators and corresponding percentage change for the

period of 2013 to 2018) or either heteroskedasticity issues. Once heteroskedasticity was corrected, the bivariate linear regression models provided insufficient significant results for analysis and a negligible explanation toward response, i.e., a low coefficient of determination (R^2). The overall effect of the LDI at the municipality level does not provide substantial and robust information toward the implications that low-density has on tourism.

Yet, when applied at the NUTS3 level, the individual simple linear regression models exhibit a statistically significant predictor variable (LDI) and important results in terms of the coefficient of determination in all tourism indicators for 2018 (Table 4). Furthermore, the results also exhibit an overall non-significant effect of the LDI on the percentage change of each tourism lodging indicator for the period of 2013 to 2018, except for the "local accommodation capacity" and "rural tourism capacity" percentage change (Table 4).

This study's findings also suggest that the LDI tends to explain a similar level of the proportion of the variation (R^2) of the response data around each mean, i.e. >34%, on every aggregate demand and supply tourism indicator (e.g., overnight stays, lodging revenue, lodging capacity). Aggregate indicators provide flat results that include both urban and rural contexts and thus tend to primarily reflect the influence of the demand and supply beyond the low-density outline. This is particularly striking due to the positive coefficient on all models apart from those which have "lodging capacity (units): rural tourism" and "LCRT percentage change: 2013–2018" as dependent variables. A positive coefficient means that an increase in the LDI, i.e., convergence toward a higher density context, determines a rise in both demand and supply tourism indicators in 2018. The contrary, a negative coefficient, which was only observed when regressing either "lodging capacity (units): rural tourism" or "LCRT percentage change: 2013–2018" on the LDI, indicates that an increase in the LDI, i.e., a divergence from peripheral and lower density areas, determines a decrease in lodging typologies that are specific to rural and outlying areas of around 1.7%,[4] as well as a positive percentage change of rural tourism lodging capacity between 2013 and 2018. This shows that the investment in specific accommodation typologies is being accomplished according to the territorial profile, which is condensed in the LDI.

Additional implications can be observed from the application of bivariate linear regression models which are associated with the relevant effect of the LDI on either the "lodging capacity (units): local accommodation" and "bed occupancy rate" response variables, explaining a significant proportion of the variation (R^2) around each indicator's mean of, respectively, 63% and 72%. Due to the positive sign of both coefficients, these results are again determined by the pull effect of urban and denser areas. In the case of the "lodging capacity (units): local accommodation," it is a result of a governmental legal change in 2008 which purged several lodging

[4]By converting the "Lodging capacity (units)—Rural tourism" variable to the log scale, the beta coefficient for "LDI" provides the percentage change in "Lodging capacity (units)—Rural tourism" for every unit increase in "LDI".

Table 4 Bivariate regression models' results (NUTS3)

Predictors	Coefficient	R^2	Adjusted R^2
Overnight stays—Total (OS) (2018)	200939** (55609.2)	0.38	0.35
OS percentage change: 2013–2018	***	–	–
Overnight stays—Portuguese residents (OSP) (2018)	42982.7** (12231.6)	0.37	0.34
OSP percentage change: 2013–2018	***	–	–
Overnight stays—foreign residents (OSF) (2018)	157956** (43560.7)	0.39	0.36
OSF percentage change: 2013–2018	***	–	–
Lodging revenue (euro) (LR) (2018)	2245.39** (677.337)	0.34	0.31
LR percentage change: 2013–2018	***	–	–
Lodging capacity (units)—total (LC) (2018)	9.18081** (2.10396)	0.48	0.45
LC percentage change: 2013–2018	***	–	–
Lodging capacity (units)—hotels (LCH) (2018)	3.67148** (1.01204)	0.39	0.36
LCH percentage change: 2013–2018	***	–	–
Lodging capacity (units)—local accommodation (LCLA) (2018)	6.25182** (1.04218)	0.63	0.61
LCLA percentage change: 2013–2018	0.002525* (0.001192)	0.18	0.14
Lodging capacity (units)—rural tourism (LCRT) (2018)	−0.742492** (0.372602)	0.16	0.12
LCRT percentage change: 2013–2018	−0.003571** (0.001363)	0.25	0.21
Bed occupancy rate (%) (BR)	0.488908** (0.06577)	0.72	0.71
BR percentage change: 2013–2018	***	–	–
Length of stay (nights) (LS)	***	–	–
LS percentage change: 2013–2018	***	–	–

Dependent variable: Average (based on municipality) LDI–NUTS3
*, ** indicates significance at 95% and 99%, respectively
*** Coefficients estimates are not significantly different from zero ($p > 0.05$)
Standard errors are reported in parentheses

classifications highly embedded in urban areas. This process led to the conversion of a vast number of lodging units to the newly legalized form of accommodation, i.e., the "local accommodation." Moreover, this result can also be explained by the enormous increase in the investment in new "local accommodation" units, particularly in urban areas. Lisbon is a clear illustration of what has been occurring in the last few years. Just in 2016, the Metropolitan Area of Lisbon has had an increase of 95% in the number of new "local accommodation" units, which resulted in a 75% increase in its accommodation capacity compared to 2015 (AHRESP 2017). The

bivariate regression results show that a rise in 1 point in the LDI (convergence towards higher-density areas) corresponds to an increase of around six "local accommodation" units.

Finally, the "bed occupancy rate" indicator's prominent proportion of response variation, i.e., 72%, provides an insight into the sustainability capability level of tourism businesses determined by the low-density indicator. Again, results suggest that lodging units that diverge from low-density areas tend to increase their bed occupancy rate significantly: i.e., a 2-point increase in the LDI means a 1 percentage point growth in the bed occupancy rate. Given the lowest NUTS3 occupancy rate in 2018, i.e., 17%, it exposes the extreme impact and imbalance of sustainable opportunities in terms of tourism development determined by geographic conditions.

5 Conclusion

By looking at mainland Portugal as an example, this study proposes and operationalizes a new methodology that can be replicated to construct a composite measure/index which allows classifying low-density areas, regardless of the territorial scale of analysis (parish, municipality or NUTS3). This index is based on a set of factors that improve on the conventional limits of demographic indicators, by integrating territorial, settlement structure, socioeconomic, and accessibility profiles. This study also contributes to theory by providing evidence about the relationship between low-density areas and tourism development through the regression of the LDI on tourism logging indicators, applied in this study as proxy variables, due to the lack of disaggregation of tourism indicators.

Moreover, this investigation demonstrates a clear polarizing influence of denser areas in terms of demand and supply by exposing their pull effect, either through positive regression coefficients or a higher proportion of response variation to the LDI. It also provides strong evidence of how territorial imbalances, condensed in the LDI, compromise sustainable tourism development.

Further empirical evidence confirms that there is a negative association between rural tourism lodging and the LDI. This can have significant managerial implications by providing a preliminary geographical reading that links spatial dissonances and tourism development trends, particularly in low-density areas. Given this evidence, this research has also policy implications by encouraging a critical interpretation of a territory's functional differences, and so offering guidance on land-use planning and development policies consistent with a complex territorial outline.

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