Assessing territorial vulnerabilities and spatial inequalities: the case of Portugal

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Abstract: The economic crisis of the past decade has exacerbated existing vulnerability problems in Europe, particularly in the southern countries. These relate to unemployment, poverty, housing conditions, access to basic services or insecurity issues, among others, and have affected particular groups as migrant or the elderly. Although the increase in quality of life is a transversal goal to cohesion and urban policies, the effects of vulnerability have only recently begun to be documented in scientific research. Generally, comparative vulnerabilities' assessments are based on limited (often economic) indicators or, if they are more comprehensive, on a limited territorial scale. Thus, they don't perform holistic analysis at national scale, nor comprehensive regional/municipal comparisons. Consequently, this paper presents a multivariate diagnosis of vulnerabilities at national scale, considering an array of indicators of quality of life in various domains as housing, health, accessibility, education, security or employment. Each indicator was geo-referenced and represented at municipal level, leading to the creation of indexes of vulnerability for each theme. An overall index of vulnerability combining all parcels was then composed through advanced statistical analyses' techniques. More than displaying territorial differences, this approach allows discussing different geographical realities within Portugal, and provide outputs for supporting planning policies concerning integration, social cohesion, urban equity, and the development of urban systems.

Keywords: Territorial cohesion; vulnerability; multi-scalar planning; Portugal

Introduction

The economic crisis that has affected Europe in the last decade has been particularly harsh to Southern European countries (Bosco and Verney, 2012, Whitehead et al., 2014, Torres, 2009, Cairns et al., 2014, Carballo-Cruz, 2011). Existing vulnerability problems have been exacerbated, and today, even if the crisis has officially passed, they are still felt. With austerity policies in place, aimed at correcting rising fiscal and external imbalances, countries like Portugal witnessed cuts in welfare benefits, wages and pensions, and saw the increase of taxes. An immediate consequence was the slowdown of production, consumption and investment, and the rise of unemployment. With the reduction of the purchasing power, the bankruptcy of families and businesses, the increasing gap between income and consumption, and the deterioration of the social security system, poverty levels have increased and new types of poverty have emerged.

Although the number of people at risk of social exclusion has decreased in Europe (Eurostat, 2019), the crisis, political unrest or citizen dissatisfaction have led to the emergence or the increased visibility of social vulnerabilities (Ranci et al., 2014). They have also contributed to increasing spatial segregation, poverty concentration and social inequalities (Madanipour and Weck, 2015). For example, access to basic services and socio-economic benefits have declined, and so have housing conditions (Frazer and Marlier, 2011, CECODHAS, 2012), whereas some types of crime, such as sexual and domestic violence, have increased (APAV, 2017). This denotes how particularly vulnerable groups, such as the low qualified, immigrants, elderly or youngsters, have been severely affected, leading to a social crisis as a result of the economic crisis. In countries where welfare support relies extensively on family resources – notably in southern Europe – these effects have created heavy strains (Madanipour and Weck, 2015). Consequently, in the words of Méndez et al. (2015) this not only brought about a second recession of the economy and a later phase of stagnation, but also emphasized the unfair distribution of its impacts.

Today, the most important political and planning discourses are concerned with responding to the UN's Sustainable Development Goals. These call, among other concerns, for the reduction of inequalities (Goal 10), and making human settlements more inclusive, resilient and sustainable (Goal 11). Quality of life (OECD, 2017), cohesion agendas (EC, 2017) and overall political initiatives (Madanipour and Weck, 2015) support such calls, advocating for policies to combat social inequality and exclusion, and emphasizing the importance of place-based approaches. However, if the scope of vulnerability issues, and their relation to sustainable planning, is being increasingly debated (Lee, 2014), the spatial dimension of social exclusion, poverty and overall vulnerability has so far been mostly neglected (Madanipour and Weck, 2015).

Impacts are not spatially uniform and the drivers for these patterns differ within countries and within regions (Marcińczak et al., 2015). The spatial dimension of exclusion, for example, is visible in the patterns of spatial segregation, in small-scale concentration of urban disadvantage, or in the rural problems of remoteness and accessibility (Murie and Musterd, 2004). However, comparative assessments of vulnerabilities have so far strongly relied on economic indicators or, if they have a greater scope, on selected sectoral indicators or a limited territorial scale. Thus, they don't perform holistic analysis at national scale, nor comprehensive regional/municipal comparisons taking into account an extensive battery of indicators.

In Portugal, the most important strategic planning document, the National Plan for Territorial Planning Policies (PNPOT), has been revised in 2018. It aims, according to Resolution n.º 44/2016 of the Council of Ministers, to further promote the territorial dimension of the public policies at various scales, by reinforcing the contribute of the urban structure and the improvement of quality of life in the country's development. It also intends to promote territorial cohesion and economic development with a strategy focused on the development of jobs and wealth outside the major metropolis, thus potentiating endogenous resources and a more planned and balanced distribution of facilities, functions and services. These goals point towards the development of mechanisms to regulate territorial inequalities that include multilevel integration of actors and instruments, but also to the construction of qualitative and analytical diagnosis. It is expected that these mechanisms allow exploring the relationships between geographies of vulnerability and the spatialization of planning policies, hence supporting spatially selective interventions and place-based prevention strategies.

Using Portugal as a test-case and contextualized in the aftermath of the revision of PNPOT, the main goal of this research is to perform a multivariate, territorial-based diagnosis of vulnerability, by creating and developing an innovative vulnerability index. This index is based on a wide range of relevant indicators of quality of life in 9 different domains, ranging from housing to economy to health. The purpose is dual; first to overcome the lack of space-based assessments of vulnerability at national scale. Second, to provide evidence-base for reshaping policy approaches and developing integrated responses.

This paper is organized into five sections. The second section reviews the (European) literature in terms of the measuring of territorial vulnerabilities and spatial inequalities at national and sub-national levels. The third section explains the methodology. The fourth section discusses the results, displaying the composite indexes produced. The fifth and last section presents the conclusions. Different geographical realities of Portugal are pointed out, raising awareness to vulnerability issues and leading to discussions regarding social cohesion and urban equity, crucial within current territorial planning in the European context.

Measuring territorial vulnerability and spatial inequalities

Sen (1976) started her well-known 1976 paper on measuring poverty by stating that two distinct problems should be faced: (i) identifying the poor among the total population, and (ii) constructing an index of poverty using the available information on the poor. This simple statement is still extremely profound and extremely relevant today, even if we substitute the word "poor" for "vulnerable" or "excluded" persons, or other related concepts. There is still the need – even more so after an economic crisis – to understand the dimensions of vulnerability, as well as to construct territorial indexes that may help us measure, understand and overcome them.

As Brown et al. (2017) state, vulnerability has many facets. The term has been widely used, particularly on the last two decades, in several areas of knowledge from medicine, to criminology to risk management (Gallardo, 2018). It has become a keyword for addressing issues of inequality or adversity, related to aspects such as economic or social disadvantage, insecurity or limited coping capacity (Brown et al., 2017). The concept itself is multidimensional, entailing a conceptual diversity that relates to the material and moral fragility of the most marginalized individuals or groups in society. Sapountzaki and Chalkias (2014) describe it as the loss potential of human, social, and economic capital. For Gallardo (2018) it is a state of defencelessness against adverse shock that could inflict damage, characterized either by the presence of certain weaknesses or internal conditions (which determine the state of defencelessness), or by the presence of certain probable external shocks (for which there is no ability to cope). Simply put, families and persons have more difficulty in facing adversities and access universal benefits and rights, either because of lack of material resources such as income, education, precarious housing or health condition; or because of discrimination due to age, gender, geographical location or an unsuitable distribution of services or goods (Marques et al., 2016, Sen, 2003).

Notwithstanding, no consensus exists on how to identify and characterize vulnerable persons in a given society. The multidimensional character of vulnerability, exclusion, poverty or, on the opposite end, well-being, is difficult to grasp, measure or monitor (Madanipour and Weck, 2015). "We can never directly observe a household's current vulnerability level", wrote Chaudhuri et al. (2002). Indeed, it seems rather impossible to encompass it into a single variable or indicator, as it derives from the cumulative overlapping of various dimensions. Many recent assessments of vulnerability, particularly those associated to the recent economic crisis in Europe, focus mainly on single macroeconomic indicators related to employment (or unemployment) and income (such as the GDP) (Artelaris, 2017, Mohseni-Cheraghlou, 2016, Madanipour and Weck, 2015). However, the fluctuations in macroeconomic indicators have often been shown to not be significantly correlated with the changes of social indicators (Boarini et al., 2006). Nor are they considered to be enough to explain the dimensions of vulnerability in a crisis period, as they provide only a partial picture of living conditions, social progress and interactions, the human and social costs of recession, as well as of other elements such as health and safety (Artelaris, 2017, Decancq and Schokkaert, 2016).

Consequently, the focus on using solely economic indicators has been challenged, leading to the rise of multidimensional approaches (Di Berardino et al., 2016) and the development of composite indicators (Artelaris, 2017). Such indicators are naturally of great interest to local, regional and even national policies, as

they can condense information, and be more easily read and understood by stakeholders and decision-makers, facilitating policy evaluation and comparison (Dialga and Thi Hang Giang, 2017). However, the formulation of such indicators has been effectively restricted. A critical aspect is the selection of the components themselves (OECD, 2008, Decancq and Schokkaert, 2016), more than often conditioned by the availability of statistical data, which results in the use of only a small number of variables (Artelaris, 2017, Madanipour and Weck, 2015). Furthermore, it is necessary to select the weights attached to each dimension, something that has been an object of extensive debate in the literature (Lee, 2014). Not prioritizing variables may cause deviation from reality; whereas weighting can produce distortive results. Variation in units of the indicators and their different directions may also cause problems. Lastly, another present critique is that the spatial dimension of exclusion or vulnerability has been mostly neglected (Madanipour and Weck, 2015), resulting on a little territorial decomposition of the results (Artelaris, 2017, Madanipour and Weck, 2015).

The theoretical framework suggested by the OECD (2017) in their 'How's Life' series relates to eleven dimensions; namely Income and wealth, Job and earnings, Housing, Work-life balance, Health status, Education and skills, Social connections, Civic engagement and governance, Environmental quality, Personal security and Subjective well-being. Previously, the European Statistical System (2011) had referred to most of the same dimensions, under slightly different names (see Decancq and Schokkaert (2016) for a comparison). Many authors have added other dimensions to cover relevant points, notably the social dimension. For example, Decancq and Schokkaert (2016) added control or dummy variables related to household size, gender, age or belonging to an ethnic minority. Artelaris (2017) added four additional dimensions related to social exclusion, social capital, family and demographic dynamics. Besides presenting similar domains as the previous, the ESPON project TiPSE - The Territorial Dimension of Poverty and Social Exclusion in Europe (ESPON, 2014) also allowed for variables related to Transport and Communication or Ethnic Composition.

Lee (2014) reviews several authors who have shown correlations between social vulnerability and indicators as various as Female population, Age, Population density, Birth rate, Infant mortality rate, Households with disabled members, Social and economic status, Poor population, Income, Percentage of population 25 years or older with lower than high school diploma, Rates of unemployment, Working population in primary sector, Strength of social network, Percentage of houses rented or seasonal houses, Public infrastructure and resources that belong to inhabitants, Quality and price of house, and Percentage of old house. The author himself, due to data collection constraints, uses just 13 indicators. Table 1 synthesizes the variables used by these and other authors including Sapountzaki and Chalkias (2014).

Table 1 – Variables for measuring vulnerability and well-being in the literature

Authors	**Lee (2014)**	**Sapountzaki, Chalkias (2014)**	**TIPSE project (ESPON, 2014)**	**Decancq and Schokkaert (2016)**	**Artelaris (2017)**
Measure of:	Social vulnerability	Social-human vulnerability	Social exclusion	Well-being	Social Well-being
Scale	Township	Metropolitan	Macro-region	Country	Region
OECD framework					
Income and wealth	% of low-income population	Human poverty	Disposable income	Total household income per capita	Disposable Income (per capita); At risk of poverty rate
Housing	Peasant household; fishing household; % of single-person households		Tenure status; Density; Amenities		
Education and skills	% of population aged 15 years or older with educational attainment below high school	Illiterate rate	Access to different kinds of school, college, cultural facility; Attainment (ISCED levels)		Early leavers from education and training (from 18 to 24 years)

Environmental quality	Superficial measure of cultivated land				
Health status	Average number of patients who were served by hospitals; Number of hospital beds per 1000 inhabitants	Old age index	Access to primary health; Healthy life expectancy	Self-reported health	Medical doctors (per 100,000 inhabitants)/ Infant mortality rates (per 1000 live births)
Job and earnings			Employed / Unemployed; Inactive; Long term unemployed; Jobless households	Unemployment status	Unemployment Rate (%)/Average number of usual weekly hours of work in main job; Long-term unemployment (%)
Work-life balance					
Social connections				Frequency of social meetings with friends, relatives or colleagues	Family Divorce rate (per capita)/ Number of marriages (per capita)
Subjective well-being			Dependency rates		Suicide rates (per 100,000 inhabitants)
Civic engagement and governance			Voters; Civic engagement; Membership of NGOs		% Voter turnout in national elections
Personal security			Crime rates	Feeling safe when walking alone in local area after dark	Homicide rates (per 100,000 inhabitants)/Burglary rates (per 100,000 inhabitants)
Other domains					
Population	% of females; % of Elderly; Population density; Crude birth rate; % of physically and mentally disabled	Population density	Ethnic composition; Proportion from minorities; Migrants as share of population	Household size, education, gender, age, marital status, being religious, urban, belonging to an ethnic minority	% Population Growth (%); Young people neither in employment nor in education and training
Transport and Communication			Post Office; Broadband; Public transport; Car availability		

Methodology

The first decision made by the project team has been to select the most important domains in order to perform the vulnerability analysis. Two methods have converged. First, an analysis of the literature review (see previous chapter). Second, a group of discussions with an expert stakeholder team. Striving for an integrated approach, complex yet easily understandable, towards measuring and representing social vulnerability in Portugal, the result has been the decision to consider nine different domains. These have been i) housing (problems and constraints of the market…); ii) employment (unemployment, precariousness, income, qualifications…); iii) education (lack of schooling, lack of performance, social contexts…); iv) health (untimely death, morbidity, offer of services…); v) services of social interest (offer, accessibility…); vi) income (inequalities, savings, power of purchase…); vii) safety (crime rates, crime typologies…); viii) environment (conditions, behaviors, offer of services…); ix) vulnerable groups (poverty, social exclusion, conditions for social vulnerability…).

Most of them have a direct relationship to the domains in Table 1. Others are a parcel of those domains (such as vulnerable groups for Population; and access to facilities for Transport and Communication). Variables directly related to work-life balance, social connections and civic engagement and governance have not been directly

considered, as they have not been in previous studies. This is mostly due to the absence of data. In view of these constraints for obtaining detailed and extensive data at municipal level for each domain, the project team has chosen to use exclusively open-access statistical information at municipal level. This included data made available by the Portuguese National Statistics Institute (INE, 2019); an Institute responsible for the production of official statistical information, collected and condensed from an array of multiple primary sources. Furthermore, the official websites of the Ministry of Education and the Ministry of Labor and Social Solidarity were consulted, where different types of information were condensed to build new indicators.

The project team had discussion with thematic experts in order to select, of the available indicators for each domain, which ones should be included in the vulnerability analysis. A difference to previous studies lies in the fact that a large array of variables has been selected within each domain, rather than just one or two representative variables. Furthermore, for each domain the analysis has been structured to respond to two main objectives. The first has been to evaluate the specific types of vulnerability that each domain contains. For example, housing problems (such as homes without bath, or in a bad state of conservation) in the housing domain; the levels of unemployment in the employment domain; or the poor accessibility to services of social interest in the accessibility domain. A total of around 10 such indicators have been selected for each of the 9 domains, totaling 83. The second objective has been to evaluate the context that may influence the levels of vulnerability in each domain. For example, the pressure of the housing market in the housing domain; the low salaries and the precarious job offers in the employment domain; or the low levels of power of purchase and savings in the income domain. A total of around 5 indicators has been selected by the team of experts for each domain, totaling 49.

Considering the 9 different domains, a total of 132 indicators were collected. For each indicator, the most recent available data was used, although this means that some indicators, such as overcrowded dwellings, were produced using data from 2011 (the last population census in Portugal and sometimes the only information source available for a given variable), whilst other indicators were produced with data from 2017 (such as average rent values, or buildings rehabilitated after 2011). In some cases, in order to add consistency to the analysis and eliminate the influence of less frequent events, an average of three consecutive years was produced. This has been done for example for crime rates (in the safety domain), where an average of values from 2015, 2016 and 2017 (the last three data years available) were used.

Using this criteria and ArcGIS software, each one of the indicators has been cartographed at national scale (see figures below). In each map the municipalities were divided into five classes, using natural breaks, ranging from low to high incidence of the given indicator. Such procedure allowed for the elimination of differences in scale between indicators when the overall vulnerability index was computed, thus putting the emphasis on comparable territorial differences. Consequently, another difference to previous studies has been not to use a mathematical formula to sum the different variables in order to produce a composite indicator, but rather to perform a Multiple Correspondence Analysis (MCA) for each domain. MCA, an extension of correspondence analysis (CA), is an exploratory data analysis technique that allows analyzing patterns of relationships of several categorical dependent variables. It can be regarded as a form of factor analysis for categorical data (Greenacre, 2017, Yelland, 2010, Abdi and Valentin, 2007) that, through the reduction of the dimensions of a given dataset, facilitates the analysis of the relationships therein. Partial indexes of vulnerability were thus produced for each indicator, and the results identifying the most vulnerable territories were discussed with territorial experts (for example of the Commission of Coordination).

From each partial index the most representative indicators (with the highest test-value) were selected, in order to feed an overall index of vulnerability combining all domains. These were the ones displaying greater significance in the territorial differentiation of vulnerabilities in each domain. About 70 of the original 132 indicators were selected for computing the composite index; around 40 for the identification of the territorial specificities of vulnerabilities (1st objective), and around 30 for the identification of the territorial contexts

affecting vulnerability (2nd objective). MCA was then performed, considering the first set of variables as active and the second set as passive. This resulted in an overall synthesis of territorial vulnerability.

Results

For this paper, and with the impossibility of showing all maps concerning the 130 indicators within the 9 domains, the housing domain has been selected as an example. Figure 1 shows the two final maps for the housing domain. The first map represents the synthesis of housing vulnerabilities in Portugal. It has been produced combining around 10 different indicators of housing problems, for example those related to derelict buildings, overcrowded dwellings, social housing dwellings, families to rehouse, among others. The second map represents the synthesis of the contextual vulnerabilities that may influence the housing domain; most notably the pressures on the housing market. Variables used to compose this second indicator include the average rent value, the bank evaluations by square meter of homes or the percentage of local accommodations.

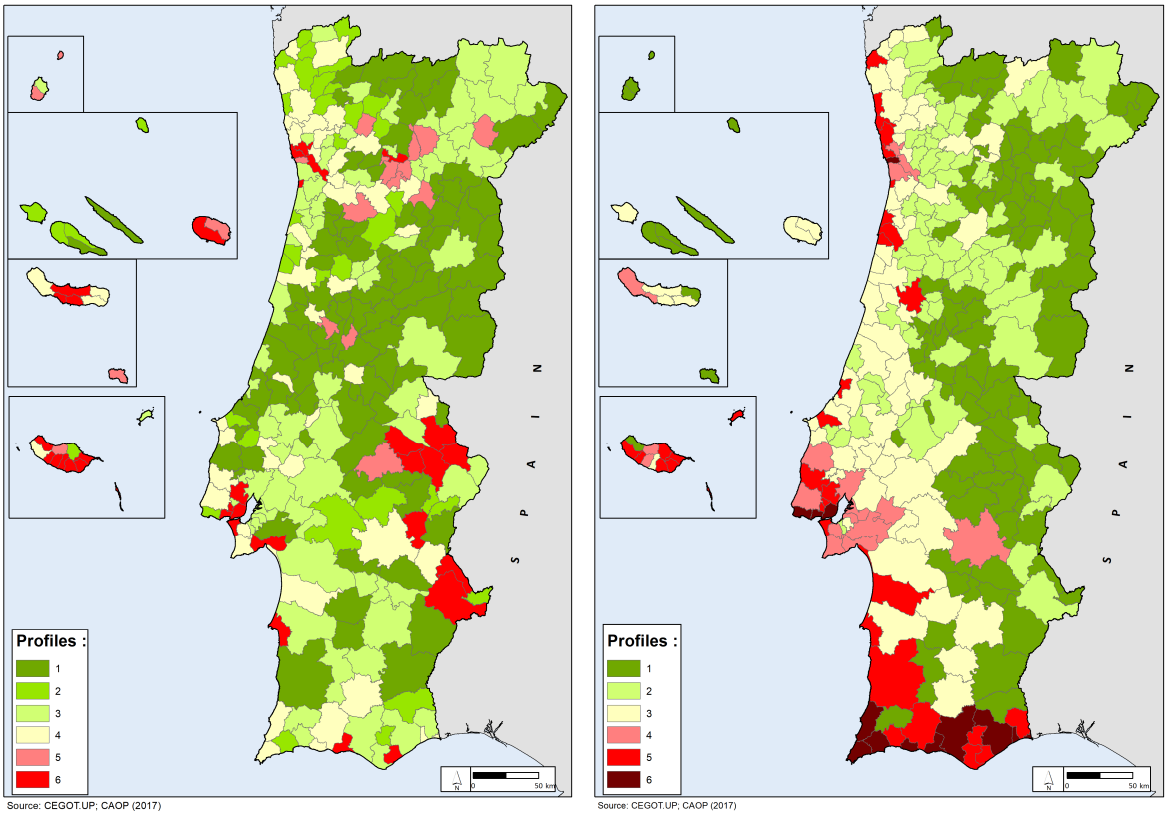

Figure 1 – (a) Synthesis of housing vulnerabilities; (b) synthesis of contextual vulnerabilities that may influence the housing domain

The highest profiles represent those where the amount of problems is larger. In territorial terms, it can be seen that housing problems (Figure 1a) feature more in the metropolitan areas of Lisbon and Porto, but also in some coastal areas, closer to the border with Spain and in some islands of the archipelago of Azores and Madeira. Although there is a strong presence of social housing, this profile is characterized by a large need of families to rehouse and overcrowded dwellings. It is also underlined by a large unemployment rate. Problems are also visible in Profile 5 in municipalities of the interior Portugal to the centre and the north, where there is a very high percentage of derelict buildings. The population in these areas is characterized by low incomes and not having an university education.

Nonetheless, the majority of Portugal has mostly been placed in Profiles 1 and 2. Both have in common a large number of derelict buildings and a medium to high population without an university education. Profile 1, dominant in central Portugal, is further distinguishable by low social housing but also low overcrowding and employment. Profile 3, with some predominance in the littoral, both to the north and the south, also shares low social housing and a medium amount of derelict buildings and families to rehouse, but is more characterized by very low incomes. Profile 4 is distinguishable by the amount of overcrowded dwellings.

The synthesis of contextual vulnerabilities (Figure 1b) clearly displays the differences between the interior and the littoral, and also between these and the areas around the metropolitan areas of Porto, Lisbon and the Algarve. Indeed, this is clearly the most problematic region, with profile 5 and 6 relating to high housing prices and rent values and large number of local accommodations. Profile 6 is also particularly characterized by unemployment and low incomes. Whereas the interior of Portugal is characterized by profiles 1 and 2 (low rents, low housing prices, low number of local accommodations), the littoral is characterized by profiles 3 and 4, where rent values and housing prices increase as the main cities of Lisbon and Porto are approached, and the percentage of income spent on housing is high.

Housing policies should be able to cross the two analyses, understanding that housing pressures are concentrated in Lisbon, Porto and the Algarve, but housing problems appear both in rural and urban territories. The most sensitive areas are those where bad housing conditions and a high pressure on the housing market, with elevated prices, hinder the access to a proper home.

Figure 2 represents the overall vulnerability results, considering all 9 domains and the 70 most representative indicators, resulting from the partial analyses, as the one for housing seen in the previous paragraphs. Five profiles have been identified, which display clear territorial patterns. Profile 4, for example, is clearly found in the interior north of the country. It represents an elderly, low income population, with poor school qualifications and a high degree of school abandonment, suffering from long term unemployment. Families are large, building dereliction is a problem and the access to high order services is low. On the other hand, Profile 5 is clearly seen around the major metropolitan areas of Porto, Lisbon and Faro (in the Algarve), as well as around other relevant medium-sized cities in the centre and south. It corresponds to a population highly qualified, with high power of purchase and high access to services, characterized by more than the average of single parent families and migrants. However, salaries are often low, the rent and evaluation values for homes are very high (although the number of social housing is also high), and there are greater problems with health, overcrowding and crime.

In between, Profile 1 is more prevalent in the littoral and center of the country, whereas Profile 3 is more prevalent in the interior, centre and south. Profile 1 has low levels of unemployment, overcrowding, housing rents, health problems and crime, and high levels of people with a complete basic education and high access to proximity services. However, incomes are low, and so is public employment and the number of social houses. Having large forest areas, these territories are also more susceptible to forest fires. Profile 3, on the other hand, is a territory susceptible to desertification. Although there is a high percentage of public employment, the percentage of elderly living alone and people with low education is high, and there are low levels of power of purchase and access to proximity and high order services. Housing is evaluated at lower values by banks and municipalities have high level of environmental expenses. Profile 2 has only a small expression in the outer rim of the larger metropolitan area of Porto. Is is distinguishable by very high levels of proximity to services, large families, single parent families and younger population. There are, however, low levels of public employment, long term unemployment and the weight of the housing rent in the family income is high.

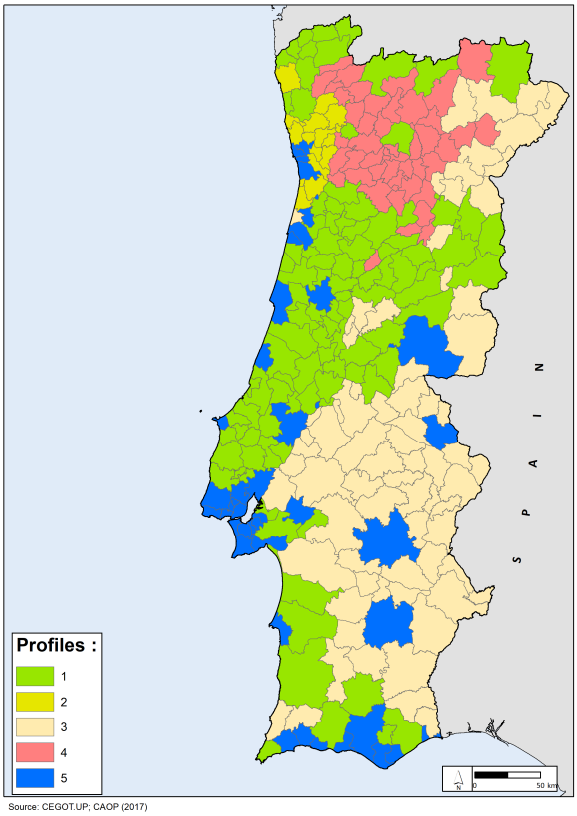

Figure 2 – Synthesis of overall vulnerability problems

Conclusions

As Lee (2014) argues, the traditional planning paradigm often stresses physical vulnerability and exposure to risk, with only a few studies applying social vulnerability to planning practices. However, in a post-crisis era, where social constraints are far from solved, the main planning agendas point towards the development of instruments capable of offering policy insights for promoting quality of life and spatially just and cohesive societies. This means improving several social indicators and reshaping how regional problems are approach (Artelaris, 2017). Combining both, it seems necessary to re-conceptualizing how territorial and social vulnerabilities as well as spatial inequalities are assessed, and how such knowledge can be integrated in strategic decision making.

In this paper, we have succinctly summarized an innovative approach applied in Portugal in the aftermath of the revision of the National Plan for Territorial Planning Policies (PNPOT) in 2018. The multivariate approach at national scale, using the municipality as a unit of measure, allowed for the extensive characterization and understanding of the territorial contexts of vulnerability and exclusion in Portugal. Firstly, it has to be acknowledged that this rather lengthy approach (over 130 indicators were initially analyzed and computed) is a step forward from previous works, because the complexity of the vulnerability phenomena, composed by a wide range of indicators of an economic, social and even physical nature, cannot be encompassed by single indicators. As Artelaris (2017) writes, wellbeing is inherently multidimensional. Even so, composite indicators themselves are the object of criticism (Dialga and Thi Hang Giang, 2017, OECD, 2008) because they may be misleading if poorly constructed and their construction often relies on subjective judgments. Yet again, i) by applying a methodology in stages, where each domain is analyzed individually and then only the most influencing variables are used for the final index score; ii) by dividing the variables in those directly related to

problems and those related to context; iii) and by using MCA rather than a mathematical expression, many of these criticisms can be overcome.

Besides displaying a national vision of vulnerabilities, replicable to other contexts, these results are intended to bring positive outputs for the guidance of planning policies regarding quality of life and the development of urban systems, by providing evidence-base for integrated responses.

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