Measuring Demographic Vulnerability and Territorial: a Composite Index Approach

João Lourenço Marques(✉), Jan Wolf, and Joana Duarte

GOVCOPP, Department of Social, Political and Territorial Sciences, University of Aveiro, Campus Universitário de Santiago, Aveiro, Portugal
jjmarques@ua.pt

Abstract. Low-density territories (LDTs) across Southern Europe have been experiencing persistent demographic contraction, population ageing, and deepening socioeconomic marginalisation. Despite the growing urgency of these challenges for territorial policy, most analytical approaches treat demographic and socioeconomic dimensions in isolation, which limits their capacity to capture the full complexity of territorial decline. This paper proposes an integrated analytical framework that simultaneously assesses demographic vulnerability and territorial attractiveness using a composite index. The framework brings together the Demographic Vulnerability Index (DVI) and a multidimensional Attractiveness Index (AI), the latter structured around three policy-relevant domains: housing conditions, economic performance, and access to general interest services and infrastructure. Methodologically, the approach applies min–max normalisation, polarity adjustment, and a two-stage aggregation procedure. Within each dimension, variables are combined using weighted arithmetic means; across dimensions, a weighted geometric mean is applied, allowing for partial substitutability within domains while penalising severe imbalances across them. When applied to the 165 Portuguese municipalities officially classified as low-density, the framework reveals a pronounced spatial duality. Demographic vulnerability is heavily concentrated in the North–Centre–Alentejo interior corridor, yet territorial attractiveness varies considerably within this same space. The coexistence of structural demographic fragility with localised development assets constitutes one of the central findings of this study. The proposed framework offers a transparent, replicable, and policy-relevant diagnostic tool for differentiating territorial profiles and guiding evidence-based regional interventions.

Keywords: demographic vulnerability · territorial attractiveness · low-density territories · composite indices · Portugal · depopulation · regional policy

1 Introduction

Population decline and demographic ageing have become defining features of low-density territories (LDTs) in Portugal and, more broadly, across Southern and Eastern Europe. What distinguishes these territories is not simply their low population density, but a compounding set of structural processes: demographic contraction, functional fragility, and progressive socioeconomic marginalisation. These dynamics stem

© The Author(s), under exclusive license to Springer Nature Switzerland AG 2027
O. Gervasi et al. (Eds.): ICCSA 2026, LNCS 16769, pp. 456–469, 2027.
https://doi.org/10.1007/978-3-032-30494-0_29

from persistently sub-replacement fertility, selective out-migration that disproportionately removes younger and more educated residents, and spatially uneven economic development. Together, they pose serious challenges to territorial cohesion and have prompted a range of public interventions—from fiscal incentives and employment support to institutional frameworks such as Portugal's Inland Mission Unit (*Unidade de Missão para a Valorização do Interior*).

Assessing the effectiveness of such interventions is methodologically difficult. Policies tend to be diffuse, counterfactual scenarios are hard to construct, and territorial trajectories are highly heterogeneous across municipalities. A further limitation lies in the analytical tools typically used: existing approaches tend to examine either demographic trends or socioeconomic indicators in isolation, thereby preventing a comprehensive understanding of territorial decline. What is needed are integrated frameworks capable of simultaneously capturing structural vulnerability and territorial attractiveness—yet operational models combining these two dimensions in a spatially consistent and policy-interpretable manner remain scarce in the literature.

This paper responds to that gap. It develops a composite index framework that jointly operationalises demographic vulnerability and territorial attractiveness within a single analytical model. The framework was produced under the REVITA project (Strategic Responses for the Revitalisation of Low-Density Territories), within the Science4Policy 2025 programme, and is designed to be methodologically replicable, spatially comparable across municipalities, and directly interpretable for policy purposes. Its empirical application to Portugal's 165 officially classified LDT municipalities demonstrates its diagnostic potential and its capacity to underpin differentiated, evidence-based territorial policy.

2 Theoretical Background

2.1 Depopulation as a Structural Process

Depopulation has gained growing public and academic visibility, often portrayed as an unprecedented contemporary phenomenon. However, as [1] notes, this perception constitutes a 'false novelty': the process is structural and long-standing, not exclusive to the present moment. [2] Coleman and Rowthorn (2011) demonstrate that the fear of population decline is recurrent throughout history, reappearing cyclically and typically amplified by emotional, symbolic, and political readings of demographic data that diverge sharply from analytical interpretations.

[3] characterises contemporary depopulation as a phased structural dynamic. In the initial stage, fertility falls below replacement level, but the natural balance remains positive due to demographic inertia. In a second phase, deepening low fertility and cohort ageing generate a negative natural balance, partially offset by positive migratory flows. Finally, at an advanced stage, even immigration can no longer neutralise population loss, leading to continuous structural decline. Portugal's LDTs have entered this third stage considerably earlier than the national average, making them important laboratories for understanding advanced depopulation dynamics.

2.2 Long-Run Demographic Trends in Portugal

Portugal displays two major national-scale demographic ruptures: in 1970 and 2021. The 1970 rupture resulted from massive post-war emigration to Europe; the 2021 inflexion reflected the simultaneous contraction of natural growth and the migration balance, compounded by the prolonged effects of the 2008 financial crisis. LDTs exhibit a markedly different chronology: structural breaks occurred predominantly between 1950 and 1960, well ahead of national turning points, and decline has been continuous and cumulative ever since [4].

LDTs reached their peak population in 1960 and have since lost more than one-third of their residents, declining from over 3.1 million to below 2 million by 2021 (INE Census data). In contrast, metropolitan municipalities nearly doubled their population over the same period. Expressed as an index (1940 = 100), LDTs stand below 65 while metropolitan areas exceed 200. This structural dualisation between a densely populated coastal strip and a sparsely inhabited interior constitutes the fundamental spatial challenge that the REVITA analytical framework addresses.

2.3 Policy Responses to Territorial Decline

Policy responses to demographic decline have oscillated between two broad strategies: compensatory growth policies centred on attracting population and investment, and adaptation and managed-shrinkage policies that acknowledge irreversibility and seek innovative solutions to maintain quality of life [5, 6]. Evidence consistently shows that most responses remain trapped in a growth culture, denying or ignoring decline and thereby delaying the formulation of more adjusted strategies [7, 8]. Planning for presumed growth aggravates the negative effects of population loss, leading to accumulated infrastructural overcapacity and underutilised equipment.

Emerging concepts such as smart shrinkage [9] and rightsizing [10] advocate for planned management of 'living with less', prioritising quality of life, service adequacy, and environmental sustainability over numerical growth targets. For LDTs, differentiated territorial strategies must simultaneously: (a) minimise threats to quality of life during demographic transitions; (b) identify and exploit endogenous opportunities for population attraction; and (c) selectively invest in territorial anchor points with demonstrated capacity for service retention and development diffusion [8].

These strategic imperatives call for analytical tools capable of diagnosing both the depth of demographic vulnerability and the latent potential for territorial attractiveness. This dual requirement informs the composite index framework developed in the following sections.

3 Methodology

3.1 Study Area and Data Sources

This study focuses on the 165 municipalities that Portugal's 2030 programme formally designates as low-density territories (Deliberation No. 31/2023/PL). In spatial terms, the sample is far from randomly distributed—the vast majority of these municipalities

occupy a contiguous interior corridor spanning the North, Centre, and Alentejo regions, reflecting the well-documented asymmetry between coastal and inland Portugal. Data were drawn from a range of official institutions: INE (censuses, housing statistics, purchasing power, and business accounts), IEFP (unemployment), DGEEC (school equipment), DGS (health services), OpenStreetMap and DGT (road network for accessibility calculations), and the Portuguese Tourism Open Data portal. For each variable, we used the most recent year available. The most recent available data were selected for each variable, producing some temporal heterogeneity across indicators. This small degree of temporal inconsistency across indicators is an unavoidable consequence of this approach, though it was assumed preferable, given that outdated data would undermine the diagnostic value of the framework.

3.2 Composite Index Framework

The analytical framework comprises two complementary composite index families, each capturing a structurally distinct dimension of territorial condition. The first is the Demographic Vulnerability Index (DVI) that characterises each territory's structural exposure to demographic risk and fragility. The second is the Attractiveness Index (AI) that captures multidimensional development conditions through three sub-indices, each corresponding to a central policy domain with direct bearing on territorial fixation capacity: Housing (IHab), Economy (IEcon), and General Interest Services and Accessibility (ISIG). Variables were selected on the basis of: (i) theoretical grounding in the literature on territorial dynamics and demographic decline; (ii) spatial consistency across municipalities, ensuring meaningful comparisons; and iii) policy interpretability, in which, each variable had to be interpretable into concrete intervention priorities, so that weaknesses identified by the index could directly inform policy decisions.

3.3 Normalisation, Polarity Adjustment, and Aggregation

The methodological procedure followed three sequential steps. First, all variables were normalised to a 0–1 scale using min–max normalisation:

$$x_{ij}^{*} = \left(x_{ij} - min_{-j}\right) / \left(max_{-j} - min_{-j}\right) \tag{1}$$

where x_{ij} is the observed value of variable j in municipality i, polarity was then adjusted so that 1 represents the best territorial condition and 0 the worst. Within each dimension, variables were aggregated using a weighted arithmetic mean, reflecting an assumption of partial substitutability among indicators capturing related aspects of the same domain.

By contrast, the overall Attractiveness Index (IA) was computed using a weighted geometric mean across dimensions:

$$I_i = \prod \left(x_{ij}^{*}\right)^{w_j} with \sum w_j = 1 \tag{2}$$

The use of the geometric mean at the aggregate level introduces a non-compensatory structure between dimensions. This choice was preferred over arithmetic alternatives for four reasons: (i) it penalises imbalances across core dimensions, requiring consistent

performance to achieve high index values; (ii) it reflects the multiplicative nature of territorial attractiveness, where housing, economic conditions and services interact rather than combine linearly; (iii) it reduces sensitivity to extreme values; and (iv) it supports a more demanding policy interpretation, whereby critical weaknesses in any dimension constrain overall performance – a desirable property in diagnostics aimed at identifying intervention priorities.

3.4 Demographic Vulnerability Index (DVI)

The DVI integrates four variables capturing complementary structural dimensions of population decline. Table 1 summarises the variables, sources, polarities, and weights. The formula is:

$$IVD_i = 100 \times \left(0.30\,P_{var,i} + 0.20\,P_{ativa,i} + 0.20\,P_{fec,i} + 0.30\,P_{migr,i}\right) \quad (3)$$

Table 1. Variables included in the Demographic Vulnerability Index (DVI).

Variable	Source / Year	Rationale
Resident pop. Change 2011/2021 (%) *(P_VAR$_i$)*	INE, Census 2021	Net result of structural and conjunctural dynamics; persistent decline increases vulnerability
Working-age pop. 15–64 (%) *(P_WORK$_i$)*	INE, Census 2021	Proxy for ageing structure; cumulative and difficult to reverse
Total fertility rate *(P_ISF$_i$)*	INE, 2021	Generational renewal capacity; low values indicate difficulty in self-replacement
Net migration growth rate (%) *(P_MIGR$_i$)*	INE, 2014–2024	Short-term population retention and attraction capacity: a key compensatory mechanism

3.5 Attractiveness Index (AI) and Sub-Indices

The AI aggregates three sub-indices with equal weights (0.33 each), reflecting the analytical judgement that housing conditions, economic vitality, and service provision constitute structurally equivalent pillars of territorial attractiveness:

$$AI_i = \left(IHab_i \times IEcon_i \times ISIG_i\right)^{(1/3)} \quad (4)$$

Table 2. Dimensions and variables of the Attractiveness Index (AI).

Sub-index	Variables used in the Sub-index	Key data sources
Housing (IHab)	(7) H_aloj: *Dwellings per inhabitant. (housing supply)*; H_vaga: *Vacancy rate of conventional dwellings (%)*; H_prec: *Median housing price per* m^2 *(€)*; H_qual: *Share of dwellings with adequate habitability conditions (%)*; H_idade: *Average building age (years)*; H_sec: *Share of secondary residences (%)*; H_tur: *Growth rate of tourist accommodation* (%)	INE Census 2021; INE Local Housing Prices 2024; Tourism Open Data 2025
Economy (IEcon)	(5) E_VAB: *Gross value added per capita (€ per inhabitant)*; E_IPC: *Purchasing power index (%)*; E_des: *Unemployment rate (%)*; E_qual: *Average years of schooling (human capital)*; E_emp: *Employment change (%), 2011–2021*	INE SCIE 2021; INE Purchasing Power 2021; IEFP 2021
Services & Access. (ISIG)	(10) (**Education**): A_esc: *Travel time to secondary schools (minutes)*; A_ebas: *Travel time to basic schools (minutes)*; A_alunos: *Students per school ratio*; A_varEquip: *Variation in school equipment (%)*; (**Healthcare**): A_hosp: *Travel time to nearest hospital (minutes)*; A_ucs; *Travel time to primary healthcare units (minutes)*; A_farm: *Travel time to pharmacies (minutes)*; A_utentes: *Patients per healthcare unit ratio*; A_med; *Physicians per 1,000 inhab*, (**Basic Goods Accessibility**): A_alim: *Travel time to food retail establishments (minutes)*	DGEEC 2021; DGS records; OSM/DGT road network 2018

The Housing Sub-index ($IHab_i$) captures the structural capacity of territories to support residential fixation through the availability, affordability, quality, and functional use of the housing stock. It integrates both supply-side conditions (e.g., dwellings per inhabitant, vacancy rates) and demand-side pressures (e.g., housing prices, tourism dynamics), while also accounting for physical adequacy (habitability and building age) and competing uses of housing (secondary residences).

Overall, the index reflects the extent to which local housing markets facilitate or constrain long-term population retention and attraction.

It is computed as:

$$\begin{aligned} I_{Hab,i} &= 100 \times (0.15\,H_{aloj,i} + 0.10\,H_{vag,i} + 0.25\,H_{prec,i} + 0.15\,H_{qual,i} + \\ &\quad 0.10\,H_{idade,i} + 0.10\,H_{sec,i} + 0.15\,H_{var_tur,i} \end{aligned} \tag{5}$$

The Economy Sub-Index ($IEcon_i$) captures the structural and dynamic capacity of local economies to generate employment, income, and development opportunities. It combines indicators of productive performance (GVA per capita), household well-being (purchasing power), labour market conditions (unemployment rate), and human capital (education levels), alongside recent employment dynamics.

Together, these dimensions reflect both the underlying economic structure and the short-term capacity of territories to sustain and attract population through viable economic prospects.

It is given by:

$$I_{Econ,i} = 100 \times \left(0.25\,E_{VAB,i} + 0.20\,E_{IPC,i} + 0.25\,E_{Des,i} + 0.20\,E_{Qual,i} + 0.10\,E_{VarEmp,i}\right) \tag{6}$$

The General Interest Services and Accessibility Sub-index ($ISIG_i$) captures the extent to which territories ensure effective access to essential services and daily-life infrastructure. It integrates spatial accessibility (travel times), service provision capacity (e.g., healthcare supply, school density), and recent service dynamics (evolution of education, healthcare, and retail networks). The index reflects how service availability and proximity shape quality of life and condition residential decision-making, particularly in low-density contexts where distance and service decline are critical constraints.

It is computed as:

$$I_{\mathrm{SIG},i} = 100 \times \begin{pmatrix} 0.10\,A_{\mathrm{Esc},i} + 0.15\,A_{\mathrm{Ebas},i} + 0.05\,A_{\mathrm{Alunos},i} + 0.05\,A_{\mathrm{VarEquip},i} \\ +0.05\,A_{\mathrm{Hosp},i} + 0.10\,A_{\mathrm{UCP},i} + 0.05\,A_{\mathrm{Farm},i} + 0.15\,A_{\mathrm{Sutentes},i} + 0.05\,A_{\mathrm{Med},i} + 0.25\,A_{\mathrm{Alim},i} \end{pmatrix} \tag{7}$$

Data were collected from official and publicly available sources, including the Portuguese National Statistics Institute (INE), the Institute for Employment and Vocational Training (IEFP), the Directorate-General for Education and Science Statistics (DGEEC), the Directorate-General of Health (DGS), and spatial datasets derived from OpenStreetMap (OSM) and the Directorate-General for Territory (DGT). The most recent available data were used for each variable, accepting minor temporal inconsistencies to ensure analytical relevance.

All variables were normalised using min–max transformation and adjusted for polarity so that higher values consistently represent more favourable territorial conditions.

Variables originally associated with negative territorial outcomes (e.g., unemployment rates, travel times, vacancy rates) were inverted before aggregation.

4 Results

4.1 Demographic Vulnerability Index

The spatial distribution of the DVI reveals a well-defined pattern across the territory. The highest vulnerability scores are concentrated in the interior of North and Centre of Portugal, extending into significant parts of Alentejo. In these municipalities, accelerated population loss, extreme demographic ageing, persistently low fertility, and negative or stagnant net migration reinforce one another, producing particularly severe conditions of demographic risk. The coastal–interior divide is sharp and persistent, consistent with the long-run structural dynamics described in Sect. 2.

Equally important, however, are the exceptions that the DVI reveals. Not all LDT municipalities follow the dominant pattern, a considerable number record intermediate or even low vulnerability scores, suggesting that demographic trajectories within this category are more varied than aggregate narratives imply. This finding carries a direct methodological implication, i.e., low-density classification cannot be treated as a uniform proxy for demographic risk. This internal heterogeneity within the LDT category makes simple binary classifications analytically inadequate, and points to the need for more granular diagnostic tools (Fig. 1).

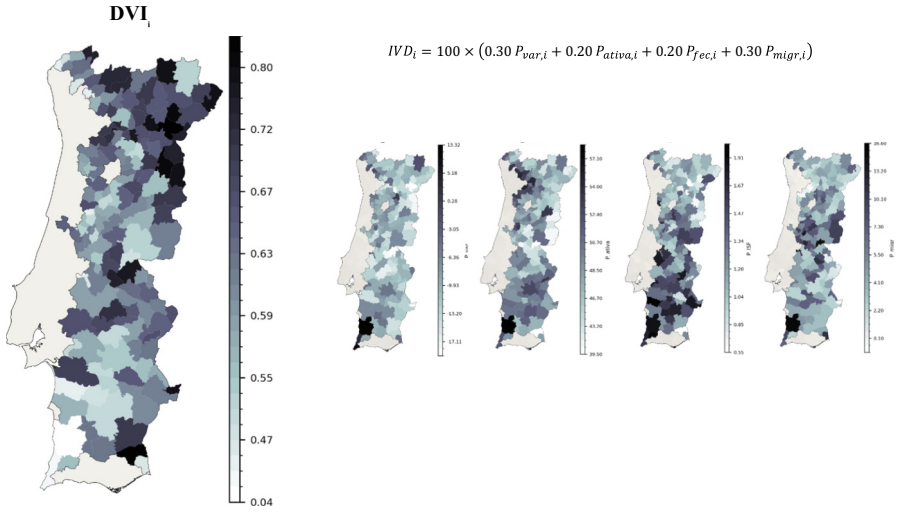

Fig. 1. Demographic Vulnerability Index (DVI) and its underlying variables: population change (P_VAR), working-age population share (P_ENV), total fertility rate (P_ISF), and net migration rate (P_MIGR).

4.2 Attractiveness Sub-Index Results

Turning to housing conditions, the Housing Sub-index (IHab) results reveal a spatial pattern that runs counter to expectations. The highest housing attractiveness scores are not

concentrated along the coast, but rather in the interior North–Centre, the very corridor displaying the greatest demographic vulnerability. This pattern reflects relatively affordable housing markets, adequate building stock quality, and limited pressure from secondary residences and tourism. Coastal municipalities, by contrast, face tourism-driven price inflation and a high concentration of non-primary residential uses, both of which substantially reduce the attractiveness of local housing to permanent residents. What emerges, then, is that housing conditions in many interior LDTs represent a latent asset for population retention, though one that cannot operate in isolation from improvements in economic conditions and service provision (Fig. 2).

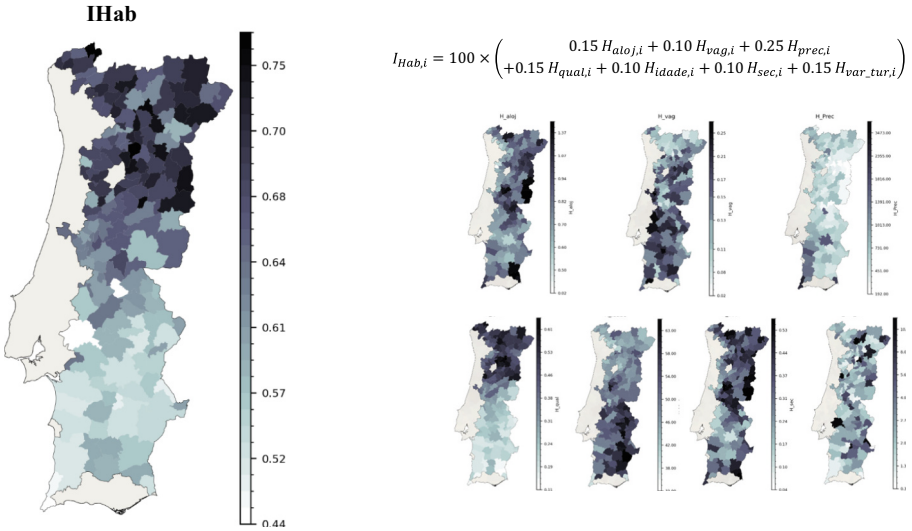

Fig. 2. Housing Sub-index (IHab) and its underlying variables: dwellings per inhabitant (H_ALOJ), vacancy rate (H_VAG), median housing price (H_PREC), habitability conditions (H_QUAL), building age (H_IDADE), secondary residences (H_SEC), and tourist accommodation growth (H_VAR_TUR).

The Economy Sub-index (IEcon) reveals a more heterogeneous territorial pattern. The municipalities with the strongest economic scores combine high productive output (measured by GVA per capita), lower unemployment levels, a more educated workforce, and positive employment dynamics. However, significant asymmetries are observable: in some cases, high economic performance is tied to a narrow set of sector-specific activities and does not translate into broader labour-market strength or human capital development. This shows that sectoral concentration alone is insufficient to ensure long-term territorial attractiveness. The most economically disadvantaged areas have a few things in common: (i) first, they have low productivity, (ii) second, many people there have limited income levels, (iii) third, there is high unemployment and (iv) finally, there

are fewer and fewer jobs available. All of these factors reflect structural constraints that reduce their capacity to sustain and attract population (Fig. 3).

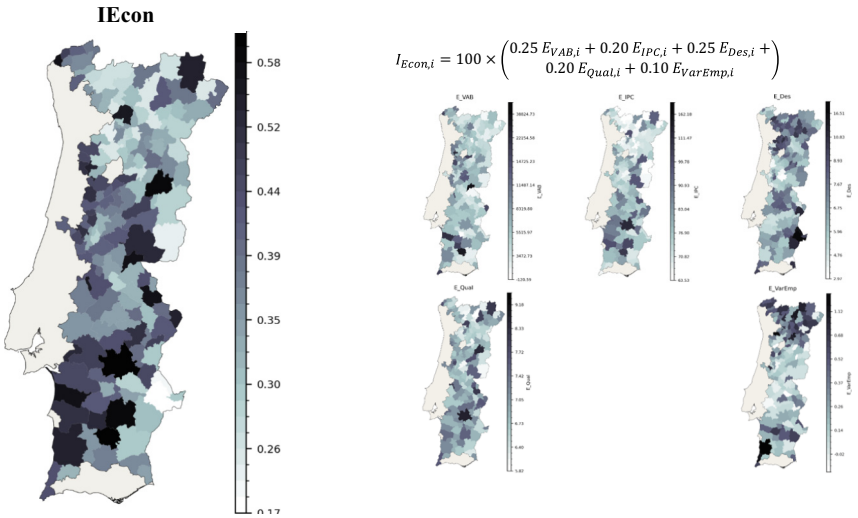

Fig. 3. Economy Sub-index (IEcon) and its underlying variables: gross value added per capita (E_VAB), purchasing power index (E_IPC), unemployment rate (E_DES), mean years of schooling (E_QUAL), and employment change (E_VAREMP).

The Services and Accessibility Sub-index (ISIG) reveals that limited access to healthcare is the most challenging issue for LDT municipalities. Travel times to primary care facilities are long, and there are few medical professionals across much of the interior. Educational accessibility is better in municipalities with viable school networks, though this varies. Access to basic goods, particularly food retail, increasingly depends on the quality of road infrastructure, a finding with direct implications for infrastructure investment priorities in the interior (Fig. 4).

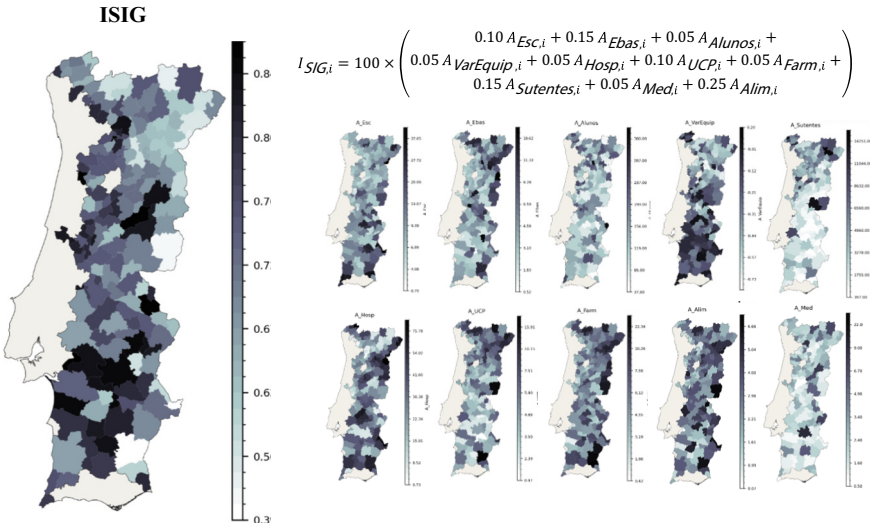

Fig. 4. Services and Accessibility Sub-index (ISIG) and its underlying variables: travel time to primary school (S_EB1), travel time to secondary school (S_EB23), pupils per school (S_ALUNOS), change in school equipment (S_VARESC), travel time to primary healthcare (S_CSP), general practitioners per 1,000 inhabitants (S_MED), change in primary care units (S_VARCSP), travel time to pharmacy (S_FARM), travel time to supermarket (S_SUPER), and change in retail units (S_VARCOM).

4.3 Integrated DVI-AI Typology

Mapping municipalities on a DVI–AI cartesian plane produces a four-quadrant territorial typology with direct policy relevance. Table 2 characterises the four emergent profiles. The largest share of LDT municipalities falls in the Critical (Double Jeopardy) quadrant, combining high demographic vulnerability with low attractiveness. The Fragile / Latent Potential quadrant reveals a meaningful subset of demographically fragile territories that retain significant assets in housing, economy, or services, creating opportunities for targeted activation policies (Fig. 5).

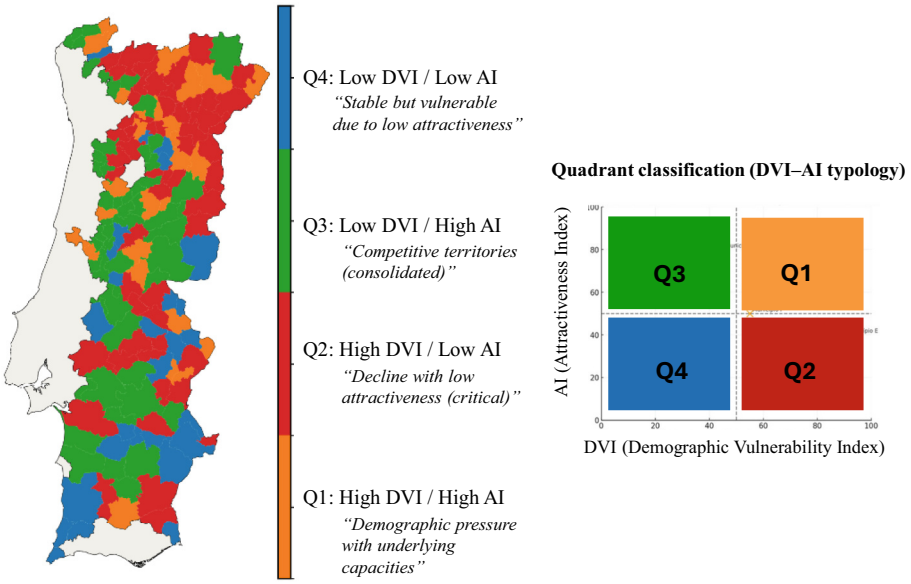

Fig. 5. DVI–AI territorial typology across Portuguese low-density municipalities, showing four quadrants (Q1–Q4) based on the intersection of demographic vulnerability and territorial attractiveness.

The DVI–AI intersection defines four territorial profiles with distinct policy implications: critical areas (high vulnerability, low attractiveness) requiring managed shrinkage strategies; latent potential territories (high–high) suited for activation policies; resilient systems (low vulnerability, high attractiveness) acting as development nodes; and stable but low-attractiveness areas (low–low), where service maintenance and monitoring are key.

5 Discussion

The empirical results support the central analytical claim of this paper, i.e., demographic vulnerability and territorial attractiveness are distinct dimensions that cannot be reduced to one another, yet they interact in ways that matter substantially for territorial diagnosis and policy design. Rather than aligning along a single continuum from decline to vitality, LDT municipalities exhibit a range of configurations, combining varying degrees of structural fragility and latent development potential. This heterogeneity is masked when analytical frameworks rely on single indicators or treat low-density classification as synonymous with uniform decline.

The paper's methodological contribution is the integrated operationalisation of both dimensions within a coherent composite index system. The use of weighted arithmetic means at the sub-index level allows for partial substitutability among closely related indicators within the same domain. The weighted geometric mean applied across dimensions introduces a non-compensatory logic: a territory with severely deficient economic conditions cannot compensate for that weakness by performing well on housing or service

provision. This design produces diagnostics that are more demanding and more policy-realistic than purely additive alternatives. The resulting four-quadrant typology (DVI–AI matrix) translates the analytical output directly into differentiated policy logics, ranging from adaptive management in highly fragile contexts to activation strategies in territories with residual structural assets.

A finding of particular policy significance is that high demographic vulnerability does not reliably coincide with low territorial attractiveness. The concentration of favourable housing conditions in some of the most demographically fragile municipalities points to underexploited assets that conventional analyses, focused predominantly on decline indicators, tend to overlook. This reinforces the case for moving beyond binary typologies and towards more nuanced, multidimensional diagnostics in both research and policy practice.

6 Conclusions

This paper has developed and applied an integrated composite index framework for the joint assessment of demographic vulnerability and territorial attractiveness in low-density territories. Applied to Portugal's 165 officially classified LDT municipalities, the analysis produces a structurally differentiated territorial map. Demographic fragility is most pronounced in the North–Centre–Alentejo interior corridor, yet the distribution of territorial attractiveness conditions varies considerably within this space, far more than aggregate narratives of interior decline would suggest.

The most significant finding is the systematic disconnection between vulnerability and attractiveness. Some of the most demographically fragile municipalities have favourable housing conditions, which are overlooked by standard analytical frameworks. This discrepancy challenges deterministic accounts of territorial decline, creating analytical space for more selective, opportunity-oriented policy approaches.

The results also make clear that effective responses to demographic decline in low-density territories cannot rely on uniform growth-oriented strategies. What is needed are territorially differentiated approaches: ones that protect quality of life under conditions of demographic contraction, mobilise endogenous assets where they exist, and selectively invest in territorial anchor points with demonstrated capacity for broader diffusion effects. In this context, adaptation, rather than reversal, is the more realistic and analytically defensible policy paradigm.

By integrating multiple dimensions into a transparent, replicable composite index system, the framework developed here provides a practical diagnostic tool for identifying territorial imbalances and informing evidence-based regional policy. Its methodological design is sufficiently flexible to extend beyond the Portuguese context, offering potential for comparative application across low-density regions elsewhere in Europe facing analogous structural challenges.

Acknowledgments. The authors acknowledge the support of PLANAPP – Centre for Planning and Evaluation of Public Policies – within the framework of the Science4Policy 2025 programme. We also thank all members of the REVITA project team for their valuable contributions, collaboration, and ongoing commitment throughout the development of this work.

Disclosure of Interests. The authors have no competing interests to declare that are relevant to the content of this article.

References

1. Recano, J.: Despoblamiento y despoblación: Dos conceptos complementarios. Boletín de la Asociación de Geógrafos Españoles **97** (2023)
2. Coleman, D., Rowthorn, R.: Who is afraid of population decline? a critical examination of its consequences. Popul. Dev. Rev. **37**(Suppl. 1), 217–248 (2011)
3. Dumont, G.-F.: Depopulation as a global structural trend. Population et Sociétés (forthcoming, 2025)
4. Gomes, M.C., Pimentel, P.: Demographic dynamics in Portugal: structure, trends and territorial differentiation. Análise Social **57**(245), 840–870 (2022)
5. Hospers, G.-J.: Policy responses to urban shrinkage: from growth thinking to civic engagement. Eur. Plan. Stud. **22**(7), 1507–1523 (2014)
6. Pallagst, K.: Shrink Smart: the Research Contribution of the European Research Network. Cardiff University, Cardiff (2009)
7. Wiechmann, T., Pallagst, K.: Urban shrinkage in Germany and the USA: a comparison of transformation patterns and local strategies. Int. J. Urban Reg. Res. **36**(2), 261–280 (2012)
8. Syssner, J.: Quietly Shrinking Cities: Swedish Planning in Contexts of Urban and Rural Population Decline. Policy Press, Bristol (2022)
9. Hollander, J.: Sunburnt Cities: the Great Recession. Depopulation and Urban Planning in the American Sunbelt. Routledge, London (2011)
10. Béal, V., Fol, S., Epstein, R., Rousseau, M.: French shrinking cities: urban policies and politics of denial. Town Plan. Rev. **90**(1), 1–21 (2019)
11. Bretagnolle, V., et al.: Combining demographic and economic indicators for territorial diagnosis. J. Reg. Sci. **59**(4), 701–724 (2019)
12. Instituto Nacional de, Estatística: Population and Housing Census 2021. INE, Lisbon (2021)