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**ANALYSING THE PORTUGUESE URBAN SYSTEM
FROM A QUALITY OF LIFE VIEWPOINT**

ABSTRACT

The idea of studying positive and negative features involved in city living is not new. Relevant works, as the classical “Where to live in Britain in 1988”, by Findlay et al., stressed the importance of several quality of life dimensions. In Portugal, a research team based in the Department of Civil Engineering at the University of Minho developed in 1998-2000 a study on quality of life in the major eighteen Portuguese cities. Results of the evaluation models developed for the dimensions considered were integrated in a quality of life grand index and mapped through a GIS system. This paper presents the quality of life surfaces developed for Portugal. In particular, it explores the overlay of quality of life and population density surfaces, attempting to find out the relationship between both.

INTRODUCTION

During 1998-2000, a research team based in the Department of Civil Engineering at the University of Minho, together with some national and international experts for specific areas, developed a study on Quality of Life in the major eighteen Portuguese cities (Mendes, 1999, Mendes et al. 1999a). During the first stage of this research, developed in 1998, quality of life was conceptualised and evaluated for the 18 cities. Afterwards, a quality of life surface was created for the country and overlaid with the population density distribution. In the next section, the quality of life evaluation model is presented.

THE EVALUATION MODEL

The theoretical foundations of the definition and evaluation of Quality of Life can be found in several works (see, for example, Brown et al., 1993; Felce and Perry, 1995; Cummings, 1998, Savageau and Loftus, 1997; Findlay et al., 1988, Rogerson et al., 1989). Standing on these contributions, Mendes (2000) pointed out that: (i) quality of life in cities can be described by dimensions; (ii) dimensions are associated with particular aspects of living in an urban context; (iii) quality of life dimensions can be described by indicators, which can be objective or subjective; (iv) dimensions and indicators can be combined through the attribution of different levels of importance (weights), based on a subjective judgement. These four points, together with a list of the relevant dimensions for a particular situation, configure a definition of urban quality of life. Considering this conceptual outline, different combinations of dimensions and associated weightings lead to different definitions, more or less personalised, that can be customised to the interests, motivations and preferences of a social group, a company, an institution, or a single citizen.

The methodology followed in the Portuguese study, including the quality of life evaluation model, stands on seven steps (Mendes et al., 1999):

- i) Identification of the dimensions to be considered, resulting in a final set of nine dimensions: climate, commerce & services, crime, unemployment, housing, mobility, architectural patrimony, purchasing power, and pollution.
- ii) Definition of weightings for the dimensions. A sample distributed over the

country was surveyed by phone in order to establish the set of weightings representing the relative importance of the dimensions.

- iii) Creation of indicators that describe each dimension. The selection of indicators resulted from the judgement of the research team, taken into account the relevance of the variables included and, on the other hand, the availability of data.
- iv) Definition of the scoring scale for the indicators. In order to make indicators comparable, a normalised score for each city and indicator was developed, given by the difference between the value of the indicator for the city and the mean over the 18 cities considered, divided by the standard deviation over the 18 cities. Denoting the value of the indicator for a city by I , the mean of the values of I over the 18 cities by $\mu[I]$, and the respective standard deviation by $\sigma[I]$, the score for the indicator is given by:

$$Score_i = a_i \frac{I - \mu[I]}{\sigma[I]} \quad (1)$$

where a_i is a variable that assumes the value +1 when higher values of the indicator i contribute positively to the quality of life, and the value -1 when higher values of the indicator contribute negatively to the quality of life.

- v) Definition of weightings for the indicators. The attribution of indicator weightings within each dimension resulted from the judgement of the research team, as presented in the next section.
- vi) Definition of the aggregation equation for the indicators. For each dimension and each city, the score is given by the weighted average of the indicator scores:

$$Score_d = \frac{\sum_i Score_i \times \omega_i}{\sum_i \omega_i} \quad (2)$$

where ω_i is the weighting of indicator i .

- vii) Definition of the aggregation equation for the dimensions. For each city, the score is given by the weighted average of the dimension scores:

$$Score = \frac{\sum_d Score_d \times \omega_d}{\sum_d \omega_d} \quad (3)$$

where ω_d is the weighting of dimension d .

DIMENSIONS, INDICATORS AND WEIGHTINGS

The complete set of dimensions, indicators and weightings, as resulted from the national survey and the research team options (Mendes, 1999, Mendes et al. 1999a) is presented in Table 1.

TABLE 1
DIMENSIONS, INDICATORS AND WEIGHTINGS

CLIMATE		0.087
Winter climate index		0.33
Summer climate index		0.33
Rainfall index		0.33
COMMERCE & SERVICES		0.117
Banks		0.143
Bank branches per 10.000 hab.	1.000	
Commerce		0.143
Retail shops	0.200	
Retail shops per 10.000 hab.	0.200	
Hypermarkets	0.300	
Hypermarkets per 10.000 hab.	0.300	
Sport facilities		0.143
Indoor sports arena per 10.000 hab.	0.200	
Outdoor sports field per 10.000 hab.	0.200	
Indoor swimming pools per 10.000 hab.	0.200	
Outdoor swimming pool per 10.000 hab.	0.200	
Athletics tracks per 10.000 hab.	0.200	
University and Polytechnic		0.143
University graduation courses	0.400	
University <i>numeri clausi</i>	0.400	
Polytechnic graduation courses	0.100	
Polytechnic <i>numeri clausi</i>	0.100	
Museums		0.143
Number of museums	1.000	
Health		0.143
Hospitals per 100.000 hab.	0.150	
Hospital beds per 100.000 hab.	0.600	
Number of physicians per 10.000 hab.	0.200	
Number of pharmacies per 10.000 hab.	0.050	
Social Assistance		0.143
Number of youth-activity facilities per 10.000 hab.	0.050	
Capacity of youth-activity facilities per 10.000 hab.	0.200	
Number of elderliness-activity facilities per 10.000 hab.	0.050	
Capacity of elderliness-activity facilities per 10.000 hab.	0.200	
Number of kindergartens per 10.000 hab.	0.050	
Capacity of kindergartens per 10.000 hab.	0.200	
Number of houses for aged people per 10.000 hab.	0.050	
Capacity of houses for aged people per 10.000 hab.	0.200	

TABLE 1 (*cont.*)
DIMENSIONS, INDICATORS AND WEIGHTINGS

CRIME		0.118
Offences against people per 1000 hab.	0.450	
Crimes against property per 1000 hab.	0.450	
Crimes against life in society per 1000 hab.	0.100	
UNEMPLOYMENT		0.119
Registered unemployment index	1.000	
HOUSING		0.120
Purchasing price per m ²	0.500	
Renting price per m ²	0.500	
MOBILITY		0.109
Buses per 1000 hab.	0.300	
Vehicles per Km of roads	0.250	
Gasoline sales per Km of roads	0.250	
Road density	0.100	
Travelling time to Lisbon and Oporto (aggregated)	0.100	
ARCHITECTURAL PATRIMONY		0.103
National Monuments and UNESCO World Patrimony	0.667	
Other National Classified Patrimony	0.333	
PURCHASING POWER		0.106
<i>Per capita</i> purchasing power indicator	1.000	
POLLUTION		0.121
Air quality		0.333
CO emissions per Km ² of urban area	0.250	
NOx emissions per Km ² of urban area	0.250	
COV emissions per Km ² of urban area	0.250	
PTS emissions per Km ² of urban area	0.250	
Water quality		0.333
Parameters G1 (11 organoleptic and microbiologic parameters)	0.115	
Parameters G2 (15 physical and chemical parameters)	0.156	
Parameters G3 (25 undesirable and toxical substances parameters)	0.260	
Number of violations of parameters G1, G2 e G3 (45 parameters)	0.469	
Urban Noise		0.333
Equivalent sound intensity level (Leq)	1.000	

QUALITY OF LIFE EVALUATION

The application of the evaluation models, together with the particular weightings set presented in the previous section, resulted in a ranking of cities. Table 2 presents the ranking and scoring for each city and each quality of life dimension.

TABLE 2
QUALITY OF LIFE: RANKING AND SCORING

Rank	Cities	Clim. <i>Score</i>	Com.Serv <i>Score</i>	Crime <i>Score</i>	Unempl <i>Score</i>	Housing <i>Score</i>	Mobil <i>Score</i>	Patrimon <i>Score</i>	Purchase <i>Score</i>	Pollution <i>Score</i>	FINAL <i>SCORE</i>
1	Lisboa	0.93	1.54	0.24	0.39	-2.69	-0.91	3.26	3.31	-1.86	0.38
2	Guarda	-0.18	-0.08	0.88	0.75	0.91	0.05	-0.58	-0.51	0.76	0.26
3	Coimbra	-0.07	0.58	0.80	0.66	-0.62	0.55	0.41	0.06	-0.36	0.23
4	Bragança	-0.64	-0.10	1.15	0.22	1.23	-0.31	-0.37	-0.54	0.41	0.16
5	Castelo Branco	-0.09	-0.02	1.20	0.03	1.00	0.27	-0.65	-0.49	-0.15	0.15
6	Santarém	-0.07	-0.41	0.54	0.50	0.44	-0.09	0.04	-0.50	0.48	0.12
7	Aveiro	0.39	0.18	-1.04	1.05	0.20	0.13	-0.61	0.02	0.16	0.05
8	Viana do Castelo	-0.05	-0.60	0.13	0.72	0.40	0.12	-0.20	-0.67	0.38	0.04
9	Évora	-0.09	0.01	0.10	0.00	-0.66	-0.27	1.28	-0.23	0.32	0.04
10	Leiria	0.39	-0.51	-0.69	1.29	0.56	0.23	-0.65	-0.33	-0.01	0.03
11	Faro	0.93	-0.01	-1.36	0.31	-0.12	0.42	-0.58	0.32	-0.17	-0.06
12	Porto	-0.05	0.97	-0.03	-0.58	-1.66	-0.19	0.52	1.76	-1.08	-0.07
13	Braga	-0.51	-0.16	-1.06	0.41	0.37	-0.04	0.15	-0.20	-0.18	-0.13
14	Vila Real	-0.64	-0.24	0.29	-0.48	0.37	0.04	-0.47	-0.65	0.25	-0.15
15	Viseu	-0.51	-0.51	-0.60	-0.03	0.45	0.24	-0.40	-0.48	0.29	-0.15
16	Beja	-0.09	-0.13	1.03	-1.21	-0.64	-0.22	-0.41	-0.41	0.44	-0.18
17	Setúbal	0.93	-0.37	-1.90	-1.08	0.16	0.18	-0.31	0.08	-0.13	-0.32
18	Portalegre	-0.53	-0.13	0.32	-2.96	0.30	-0.19	-0.41	-0.54	0.46	-0.41

For a detailed example of the calculations for a particular dimension, see Mendes et al. (1999a), where evaluation models for the scoring of air quality, water quality and urban noise are presented and aggregated to produce general city pollution scoring and ranking.

QUALITY OF LIFE MAPPING USING GIS

The results of the quality of life evaluation models were integrated in a GIS database, in order to allow analysis and mapping of the results. Indicator values for the different dimensions and relative scores are mapped through ArcView software, showing the current "quality of life landscape" for the major eighteen Portuguese cities (Figure 1). It must be stressed that the quality of life surfaces created are based in 18 point values, which means that, particularly in the Southern part, the interpolations are approximate.

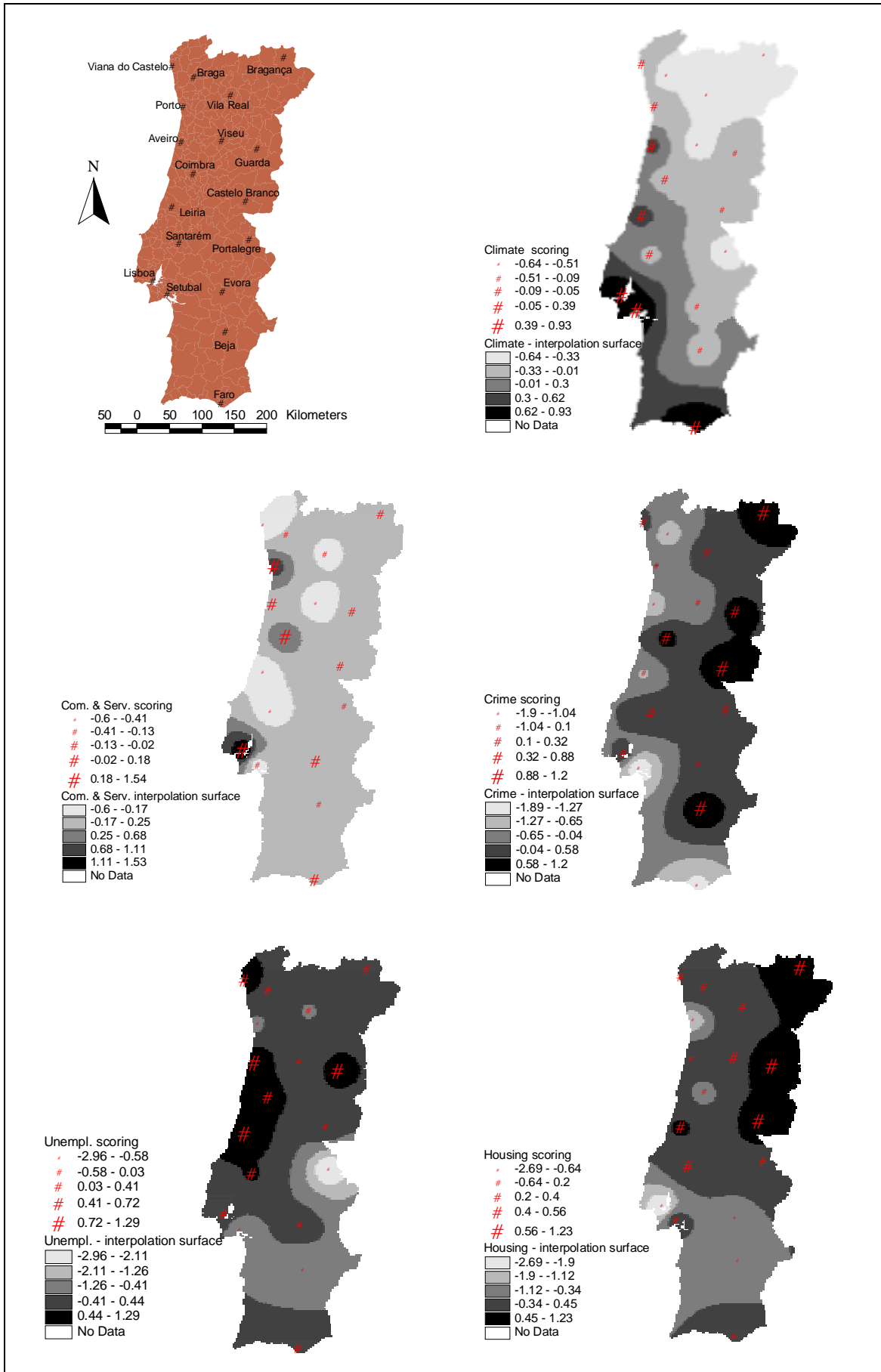


Figure 1 - Quality of life surfaces

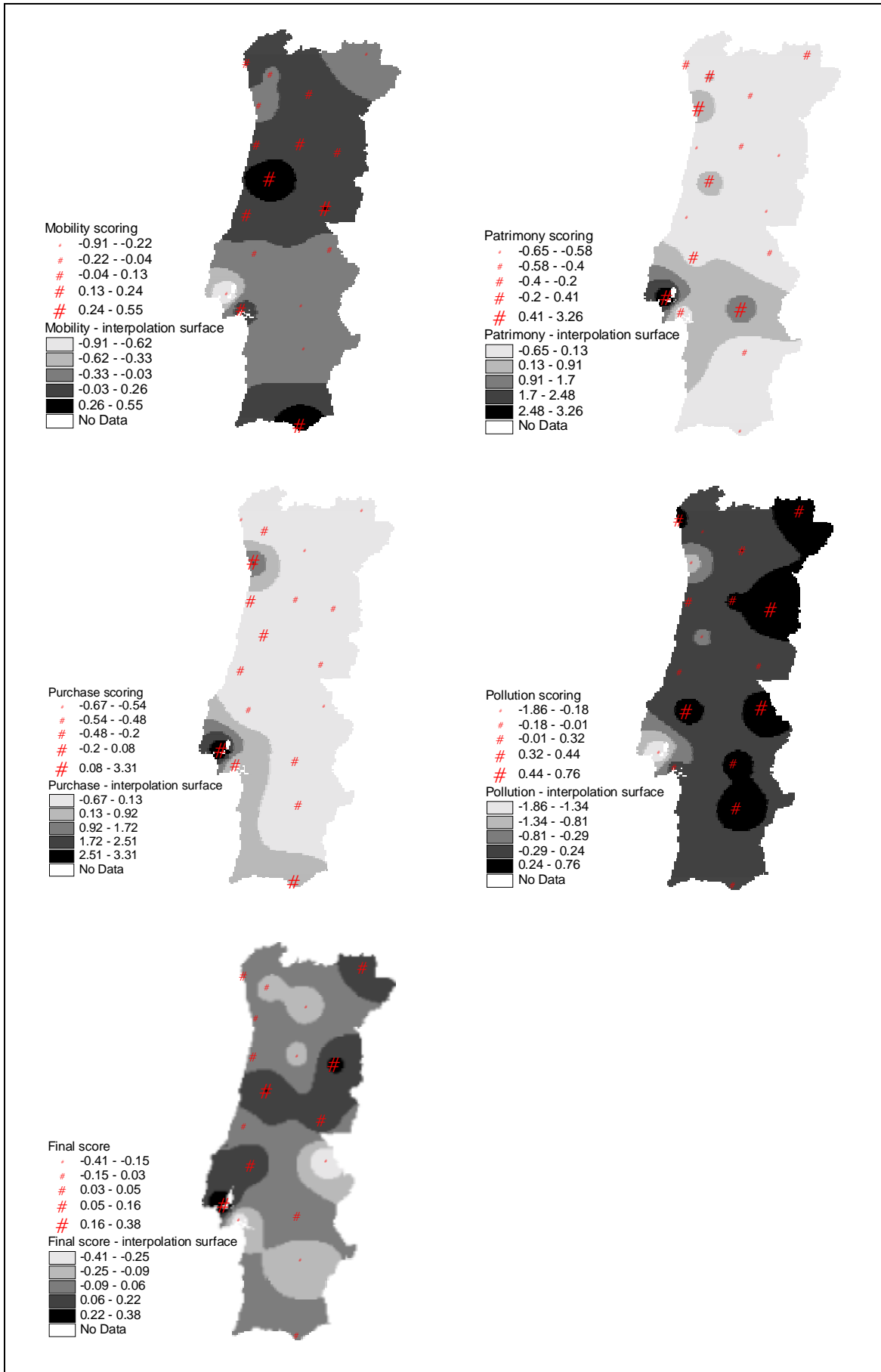


Figure 1 (cont.) - Quality of life surfaces

Standing on Figure 1, some comments can be made regarding the spatial distribution of the quality of life scores, as follows:

Climate. Scores rise from Northeast to Southeast. A high-score belt can be identified between the region of Lisboa and the region of Faro, due to lower rainfall rates and moderately high temperatures.

Commerce & Services. Lisboa and Porto have high concentrations of commerce and services. Also Coimbra shows a good concentration due mainly to the presence of strong health and university facilities. Surprisingly, cities like Viana do Castelo, Vila Real, Guarda, Coimbra e Santarém have low scores due to low services/population ratios. On the contrary, inland regions have slightly higher scores due to lower concentrations of population.

Crime. There is a pattern indicating that seaside regions have higher crime rates than inland regions.

Unemployment. Two patterns can be identified. First the one which shows that Northern regions have lower unemployment rates than Southern regions. Second the one that shows a cluster of low unemployment in cities located on the west corridor of the central regions of the country. A particular high unemployment point can be identified in the city of Portalegre.

Housing. As expected, the cities of Lisboa and Porto show very low scores regarding housing. In addition, also Coimbra is an expensive housing city. Cities in Eastern and Northeast regions have higher scores.

Mobility. Lisboa is clearly the city with lower levels of mobility, due to high concentration of people and traffic. Cities like Coimbra and Faro show higher levels of mobility.

Patrimony (architectural heritage). Lisbon has the highest concentration of classified urban heritage elements. Also Évora, Coimbra, Porto and Braga are clearly at an higher level than the rest of the country.

Purchase power. Lisboa has a score that is more than three times the mean for Portugal. Porto and Faro also show values which are clearly higher than the rest of the country.

Pollution. The main pattern of pollution scores shows that cities on the East corridor, which have lower concentrations of people and traffic, have less pollutant emissions. On the other side, the cities of Lisboa and Porto show, as expected, higher levels of emissions.

Quality of Life – final score. The quality of life landscape in Portugal shows that Lisbon is still the most attractive city due mainly to high scores of commerce and services, architectural patrimony, purchasing power and climate. There is a corridor that crosses the country in the center region, which includes Coimbra, Guarda and Castelo Branco, all having scores above the mean. Coimbra takes advantage of a balanced distribution across quality of life dimensions, while Guarda and Castelo Branco enjoy good scores in crime, housing, mobility and pollution; for similar reasons, Bragança has an acceptable quality of life global score. Portalegre and Setúbal have some of the lower scores in most of the quality of life dimensions, which leads to the poorest global scores.

Also important is the analysis of the quality of life distribution, as evaluated with the current model, weighted by the population density. This gives an idea of the actual distribution of the population subjected to different levels of quality of life.

Figure 2 shows, for each dimension and for the overall quality of life index, the surfaces calculated through the multiplication of the scores with the population density.

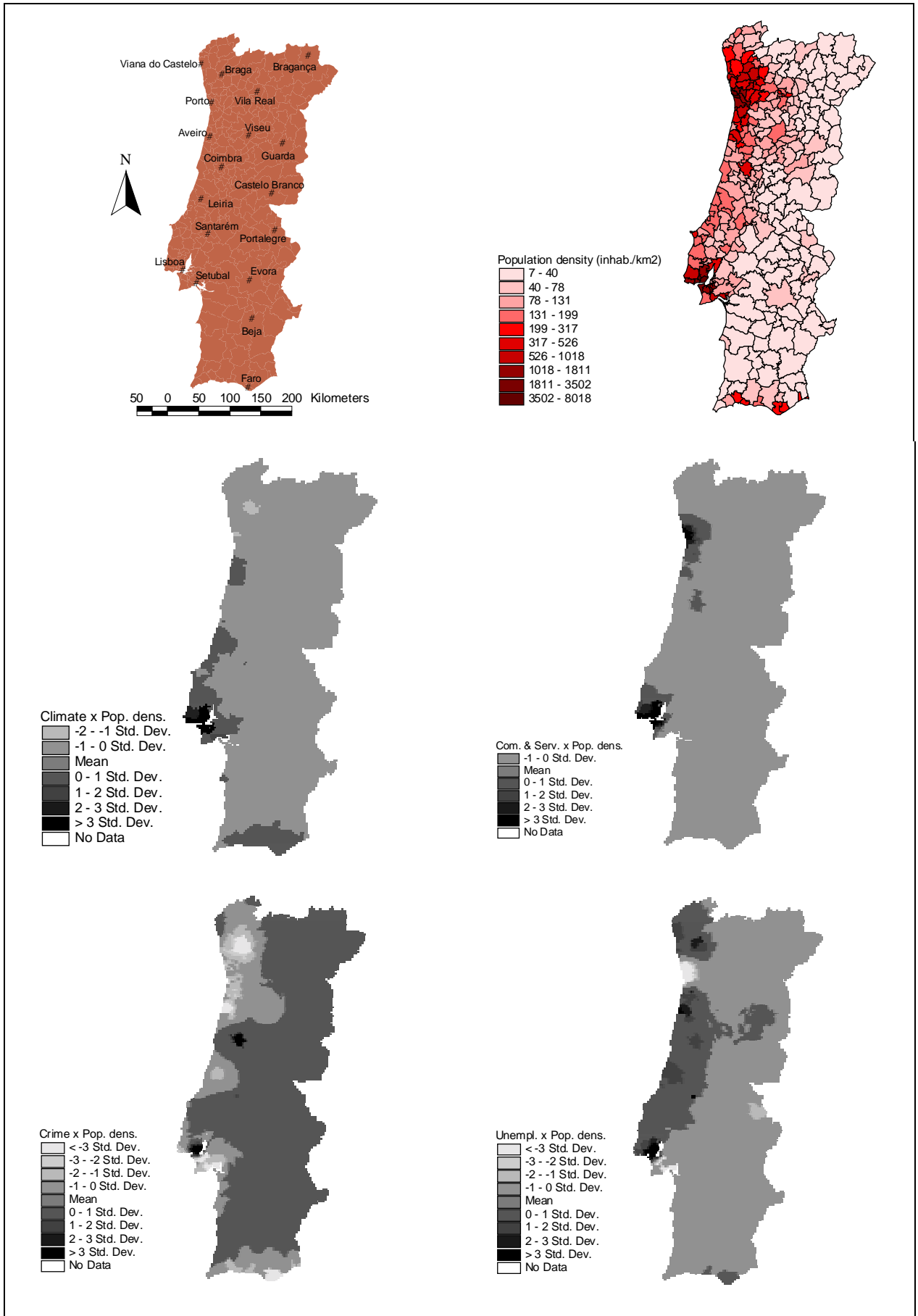


Figure 2 - Quality of Life x Population density surfaces

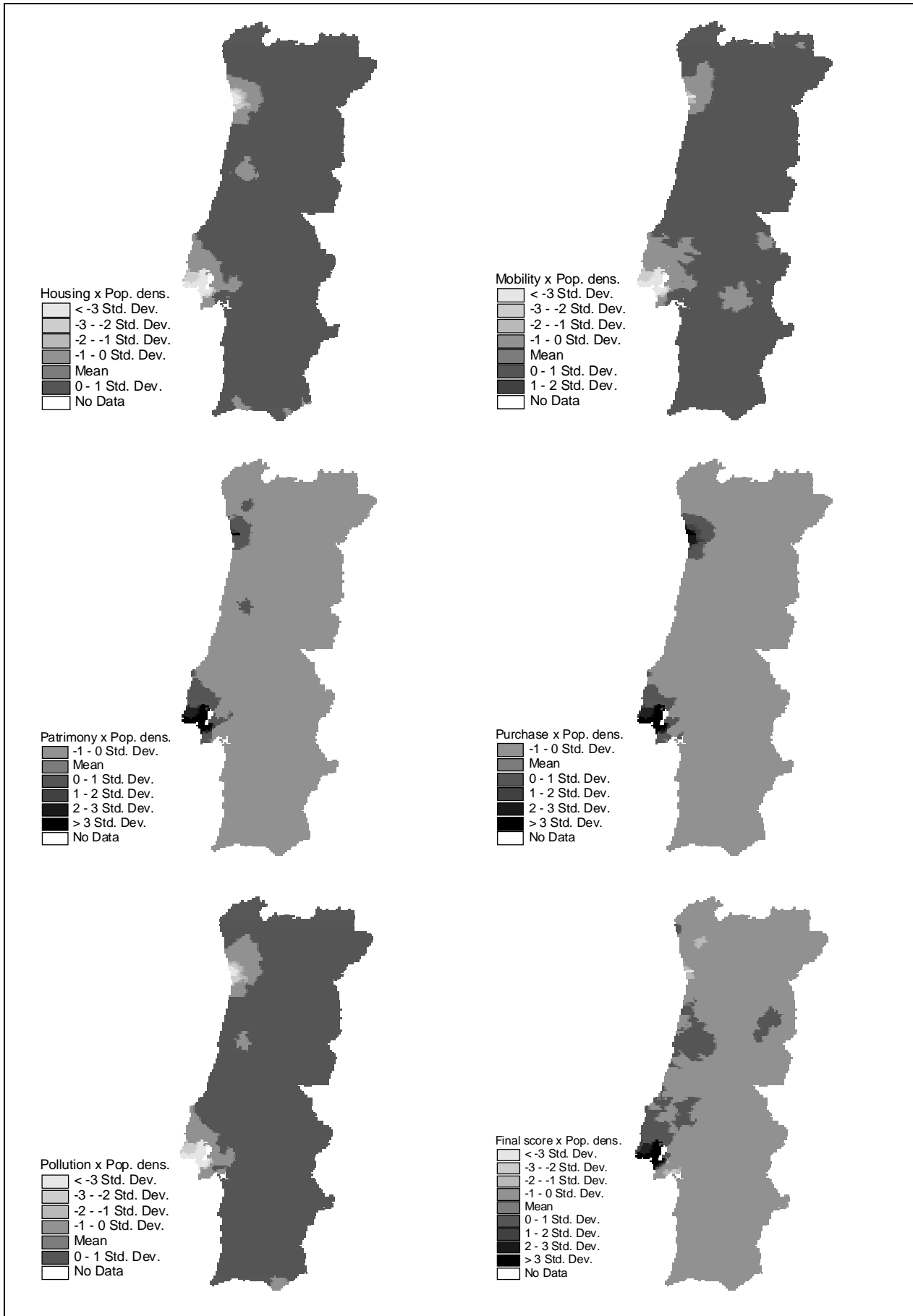


Figure 2(cont.) - Quality of Life x Population density surfaces

Again we produce the following comments:

Climate. Most of the population lives subjected to a climate which is under the mean.

Commerce and Services. Lisboa and Porto are still islands, in a country where most of the population live under the mean.

Crime. There is a concentration of people subjected higher crime rates along the west coast (North of Lisboa) and along the South coast. The rest of the country population (inland) lives safer.

Unemployment. Along the coast line, between Lisboa and Viana do Castelo, the situation is over the mean, with the exception of Porto. In the rest of the country, there is deficit of employment.

Housing. Lisboa, Porto and Coimbra are islands, with great concentrations of people subjected to expensive housing, in a country where there is generally an homogeneous over-mean distribution..

Mobility. In most of the country there is not many people subjected to low levels of mobility. The exceptions are, as expected, Lisboa and Porto. Évora, Castelo Branco and Bragança are also places where there are concentrations of people with mobility difficulties (the two later ones due to their eccentric location, far from Porto and Lisbon).

Patrimony (architectural heritage). The combination of scores and population density shows a country where Lisboa, Porto, Coimbra and Braga have a privileged situation.

Purchase power. This dimension shows how heterogeneous the country can be, where the concentrations of people in Lisboa and Porto enjoy much higher levels of purchasing power than the rest.

Pollution. This dimension shows the concentration of people living in Lisboa, Porto, Braga, Coimbra, Setúbal and Faro subjected to much higher levels of pollution than in the rest of the country.

Quality of Life – final score. The current situation in Portugal shows that the areas of Lisboa, Santarém, Coimbra, Guarda and Viana do Castelo host the highest concentrations of people enjoying better quality of life. The highest concentrations of people subjected to worse quality of life are in the areas of Porto, Braga and Setúbal. In the rest of the country, there are places of good and bad quality of life, but the population density is generally low, which means that most of the respective map is homogeneous.

CONCLUSIONS

Even considering that only 18 cities are not enough to have a well detailed quality of life surface in Portugal, the analysis undertaken allows some general conclusions.

Comparing the two final maps of Figures 1 and 2, one can conclude that the spatial distribution of the population in Portugal does not follow the spatial distribution of the quality of life. In fact, due to the known East-West unbalance in population, the final map of Figure 2 shows a country with a vast zone of indifference and two extreme opposite situations: Lisboa, Santarém, Coimbra, Guarda and Viana do Castelo, on one hand, and Braga, Porto and Setúbal, on the other hand. Particularly important is to acknowledge that the cities of the later group show a combination of lower quality of life and high concentration of population. This deficit in quality of life should be considered when planning investments to mitigate the situation and, in addition, when redesigning the Portuguese urban system.

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