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Challenges in regional approaches: Lessons from Energy Poverty research in a small scale European member state

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Abstract. Energy poverty is an issue now widely recognised for its detrimental impacts and research in Europe has intensified over the last decade. Many different methodologies of examining the topic have surfaced, with a common one being based on regional-based practices. Open source data are extremely useful for such approaches, because they offer unlimited access to information. The Nomenclature of Territorial Units for Statistics (NUTS) is a framework for data collection on different geographic levels that provides different levels of statistical analysis for regions within a single country. It was set up in the 1970's by the European Union, and existing research work has already explored the valuable application of the NUTS system in certain areas. Nevertheless, the constraints of open source data (such as data based on NUTS regions), in reference to small scale member states, have not been exhaustively addressed.

In this study the shortcomings of open source data are explored, by examining energy poverty in an area where the efficacy of the NUTS system is restricted. Cyprus is a member state in the European Union and is represented by a single NUTS category, for all levels of classification, unlike the majority of the rest. Data therefore exists only at the national level – something which contradicts the purpose of the different NUTS levels. In effect, for the case of Cyprus, this results in lack of differentiation among distinct climatic regions and disregarding the urban-rural dichotomy. It essentially renders this classification system inapt for Cyprus, while research activities become limited to the extent of data obtained through other means. Therefore, the study highlights the challenges researchers have to face when approaching a topic for Cyprus from a regional lens. To this end, geographical information systems software is used to observe a simplistic composite indicator of energy poverty in a medium-scale country (where NUTS is applicable), in relation to Cyprus. The effectiveness and potential impact of the outcomes in relation to public awareness, decision-making for policy makers and initiatives of local agents are examined and discussed.

Ultimately, the study highlights that even when high quality indicators of energy poverty exist at the European Union level (Eurostat), under current circumstances they cannot be employed effectively to examine energy poverty regionally within Cyprus. Recommendations are proposed to overcome data access limitations in areas where popular open access databases are inadequate.

1. Introduction

Energy poverty affects approximately 1 in every 10 European citizens, manifested in a multitude of ways, such as delays in payments of energy bills or living in thermal discomfort and social isolation [1]. The prolonged economic crisis has proven a decisive factor to large scale recognition of the issue and its incorporation in the policy agenda of most member states [2]. On a nationally legislative level, only a few European Union (EU) countries have taken action, with established definitions and measurable detection methodologies. Even in cases where legislation exists, definitions may be vague and profiles of "energy poor citizens" imperfect. That is the case for Cyprus, where a definition exists since 2013 and is based on vulnerable consumer groups that may not fit the profiles of the *energy vulnerable* [2–4]. The difficulties in detecting energy poverty in various circumstances has led to lack of universal definitions and methodological guidelines. It has also triggered diverse courses of action and pathways of investigations, making energy poverty a highly multidisciplinary topic of research.

In a nutshell, energy poverty is understood as the inability to secure a socially and materially necessitated level of energy services in the home [5]. The lack of such basic amenities often leads to impacts on individuals' physical and mental health, with further repercussions on their social lives and productivity [6]. The necessity to address energy poverty officially is highlighted by the increasing interest of the EU to facilitate research, foster innovation and include energy poverty in policy agendas [7,8]. Nevertheless, up to now, there has been no formal instrument dedicated to eradication of energy poverty by means of obligatory measures, nor a single authoritative body to ensure implementation

Moreover, one of the most commonplace limitations of energy poverty research is unavailability of high quality temporal and spatial data. Open source databases are crucial and that is why the European Energy Poverty Observatory (EPOV) constitutes a major accomplishment of the EU, disseminating knowledge and resources to the wider public [9,10]. Another framework of particular notice for this study is the Nomenclature of Territorial Units of Statistics (NUTS) system, which in many occasions has allowed in-depth analysis of energy vulnerabilities in regional studies. The following sections outline the classification system's basic characteristics and its employment in relative research topics.

1.1. Relevance of NUTS to scientific applications

The NUTS system has been employed in national studies presenting demographic and statistical information. This system was launched in the 1970s and serves as a geographic basis for investigations in a variety of subjects. There are three tiers of administrative units, based on demographic thresholds. NUTS 1 includes all areas with populations between 3 and 7 million, NUTS 2 contains "provinces" between 800,000 and 3 million and NUTS 3 refers to smaller departments ranging from 150,000 to 800,000 in population. Adopting NUTS therefore ensures some level of harmonised statistical information. That is possibly its most attractive feature, rendering it suitable for use in a range of studies.

In the field of energy, NUTS has been applied to explore the potential of biomass towards electricity production [11], as well as to develop roadmaps towards achieving the EU 2020 goals in shares of renewable energy and greenhouse gas reduction [12–14]. Information on the NUTS 2 level was employed by Diana et al. (2017), to investigate the carbon footprints of EU regions [15]. Furthermore, Persson et al. (2014) utilise the NUTS system to identify strategic regional hotspots of excess heat in Europe. Such regions could be suitable for large-scale implementation of district heating – an energy efficiency measure often underestimated in decarbonisation strategies [16]. Additionally, a more recent study measured area-specific human poverty at the NUTS 2 level, by constructing a composite index using different indicators available at that level [17]. In another recent study, Chaton and Lacroix (2018) examined the fuel poverty trap in France and employed the NUTS classification to investigate multiple aspects related to dwellings [18].

1.2. Regional approach in energy poverty

A common practice in studying energy poverty issues is to approach them in a regional manner, dividing large areas into smaller, more manageable sections of interest [19–21]. Bouzarovski has investigated on several occasions the geographies of energy vulnerability [5,22,23], highlighting that "there is a need to understand how spatial patterns of energy poverty map onto existing inequalities within and among cities, regions and countries, in light of the known economic and infrastructural embeddedness of the condition" [24]. Researchers have taken a special interest in post-communist countries of Eastern Europe, where large portions of the population inherited an energy inefficient housing stock and at the same time are forced to deal with material deprivation [25]. For instance, the demographic and geographic features of energy poverty were analysed for the Czech Republic, Poland and Hungary, indicating that in all three, suburban areas or regions with low population densities experienced most problems with energy inefficient housing stock [26]. At the same time, patterns of vulnerability reveal specific circumstances for each country, for example, in regions with particular economic activities (predominantly agricultural areas), higher shares of population were described as vulnerable [26].

Other studies explore the varying spatial patterns of vulnerabilities under different detection methodologies, according to the dimensions of energy poverty prioritized by each approach [27,28]. The NUTS classification system is often being used by member states to carry out national surveys [29,30], even if it is not directly related to the analysis at times. For example, the Slovakian HBS, although not formally accrediting the NUTS system, offers statistical information on the country's NUTS-3 regions [31]. Microdata is also available upon request from the Slovak Statistical Bureau, offering prospective studies the opportunity to examine issues beyond the NUTS-3 level [32].

The scarcity of national data on energy poverty that is robust and comparable, has already been highlighted in previous studies [2,20,33]. To this end, many prominent examinations have approached the matter based on openly sourced information that has been made available via Eurostat, National Budget Surveys or EPOV [8,32,34]. The inability to apply openly sourced data within small member states may therefore augment the already problematic aspects of data acquisition.

The following section introduces the limitations of NUTS regions relating to small scale countries. That, of course, is true only if there is indeed significant variability within the territories which are represented as of uniform statistical significance. Cyprus is used as a case study, to show that variability in terms of demographic, climatic and economic data is flattened under representation with the NUTS system. The following section outlines the variability in different regions in Cyprus and highlights the need to address different geographic areas in more detail than currently available.

2. The case of small member states and open access data

The EU includes countries of different demographic and territorial scales. France covers almost 650,000km^2, with more than 67 million in population and one of the smaller member states, the Netherlands, covers over 40,000km^2 and is home to over 17 million people. In contrast, Cyprus has a total land cover of less than 6,000km^2 and its population is under 1 million.

Cyprus is an eastern Mediterranean island with a full history of conquerors and political turmoil. It is strategically located both geographically and socioeconomically and since 1974, it remains divided due to occupation troops on the North side of the island. Recent years have seen Cyprus arising to a hub for environmental research, focused especially on the MENA (Middle East and North Africa) region which is projected as a climate change hotspot [35,36]. For this reason, access to resources, both on the global and the regional scale, are now in demand. The quality of data however, at times, does not reflect the eminence of research in this member state. This paper focuses specifically on the amount and nature of data available on the topic of energy poverty. The variations across the five districts of Cyprus, as shown in Fig. 1 (Lefkosia, Lemesos, Larnaka, Paphos and Ammochostos), are explored based on three dimensions: demographic, climatic and economic. A sixth district exists (Kyrenia), however it is located in the north side of the island which is not controlled by the Republic of Cyprus.

Figure 1. Administrative districts of Cyprus. Created in ArcMap 10.3.

2.1. Population distribution in Cyprus districts

According to de jure population data obtained from the Cyprus Statistical Service (CyStat), population increased in all districts during the period 1992-2017 [37]. The data relates to urban and rural regions of each district, as presented in Table 1. For the district of Ammochostos, which is under occupation for the most part, data exists only on the rural level. That is because after 1974, Ammochostos lost its urban centre and only the rural areas of Ammochostos remain unoccupied and participate in the census of the Republic of Cyprus.

Urban and rural regions both witnessed a population increase by approximately 40% within this 15-year period, with rural populations increasing slightly more in total. The steepest increase was observed in the urban area of Paphos, a coastal city on the westernmost part of the island. Despite Paphos almost doubling in population, it was and still is the smallest district, both on the urban and rural levels. This urbanisation trend may be driven by the developmental works in this district (e.g. new airport, works due to cultural capital of Europe), low living costs, intense touristic activity and increasing business activity with foreign investors. Some of these features are also true for the city of Lemesos. Nevertheless, living costs in Lemesos are far higher than Paphos, which, being a very thinly populated district to start with, had a lot of potential for development and attraction of new inhabitants.

Table 1. Population change in Cyprus districts, for urban and rural areas, 1992-2017. Source: [37].

District	**1992**	**2017**	**% change**	**District**	**1992**	**2017**	**% change**	**Total 2017**
Urban	**418,900**	**583,200**	**+39.22**	**Rural**	**200,300**	**281,000**	**+40.29**	**Urban +Rural**
Lefkosia	182,500	246,900	+35.29	*Lefkosia*	68,800	89,000	+29.36	335,900
Lemesos	140,300	184,600	+31.58	*Lemesos*	38,300	57,400	+49.87	242,000
Larnaka	62,600	86,600	+38.34	*Larnaka*	40,900	59,900	+46.45	146,500
Paphos	33,500	65,100	+94.32	*Paphos*	20,600	27,200	+32.04	92,300
Ammochostos	-	-	-	*Ammochostos*	31,700	47,500	+49.84	47,500

The rest of the urban centres witnessed a population increase of similar magnitudes (31-38%). Of the five districts, only in Lefkosia (the capital) and Paphos was the urban increase higher than the rural increase. In the case of Lefkosia, this possibly indicates a limited degree of urbanisation due to the fact that the capital is a business hub. For Paphos, aside from the favourable features of the urban area mentioned above, rural areas include very remote, hard to access mountainous areas, suggesting that fewer people would be willing to permanently inhabit rural Paphos. The largest increase in rural regions is encountered in Lemesos. This indicates that high living costs in the urban centre may have caused a population shift to the rural surroundings of the city. Overall, there is a varying landscape in terms of inhabitants among and within the five Cypriot districts, which is affected by various external factors.

2.2. Climatic characterisation of Cyprus districts

Although a small island, Cyprus features four distinct climatic zones. These are mountainous regions, semi-mountainous, inland plains and coastal areas [38–40]. Lefkosia is largely characterised by inland conditions, with mountainous and semi-mountainous regions (see Fig. 2). The coastal land of Lefkosia is largely under occupation therefore not taken into consideration at this time. Paphos and Lemesos include coastal, semi-mountainous and mountainous domains, whereas Larnaca and Ammochostos are mostly coastal with limited inland areas.

Altitude lowers temperatures by about 5°C per 1,000 metres and the presence of sea offers cooler summers and warmer winters near most of the coastline [41]. There is a considerable seasonal difference between mid-summer and mid-winter temperatures, at 18°C inland and about 14°C on the coasts. As for the day maximum and minimum temperatures, in inland areas the difference ranges from 8-10°C and coastally this lowers to 5-6°C, in the winter. The difference is more pronounced in the summer, where inland areas experience a min-max difference of 16°C and other areas between 9-12°C. At times, inland regions have approximately 10°C higher temperatures than mountainous regions in the summer months. Respectively for winter, inland areas have about 5°C warmer climate than mountainous regions, on average [41]. Relative humidity also varies among different climate zones, often reflecting temperature patterns, with coastal regions experiencing higher humidity than inland and mountainous regions [42].

Temperature and relative humidity in the different climatic zones of Cyprus define many aspects of the built environment, on the principles of vernacular architecture [42]. For example, design of buildings in coastal areas relies heavily on movement of air, due to year-round high humidity levels, something which is not essential in inland or mountainous regions [42]. In the mountain ranges, buildings mostly adhere to traditional materials and techniques, whereas in urban centres, high-rise buildings dominate the landscape.

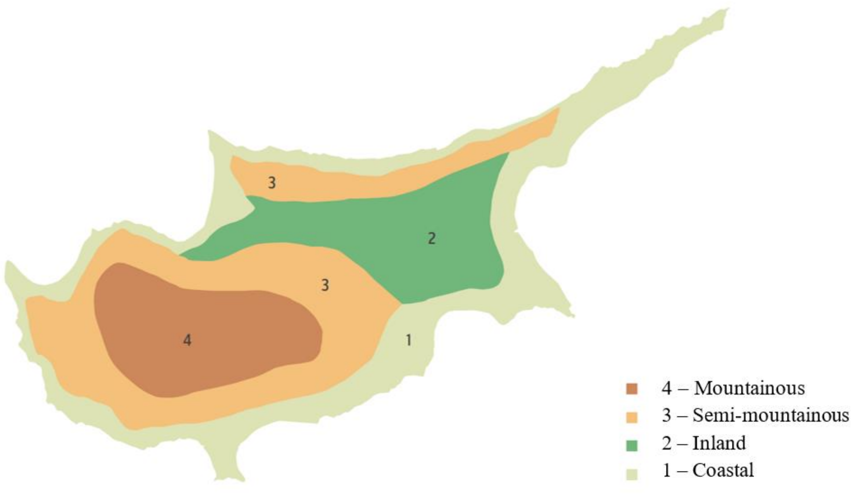

Figure 2. Climate zones in Cyprus, adapted from [38].

This is especially true for the coasts of the island, where the sea front is overtaken by touristic complexes and hotels. Equipment needs also vary according to climatic conditions, according to data obtained from the Cyprus Statistical Service (Cystat). For example, more than 90% of dwellings are equipped with air conditioning (a/c) systems in urban inland areas. On the other hand, in mountainous regions, 65% or less of the households are equipped with a/c systems.

Different climatic conditions within Cyprus therefore impact upon the built environment of regions, as well as the use of services and ultimately energy demands.

2.3. Socioeconomic conditions in Cyprus districts

This sections presents rudimentary information on the differences of mean equivalised disposable income among urban and rural regions of the five districts. The data used for this analysis were also obtained from Cystat (EU-SILC, 2017), but cannot be published in detail at this moment. Overall, only in Paphos is the income higher in rural regions relative to urban ones (by app. 4%). In the rest of the districts (except Ammochostos which is completely rural), income of populations in the urban centres are 8-36% higher than the rural counterparts. Among the rural regions of the five districts, the higher income comes from Lemesos, whereas the highest wages overall are found in the urban centre of Lefkosia. The lowest income is observed for urban Paphos. A distinct observation can be made for Lefkosia and Lemesos, because only these districts have a total income (urban and rural) that is higher than the Cyprus average. Ammochostos, Larnaka and Paphos present 13-21% lower income than the country's average. These numbers can be used to highlight the differences in economic development and predominant activities of each region (e.g. agriculture versus business hubs).

In general, the mean equivalised income seems to depend on the economic activities upon which each district relies on. In addition, variance exists not only among districts, but also between urban and rural regions, highlighting the dichotomy. Income is also affected by the varying costs of living for each district, which are however not discussed in this paper.

3. Example comparison in energy poverty research using NUTS datasets

Regional studies investigating energy poverty could be adopted with relatively effortless data acquisition, using existing indicators readily available. For example, using statistics available from Eurostat, a simplistic composite indicator of energy poverty was calculated for Bulgaria's NUTS regions, for three different years in the decade 2008-2018 (see Fig. 3). This was calculated considering the shares of populations exposed to risk of poverty and social exclusion (weight of 0.3) in conjunction with severe material deprivation (weight of 0.7). These two statistical factors were included because on the one hand, monetary poverty is in some ways related to energy poverty [43]. On the other hand, severe material deprivation includes 9 categories of unaffordability, related to: paying rent, mortgage or utility bills; keeping home adequately warm; facing unexpected expenses; eating meat or proteins regularly; going on holiday; owing a television set; owing a washing machine; owing a car or owing a telephone. The first two categories have often been directly related to aspects of energy poverty, a deciding factor in the higher weight attributed to this indicator.

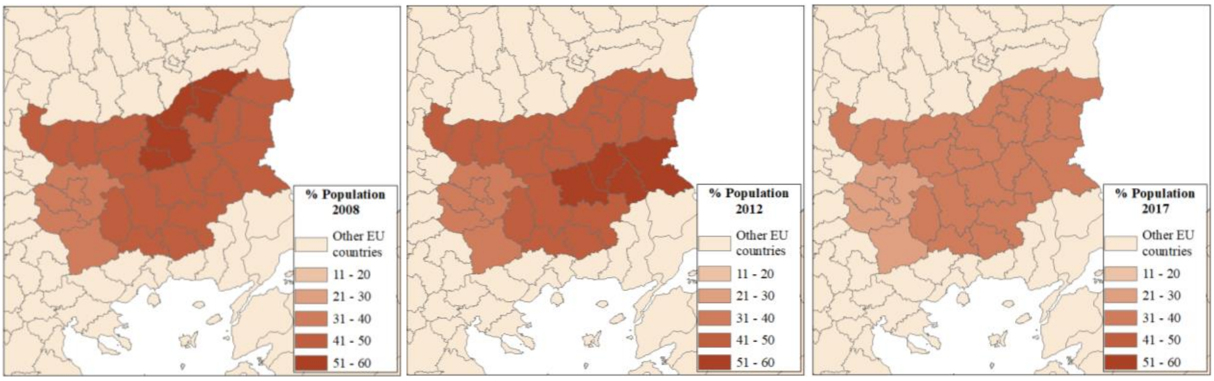

Figure 3. Composite indicator showing vulnerability patterns in Bulgaria, in 2008, 2012 and 2017. Data source: Eurostat. Maps created using ArcGis 10.3.

The graphical output of this analysis indicates more intense vulnerability in the North-central part of Bulgaria. However, by the end of the decade, the differences among regions are evened out. Moreover, in 2oo8 the highest vulnerability recorded was approximately 52%, in 2012 it almost reached 54% and in 2017 it fell to a little over 38% (recorded for different regions each period). This trends coincide with the GDP of the region, which were lower than the average of the rest of the country but has been improving since 2011 [44]. Therefore, the current analysis with the openly sourced information reveals both geographic and temporal patterns of vulnerability. Such information would offer insight to the most appropriate policy strategies in different territories, as well as assessments of practices that have already taken place.

The same dataset offers significantly less information related to the patters of vulnerability in Cyprus. It is actually not possible to offer insights as to the changes occurring in the various regions of Cyprus during the examined time period. That is because Cyprus is not represented by subdivisions in the NUTS system. The entire area of Cyprus is one NUTS region for levels 1 to 3, having no subdivisions similar to the example of Bulgaria (see Fig. 4). As a result, the outcome of research using the same database as the previous Bulgarian example, cannot be interpreted as successfully for the different regions within Cyprus. Consequently, the economic and demographic changes described in section 2, as they relate to each district of Cyprus, are not reflected in the open source information available from Eurostat. The lack of such detailed information positions small-scale member states at a disadvantageous place, where research is limited to local efforts.

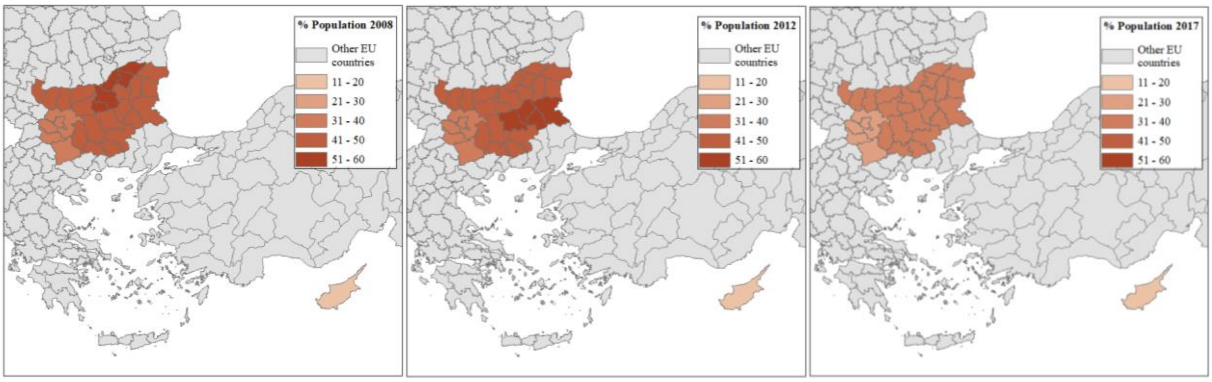

Figure 4. Composite indicator showing vulnerability patterns in Bulgaria and Cyprus, in 2008, 2012 and 2017. Data source: Eurostat. Maps created using ArcGis 10.3.

It should be noted that the composite indicator introduced here is rudimental. It only serves the purpose of showcasing the applicability of open source data towards investigations of temporal and spatial patterns of vulnerability. Moreover, the existing available information comes with various limitations which should not be overlooked. Using the above example for Bulgaria, while the available data is aggregated at the NUTS 2 level, the underlying map data is only fully available at the NUTS 3 level. For this reason, an inconsistency of subdivisions and available information is visible in Fig. 3, where each shaded region includes several subdivisions, all of which hold the same numerical values.

4. Discussion

The previous sections have exhibited that although one of the smallest member states in the EU, Cyprus is characterised by diverse demographic, climatic and socioeconomic conditions (among others) in its five districts. Each of the three dimensions discussed has overlapping effects on the others, aligned with the society-environment-economy nexus. The present analysis does not aim to offer an in-depth inquiry on the regional vulnerabilities of Cyprus, rather to simply highlight the need to investigate some matters using a regional approach. The lack of currently available open source data has been illustrated by employing a single dataset to examine vulnerability patterns in Bulgaria and Cyprus. According to the findings of this comparison, whereas some insights are decipherable for Bulgaria, the dataset does not offer regional remarks for Cyprus. In this case, the NUTS system seems to be inadequate for application in Cyprus. However, the vastly diverse scales of member states in the EU render it fundamentally unavoidable to come across such disparities at some degree.

This drives researchers in small-scale countries to pursuit alternative data sources, such as national statistical offices. At times, this type of data hunting may not be fruitful. That is because while sampling surveys in member states with extensive geographic spread may contain multiple levels of administrative boundaries, in small member states, sampling surveys such as EU-SILC translate into very few households per post code. Thus, even microdata available upon request may not be sufficient to examine regional characteristics. As a result, in order to observe and compare statistically significant information, often times geographic detail is lost and microdata in small-scale countries are very limited. This is where stakeholder engagement may arise to rectify an adverse situation and produce adequate regional microdata even in small countries such as Cyprus.

Robust and reliable findings of regional approaches permit not only consultation towards policy makers, but also allow for maximum dissemination of results to raise public awareness. In addition, as data acquisition is and will remain a problematic aspect of research, the collaboration and own initiative of relevant stakeholders such as municipal authorities gain a paramount role. In such small countries such as Cyprus (33 municipalities), only a few well-documented case studies may be adequate to obtain meaningful results, especially if data is available on an open-source basis. Therefore, it is recommended to view the lack of open source regional data as an opportunity to show initiative and create best practices, whilst safeguarding statistical importance in smaller geographical ranges.

In summary, open source data or even microdata that is suitable to implement in research for small EU member states is a rarity. This situation hampers inquiries in fields where regional approaches are most beneficial. Energy poverty is such a topic, where the most effective solutions involve tailor-made (to a permissible degree) interventions. For this reason, supplementary data of statistical importance are suggested to allow for regional investigations. As well elaborated by Brandmueller et al. (2017), “subnational statistics offer different but interrelated perspectives. They can be combined in multiple ways to create new possibilities for policy analysis and to illustrate social and economic characteristics at varying levels of geographic detail” [45]. Therefore, where open source data fails to adequately cover specific regions, a sagacious course of action involves potential recognition and independent investigations in higher spatial and temporal resolution.

5. Conclusions

This study has provided evidence that a small member state of the European Union, Cyprus, encompasses a range of differentiated regions. Variances on the urban-rural dichotomy of districts have been detected, as well as demarcations among the five districts of the island. This is because each district is distinctly characterised on at least three axes: demography, climate and socioeconomic conditions. The NUTS system offers a framework upon which data collection is carried out, principally by national statistical authorities. In some cases, microdata related to the NUTS system offer adequate detail to allow for regional approaches. For small-scale member states, that is not the case and collection of subnational statistics is recommended. In the context of energy poverty in Cyprus, surveys can be complemented through the use of case study examinations, by focusing on smaller administrative levels of Cyprus (e.g. municipalities). As energy poverty is a complex problem, solutions are required on various timescales. Immediate action by local authorities, citizen initiatives or NGOs towards short- and medium-term interventions can be highly effective. Structural change is required on the long-term horizon to ensure that vulnerable populations are safeguarded. This can be achieved by collection of an adequate volume of regional data under the guidance of national agents, in order to detect problematic aspects of each region and assess the most appropriate policy tools.

It is concluded that even when high quality indicators of energy poverty exist, accessible through Eurostat, under current circumstances they cannot be employed effectively to examine energy poverty regionally within Cyprus. In addition, high quality spatial and temporal data that are openly accessible by researchers, policy makers and the general public will fortify efforts to mitigate energy poverty, whilst allowing for application of data in a multitude of fields. Consequently, in the case of Cyprus and other small-scale member states, complimentary data and microdata are required to augment nationally collected information. A well-designed strategy encompassing various stakeholders at regional levels will ensure reliable and uniform data acquisition, analysis and consultation for policy makers, as well as making the public aware of precarious situations and how to deal with them.

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