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Ageing and Urban Form in Aix-Marseille-Provence Metropolis

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Abstract

The world population is ageing. In France, this phenomenon is particularly pronounced with 19.6% of the population being over 65-year-old in 2018. While it has been recognized that urban form plays an important role in ensuring a sustainable future for urban areas, ageing dynamics are challenging the core concept of urban sustainability. Maintaining or improving the quality of life of an ageing population through urban built form will become as much important, and as much recognized, as ensuring urban environmental sustainability in the future. Today, the well-being of the elderly is still reduced to the economic aspects of the silver economy or to ergonomic aspects in building design. While socio-demographic micro-data on the elderly are available, a comprehensive metropolitan-wide and fine-scale description of the urban forms where seniors live must rely on the latest developments of urban morphometrics. From historic city centres to suburban residential areas, passing through modernist apartment blocks, none of these typical forms seems particularly suited to the needs posed by ageing, which must accommodate accessibility to housing itself and to local shops, health care and services in general. The question of the role of different urban forms over the spatial distribution of the seniors thus arises, as well as the capacity of spatial arrangements to suit the needs and specificities of an ageing population. The case study is a metropolitan area that offers a great heterogeneity of urban forms: Aix-Marseille-Provence, in Southern France. Some areas show over or under-representation of seniors, while others are better at ensuring a generational mix. In most cases, the spatial distribution of the seniors can be linked to specific building hull forms. The spatial distribution of these hull types, and their close relationships to ageing and accessibility are presented in this paper.

Keyword: *ageing, urban form, urban morphometrics, Aix-Marseille-Provence.*

Introduction

The world population is ageing, and there is no stopping a demographic trend that is challenging the core concept of urban sustainability. Ageing induces irreversible changes on behaviours, but some inherited urban forms may not be suited to the needs posed by ageing, which must accommodate accessibility to housing itself and to local shops, health care and service in general. This paper proposes a crossed analysis of building hull forms with micro-data on population and income structures, and on the location of amenities and services. The case study is the Aix-Marseille-Provence Metropolitan area, located in southern France. The next section presents a short literature review on ageing and urban form within the case study area. The third section presents the raw data used in this research and summarizes the different applied methods, namely calculation of demographic and morphometric indicators, clustering of building hulls, aggregation of clustering results and amenity/service locations at the census tract scale. The fourth section presents preliminary results on the link between the spatial distribution of seniors and urban forms. A final section concludes the paper.

Background: ageing and form in Aix-Marseille Provence Metropolis

In 2019, 20% of the French population is over 65-year-old (INSEE, 2019) and this proportion is expected to rise to 26.9% by 2040 (World Bank Open Data, 2021, population estimates and projections). Since the south of France is a preferred location for retirement, this phenomenon is even slightly accentuated here (20.6% of people over than 65-year-old in Provence-Alpes-Côte d'Azur region, INSEE 2017). A glance at **Figure 1** shows that in the future, the age distribution within southern France (*Provence-Alpes-Côte d'Azur* region) is not only going to accommodate more seniors, but also to hold fewer people from within the working-age category. This is partly due to ageing mid-20th century baby boomers, but also to a growth rate bellow France’s average in southern France. In France, most of urban spaces have been designed for a population of young households and during a period of growing demand for housing (apartment blocks of the post-WW2 'Glorious Thirty', suburban residential areas made of single-family homes, etc.). The case study of this research, the metropolitan area of Aix-Marseille Provence, possesses this great heterogeneity of urban forms, but also some specificities. Mentions can be made of the *3 fenêtres marseillais* (3-window-building from Marseille), which is the prevailing architectural type built along the new streets of the 19th century expansion of Marseille (3 to 4 storeys building that has a facade length of 3 windows, e.g., Dell’Umbria, 2006), or of the 1960s and 1970s seaside urbanization, that saw the rise of free-standing complexes of apartments, terraced or with large balconies. The Aix-Marseille Metropolitan Authority is a public body for inter-municipal cooperation which accounts for 92 municipalities and around 1.8 million of inhabitants. The entire metropolitan area possesses a surface of 3.173 km² and two large agglomerations: Marseille and Aix-en-Provence (25 km north of Marseille, **Figure 1**). The heterogeneity of forms within the Aix-Marseille-Provence metropolitan area raises questions about the capacity of different neighbourhoods to suit the needs and specificities of an ageing population, as well as ensuring a successful generational mix in the future. Certain forms or endogenous characteristics of urban spaces are likely to influence residential mobility; as they can filter populations having different lifestyles, health conditions, plans, opportunities, or financial situations. Many authors have stressed the economic and social disparities amongst the population living in the metropolitan area, especially between the northern and southern parts of the agglomeration of Marseille (see the ‘social division of urban space’ in Roncayolo, 1996; detailed in English in Noizet, 2009). Poverty in downtown Marseille as well as within the free-standing modernist social housing units are also often pointed out (Zalio, 1996). Despite the fact that research between urban and social sustainability is taking roots in the scientific community (Bramley *et al.,* 2009; Mouratidis, 2018), no research focusing on ageing and form have been attempted in Aix-Marseille Provence yet. Ascaride and Condro (2001) were nonetheless already stressing twenty years ago that elderly people living alone in downtown Marseille were often impoverished immigrants living in extremely precarious conditions.

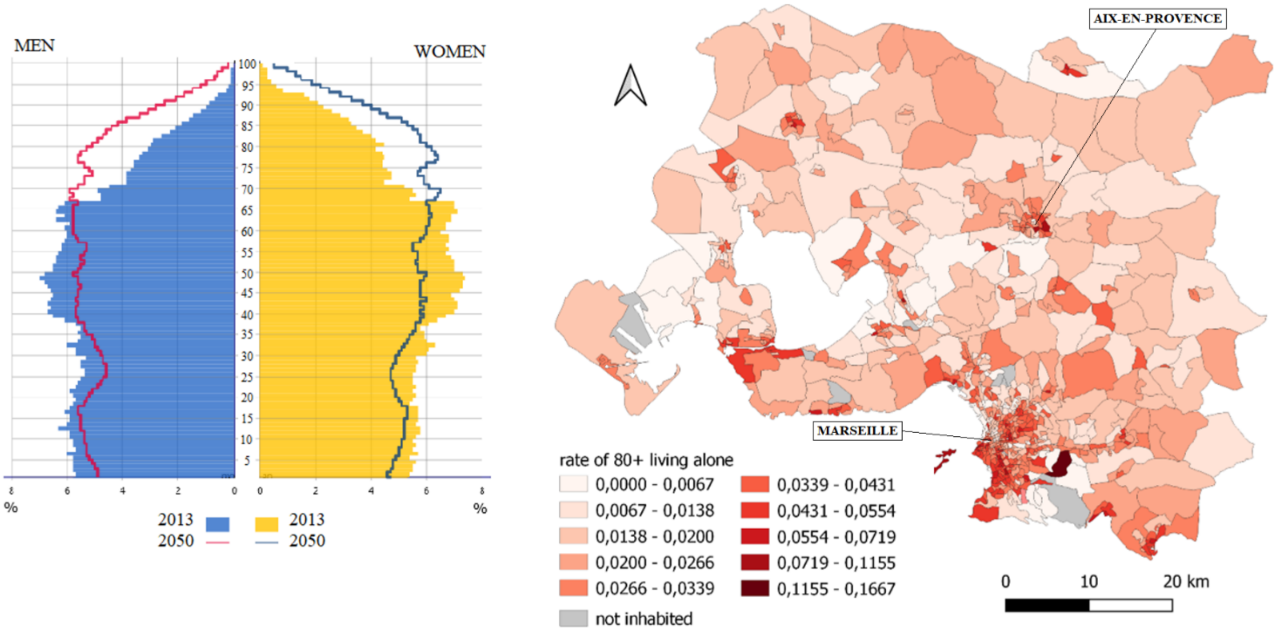

Figure 1. *Left: Age distribution in 2013 and 2050 (projection) in Provence-Alpes-Côte d'Azur region (Source: INSEE, 2017). Right: Rate of people aged 80 and over living alone (Data source: INSEE, 2016 population censuses; basemap: IGN, IRIS 2016 outlines).*

Today, the rate of elderly people living alone, which excludes people living in retirement homes (EHPAD and residences for elderly people), is still showing strong signs of spatial disparities. It is higher in the outskirts of the two largest agglomerations of the metropolis (Marseille and Aix-en-Provence) than in their city centres, with a tendency towards spatial clustering in certain districts, such as in the south and east of Marseille and in the east of Aix-en-Provence (**Figure 1**). In smaller urban units, the rate is systematically higher in the centres than in suburban areas. The rate rises in small areas away from the two largest agglomerations, and in rural municipalities.

Data presentation and methodology

Four different kinds of data are used in this study:

- The 2019 BD TOPO® from the French National Geographic Institute (IGN), which provides an exhaustive dataset of building footprints with a metrical precision. BD TOPO® also includes attribute data, such as building heights, number of housing units per building, construction date, etc.
- The « *Couples - Familles - Ménages* » (couples, families, households) spreadsheet of the 2016 population Census of the French national institute for statistical and economic studies (INSEE) at the sub-municipal IRIS level (*« Ilots Regroupés pour l'Information Statistique* »).
- The 2017 income structure from the *« Dispositif Fichier localisé social et fiscal (*Filosofi*) »* of INSEE at the sub-municipal IRIS level.
- The 2019 *« Base Permanente des Equipements (*BPE*) »* of INSEE, providing information of services and amenities at the finest scale, thorough their geographical coordinates.

Using the IRIS level, we first filter all the aforementioned datasets according to the extent of Aix-Marseille Provence metropolitan area (779 IRIS units, as displayed in **Figure 1**). Then, we implement a clustering approach specifically developed to identify typologies of residential and mixed-use building hulls from the 2019 BD TOPO®, as recently proposed in Araldi *et al.* (2021). Starting from five morphological descriptors of the building hulls (convexity, elongation, surface, height, and adjoining neighbours, as detailed in Perez *et al.,* 2019, and number of dwellings), a two-step protocol combines Naïve Bayesian and Hierarchical clustering. The former is based on a probabilistic framework (Iterative Naive Bayesian Inference Agglomerative Clustering, INBIAC), and implemented with one-hundred different seeds for each cluster solution *k*, ranging between 6 and 16. The optimal clustering solutions for each solution *k* is then selected according to performance parameters, such as the log-likelihood loss scores. The subset of the 16 more robust INBIAC clustering solutions is then used to divide the original dataset in smaller groups of buildings (kernels) always clustered together. These kernels represent the finest partition for which the highest inter-level consensus is observed. Implementing an HCA algorithm produce hierarchically nested groupings based on clustering agreement amongst the 16 INBIAC solutions. This approach shares the same underlying hypothesis of consensus clustering protocols (Monti *et al.,* 2003), where several cluster solutions are combined to achieve a more robust solution. From the resulting dendrogram, three clustering solutions are finally retained at 16, 11 and 7 clusters.

Table 1. Description of the 7, 11 and 16 retained cluster solutions

Description	16-CL	*n* / %	11-CL	*n* / %	7-CL	*n* / %
Tall adjoining small collective buildings	C2	3,380 0.83 %	C2	3,380 0.83 %		
Mid-rise mid-sized adjoining and compact apartment buildings	C13	6,465 1.60 %	C9	6,465 1.60 %	C2	10,498 2.59 %
Combined or isolated towers/buildings	C11	653 0.16 %	C8	653 0.16 %		
Very large articulated adjoining mid to high rise apartment buildings	C5	1,437 0.35 %	C5	1,437 0.35 %	C4	1,437 0.35 %
Isolated towers and short longitudinal apartment blocks	C8	5,811 1.44 %				
Isolated longitudinal and low rise apartment blocks	C9	2,960 0.73 %	C7	9,617 2.37 %	C6	9,617 2.37 %
Large articulated apartment blocks isolated (sometimes combined)	C10	840 0.21%				
Big articulated 1-storey townhouses (sometimes multi-family)	C4	5,719 1.41 %				
Big articulated 2-storey townhouses (sometimes multi-family)	C6	3,673 0.91 %	C4	16,581 4.1 %	C3	16,581 4.10 %
Mid-rise 3-storey articulated adjoining single- or multi-family buildings	C12	7189 1.78 %				
Very small adjoining compact buildings single- or multi-family (2/3-storey)	C3	27,018 6.68 %	C3	27,018 6.68 %	C1	115,959 28.67 %
Townhouses (mainly 1-storey)	C1	88,941 21.99 %	C1	88,941 21.99 %		
Very compact and small houses 1/2-storey (sometimes semi-detached)	C14	155,610 38.48 %	C10	155,610 38.48 %	C7	155,610 38.48 %
Very large and articulated 1/2 storey isolated or combined buildings	C7	4,521 1.12 %	C6	4,521 1.12 %		
Big 1-storey articulated/elongated houses (sometimes semi-detached)	C15	48,069 11.89 %	C11	90,163 22.30 %	C5	94,684 23.41 %
Big 2-storey articulated houses (sometimes semi-detached)	C16	42,094 10.41 %				

Table 1 and **Figure 2** provides descriptive statistics and illustrations for the different building hulls clustering solutions. It should be noted that the *3 fenêtres marseillais,* seaside urbanization, and the free-standing social housing tower blocks discussed in the previous section are respectively found in C3, C10 and C8 of the 16 clusters solution. Other typical clusters stand out, such as C7, which integrates traditional Mediterranean farmhouse, namely the *« Bastide »,* or C1 which integrated both small adjoining townhouses and former unplanned housing units constructed by and for poor workers during the industrial revolution, namely the *« courée ouvrière »* (Bonillo *et al.,* 1988).

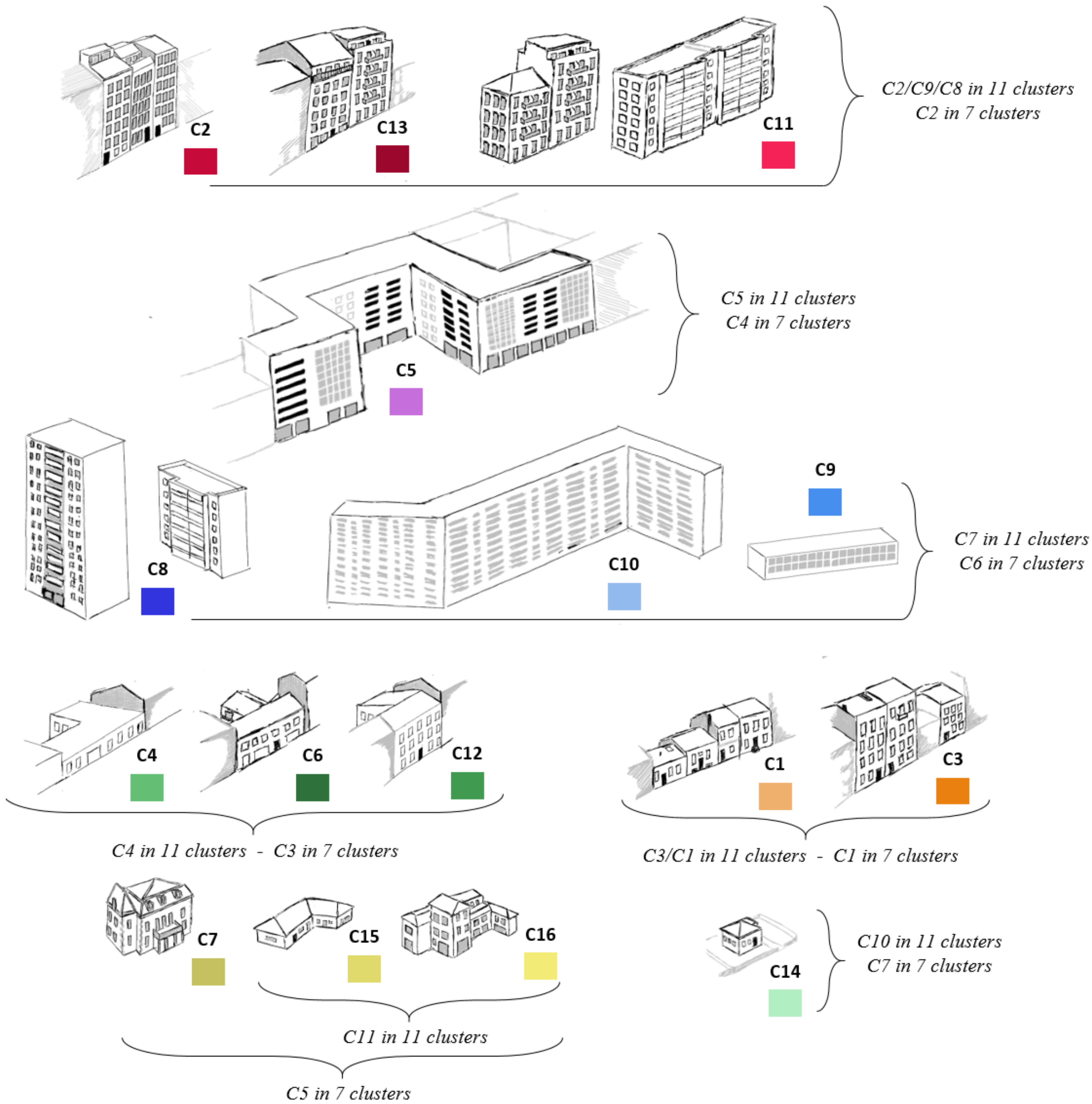

Figure 2. *illustrative examples for the 16 clusters solution, alongside grouping for the 11 and 7 cluster solutions*

The prevalence of each building hull type is then calculated at the IRIS level for the three retained cluster solutions, using the gross floor area (GFA) proportion of each cluster per IRIS. Finally, the location of services and amenities dataset (BPE) is aggregated at the IRIS level. A composite indicator focusing on local accessibility is conceived, named PBSE (for «presse», «boulangerie», «supérette» and «épicerie»), which aggregates into one indicator the newspaper points of sales, bakeries, mini-markets, and grocery shops. The IRIS dataset conceived for this project ultimately contains hundreds of variables, taken from the 2019 prevalence of building hull types, the 2016 population census, the 2017 income structure and the 2019 service and amenity locations.

Results and Discussions

In Marseille proper, there is an interesting although not surprising centre-periphery gradient, with a prevalence of mid-rise and mid-sized adjoining and compact apartment buildings in the central areas (C13 in 16 and C2 in 7 clusters, **Figure 3**) shifting into *3 fenêtres marseillais* (3-windows from Marseille) during the 19th century expansion of Marseille (C3 in 16 clusters). The prevalence in peripheral urban areas can be described as a patchwork made mostly of modernist isolated towers (C8 in 16 and C6 in 7 clusters), low rise apartment blocks (C9 in 16 and C6 in 7 clusters) and townhouses, that are often old village centres caught by urban sprawl (C1 in both 16 and 7 clusters). Suburban areas within the whole metropolitan area are dominated by articulated or small single-family houses (C16/C14 in 16 and C5/C7 in 7 clusters). Bivariate analysis at the IRIS scale and ANOVA results are displayed in the table below. Scatter plots with confidence intervals are also available in **appendix 1**.

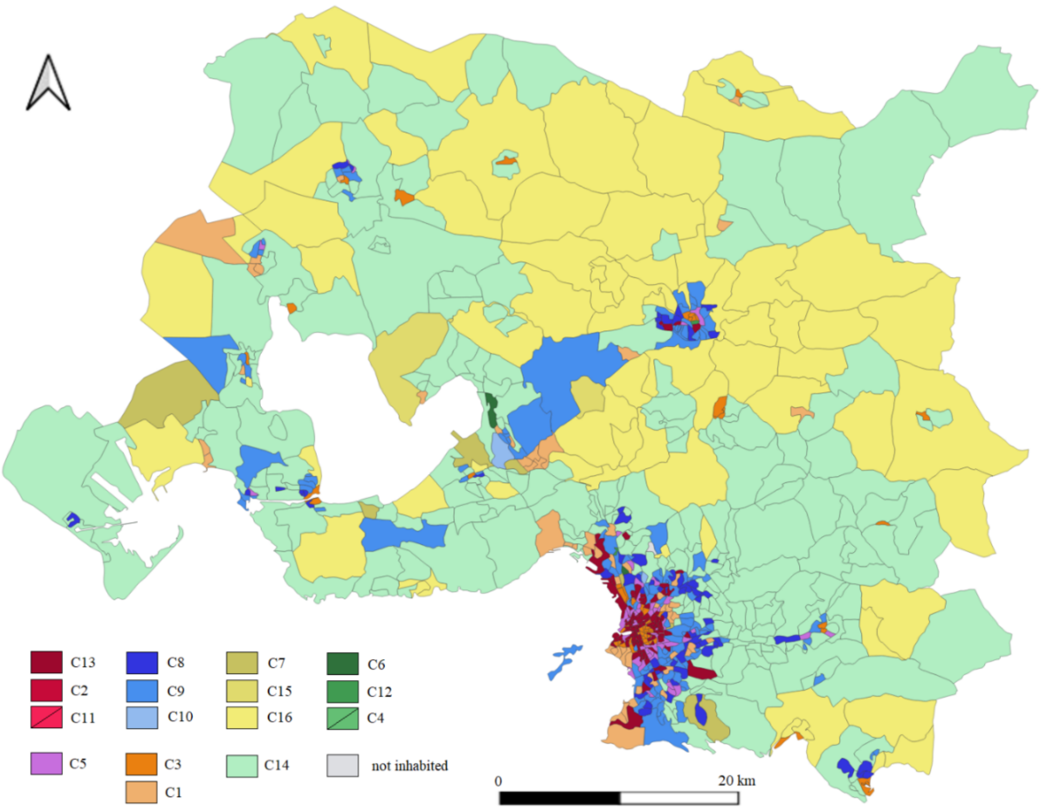

Figure 3. *Dominant cluster (exhibiting the maximum share of floor area) for the 16-clusters solution (also grouped by the 7-clusters solution in the legend) at the IRIS scale. (Basemap: IGN, IRIS 2016 outlines).*

Table 2. Correlation coefficients and ANOVA results at the IRIS scale for the 7, 11 and 16 retained cluster solutions

<table>
<tr><th>16-CL</th><th>CR 80+ *</th><th>CR PBSE *</th><th>CR INC *</th><th>Anv. **</th><th>11-CL</th><th>CR 80+</th><th>CR PBSE</th><th>CR INC</th><th>Anv.</th><th>7-CL</th><th>CR8 0+</th><th>CR PBSE</th><th>CR INC</th><th>Anv.</th></tr>
<tr><td>C2</td><td>-0.03</td><td>0.62</td><td>-0.24</td><td></td><td>C2</td><td>-0.03</td><td>0.62</td><td>-0.24</td><td></td><td rowspan="3">C2</td><td rowspan="3">0.19</td><td rowspan="3">0.5</td><td rowspan="3">-0.29</td><td rowspan="3"></td></tr>
<tr><td>C13</td><td>0.23</td><td>0.41</td><td>-0.25</td><td></td><td>C9</td><td>0.23</td><td>0.41</td><td>-0.25</td><td></td></tr>
<tr><td>C11</td><td>0.08</td><td>-0.02</td><td>-0.12</td><td></td><td>C8</td><td>0.08</td><td>-0.02</td><td>-0.12</td><td></td></tr>
<tr><td>C5</td><td>0.23</td><td>0.09</td><td>-0.18</td><td></td><td>C5</td><td>0.23</td><td>0.09</td><td>-0.18</td><td></td><td>C4</td><td>0.23</td><td>0.09</td><td>-0.18</td><td></td></tr>
<tr><td>C8</td><td>-0.02</td><td>-0.21</td><td>-0.21</td><td></td><td rowspan="3">C7</td><td rowspan="3">-0.25</td><td rowspan="3">0.01</td><td rowspan="3">-0.23</td><td rowspan="3"></td><td rowspan="3">C6</td><td rowspan="3">-0.25</td><td rowspan="3">0.01</td><td rowspan="3">-0.23</td><td rowspan="3"></td></tr>
<tr><td>C9</td><td>0.04</td><td>-0.18</td><td>-0.17</td><td></td></tr>
<tr><td>C10</td><td>-0.14</td><td>-0.13</td><td>-0.02</td><td></td></tr>
<tr><td>C4</td><td>-0.01</td><td>-0.11</td><td>-0.03</td><td></td><td rowspan="3">C4</td><td rowspan="3">0.07</td><td rowspan="3">0.16</td><td rowspan="3">-0.04</td><td rowspan="3"></td><td rowspan="3">C3</td><td rowspan="3">0.07</td><td rowspan="3">0.16</td><td rowspan="3">-0.04</td><td rowspan="3"></td></tr>
<tr><td>C6</td><td>0.04</td><td>-0.01</td><td>-0.03</td><td></td></tr>
<tr><td>C12</td><td>0.07</td><td>0.25</td><td>-0.03</td><td></td></tr>
<tr><td>C3</td><td>0.11</td><td>0.49</td><td>-0.17</td><td></td><td>C3</td><td>0.11</td><td>0.49</td><td>-0.17</td><td></td><td rowspan="2">C1</td><td rowspan="2">0.11</td><td rowspan="2">0.29</td><td rowspan="2">-0.06</td><td rowspan="2"></td></tr>
<tr><td>C1</td><td>0.04</td><td>-0.15</td><td>0.11</td><td></td><td>C1</td><td>0.04</td><td>-0.15</td><td>0.11</td><td></td></tr>
<tr><td>C14</td><td>-0.26</td><td>-0.35</td><td>0.44</td><td></td><td>C10</td><td>-0.26</td><td>-0.35</td><td>0.44</td><td></td><td>C7</td><td>-0.26</td><td>-0.35</td><td>0.44</td><td></td></tr>
<tr><td>C7</td><td>-0.07</td><td>-0.18</td><td>0.14</td><td></td><td>C6</td><td>-0.07</td><td>-0.18</td><td>0.14</td><td></td><td rowspan="3">C5</td><td rowspan="3">-0.31</td><td rowspan="3">-0.33</td><td rowspan="3">0.5</td><td rowspan="3"></td></tr>
<tr><td>C15</td><td>-0.33</td><td>-0.29</td><td>0.41</td><td></td><td rowspan="2">C11</td><td rowspan="2">-0.31</td><td rowspan="2">-0.31</td><td rowspan="2">0.51</td><td rowspan="2"></td></tr>
<tr><td>C16</td><td>-0.28</td><td>-0.31</td><td>0.54</td><td></td></tr>
<tr><td>Domi-nant CL</td><td></td><td></td><td></td><td>9.46 (p = 2.84 E-12)</td><td>Domi-nant CL</td><td></td><td></td><td></td><td>10.36 (p = 1.92 E-12)</td><td>Domi-nant CL</td><td></td><td></td><td></td><td>14,87 (p = 6.16 E-14)</td></tr>
</table>

** Pearson correlation coefficients between the GFA proportion of each cluster per IRIS and the proportion of people aged 80 and over living alone (CR 80+), the number of newspapers points of sales, bakeries, mini-markets, and grocery shops per square kilometre (CR PBSE) and the median of gross annual income (CR INC).*
*** ANOVA (F test) indicating whether there are any significant differences between the mean CR80+ in the groups of spatial units characterized by the same dominant cluster solution. The dominant cluster solution is the one presenting the maximum GFA proportion.*

First, ANOVA tests carried out show the relevance of partitioning spatial units according to the most prevalent type of building hull according to the variation in rates of people aged 80 and over living alone. The relevance improves as the typology is carried out with a lower number of clustering solutions.

Now considering the proportions of all types in the three typologies, we see that there are no significant correlation values between them and the distribution of elders. Weakly to moderately significant correlations start to appear with the distribution of elders living alone only. These correlations can be divided into two groups. On the one hand, we have the positive relations, with neighbourhoods (IRIS level) predominantly made of adjoining and compact apartment buildings (C13/C9/C2 in 16,11 and 7 clusters) and with large articulated buildings (C5/C5/C4 in 16,11 and 7 clusters). On the other hand, we find the negative relations, with neighbourhoods predominantly made of suburban single-family homes (C14/C10/C7 in 16,11 and 7 clusters), large 1 to 2-storey articulated houses (C15/C16 in 16, C11 in 11 and C5/C7 in 7 clusters) and modernist apartment blocks (C10 in 16, C7 in 11 and C6 in 7 clusters). To summarize, central neighbourhoods showing high prevalence of adjoining and compact apartment buildings are those where elders living alone are overrepresented and in which accessibility to local shops is not lacking. This is also the hull type with the strongest negative correlation to the median of annual incomes (followed by modernist social housing units) thus consistent with the work of Ascaride and Condro (2001) mentioned in the second section. The prevalence of large articulated buildings is associated with a non-significant correlation to the median of incomes. Knowing that this built form corresponds to both social housing and high-standing condominiums, the latter could be associated with well-off seniors, and the former with poorer ones. Finally, neighbourhoods in which urban landscape is dominated by suburban single-family homes, both modern and traditional, are associated with an underrepresentation of the elders, and, without any surprise, to the highest incomes and a lack of accessibility to local shops. Yet, the question clearly emerges of what will happen when their population will get older.

Conclusions

This paper cross-analysed the prevalence of types of building hulls at the IRIS level with data about population structure, accessibility, and income levels. The exploratory methods tested in this paper show interesting patterns, such as several statistical associations with the prevalence of hull types and over or underrepresentation of elderly people living alone at the census block level (IRIS). The overrepresentation of seniors living alone in central neighbourhoods is interesting because gentrification of urban centres make people think of a city for the young, whereas Marseille shows the possibility that a less gentrified city centre can become the ideal city of the elderly; or at least the most modest among them. These results are only preliminary, and ought to be confirmed by additional tests, notably through multivariate statistics, geostatistics, and field investigations. The next step will aim at quantifying and theorizing the roles of urban form on the spatial distribution of ageing sub-populations. As a matter of fact, this research falls within a broader research project (FOR-VIE) that aims at proposing new morphometric analyses of the Aix-Marseille Provence metropolitan area, in order to assess and quantify the viability and resilience of urban spaces, to an aging population. Beyond building types, forms of the urban fabric and accessibility patterns to service and amenities will be addressed at different scales than the census units.

Acknowledgements

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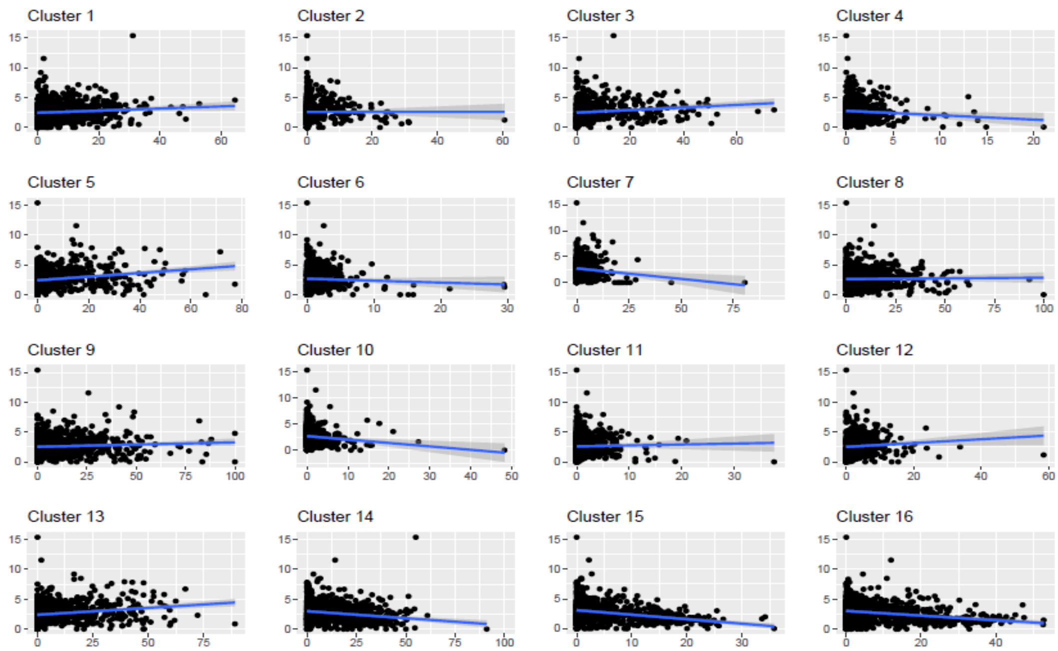
APPENDIX 1



Scatter plots between the proportion of people aged 80 and over living alone and the gross floor area (GFA) proportion of each hull type for the 16-clusters solution (per IRIS)