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The City and the Metropolis: Urban Form through Multiple Fabric Assessment in Marseille, France.

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Abstract

This paper presents a multi-scale detection of urban fabric types through Multiple Fabric Assessment in Marseille, France's second city. MFA is a computer-aided streetscape-based urban morphometric protocol for morphological regionalization of large urban areas. First presented at ISUF 2017, MFA has already been successfully applied to the metropolitan areas of the French Riviera, Osaka and Brussels. The protocol is first applied to the central city, and then to the much larger metropolitan area around Marseille and Aix-en-Provence, stretching over 7000 km2 and home to 2.6 million inhabitants. In both cases, MFA detects eight well-defined families of urban fabrics with clear morphological specificities. The change of spatial extent has nevertheless consequences on the analysis results. On the one hand, urban fabric types detected at the two scales show a precise pattern of correspondences. On the other, each scale allows a finer description of its most preponderant morphological regions, detecting more specific types which are bundled together at the other scale. This is the case for the traditional urban fabrics of the compact city at the municipal scale, and for the suburban fabrics at the metropolitan scale. Accepting some generalisation, the urban fabric types detected by MFA are able to account for the variety of urban forms identified in 36 urban fragments by Marseille's metropolitan planning agency through classical morphological analysis. Beyond the different grain of the analyses (streetscapes vs urban blocks), expert-based and computer-aided classifications are in good agreement. Allowing comprehensive multi-scale analyses of urban fabrics for the whole metropolitan area of Marseille, MFA showed the patchwork nature of its 20th century developments and put in perspective the overstated fragmentation of the 19th century urbanisation. Participating to the emerging field of urban morphometrics, MFA opens the way to wider comparative analysis at the national and international levels.

Keyword: *Urban Fabric, Morphological Regionalization, Urban Morphometrics, Multiple Fabric Assessment, Marseille*

1. Introduction

France's second city, Marseille has been able to contain its urban growth within its municipal boundaries until the first half of the 20th century. Since then, its growth has given rise to a polycentric urban region well beyond city boundaries. The control of urban form has been traditionally weak in Marseille, as local authorities have given much freedom to private and public bodies in the development of urban land. Both the city proper and the other components of its metropolitan space are thus characterised by particularly complex form patterns, where fragments of old and new urbanisation are often interspersed. Identifying morphological regions seem particularly daunting in and around Marseille. At the same time, urban policies and plans are increasingly attentive to the morphological context of their intervention. Densification, to name one of the most important policies of sustainable urban development, needs to address both the qualitative content of the proposed density and the specificities of the present patterns of urbanisation. Both are questions of urban form and any space-specific implementation of such policies should be based on the

boundaries of objectively defined morphological regions. The goal of this paper is precisely to take up this challenge through the geoprocessing protocol of Multiple Fabric Assessment (MFA, Araldi and Fusco, 2019). The analysis will first have to identify the urban fabric types of Marseille and its metropolitan area, to subsequently project them in space and propose a description of the spatial organisation of its morphological regions. Literature on building and urban fabric types in Marseille is relatively abundant, even if sometimes fragmentary and exclusively in French (Bonillo et al., 1988, 1992, 1996, Roncayolo, 1996, AGAM, 2005). This gives the possibility to compare geoprocessing outputs to more traditional analyses of urban morphology and to gain new insights on the advantages and shortcomings of the proposed method. The twofold application of the MFA protocol to Marseille proper and to its metropolitan area is also the occasion to understand the implications of the spatial extent of the analyses on their final outcomes. The paper is organised as follows. Section 2 gives the background knowledge of the case study of Marseille. Section 3 presents the geoprocessing protocol of MFA and its specific two-fold application to the case study. Section 4 presents and interprets the outcomes of the MFA analyses of Marseille and discusses them through the comparison with the expert-based classification of 36 urban fragments produced by the metropolitan planning agency (AGAM, 2005). An overview of the morphological regions in Marseille is thus possible. Section 5 concludes the paper by highlighting the significance and the limits of the new morphological knowledge produced on Marseille and proposes future directions of research.

2. Background: Marseille, the City and the Metropolis.

On its southern Mediterranean coast, Marseille is the first port of France and its second city, with 870,000 inhabitants. Its metropolitan area, differently defined by the national institute of statistics INSEE or by EUROSTAT is the third in France, after Paris and Lyon, home to 1.7 M people (Urban Area by INSEE) or 3.1 M people (Functional Urban Area by EUROSTAT). The municipal area is relatively vast (242 km^2) and well delimited by the Etoile mountains, making it an amphitheatre open towards the sea. The ancient Greek and later medieval city developed in a compact, organic form on the northern bank of a small fjord, the Lacydon basin, well protected from the winds, and the site of the prosperous old port. The city almost tripled its surface with the extension plan of the late 17th century, east and south of the old port. This expansion was a first modernisation of Marseille's urban fabric, with wider streets organised in a geometrical grid (although including rectified rural paths and baroque diagonal avenues) and was interfaced with the old city by the Cours Belsunce (Bonillo et al., 1996). The same scheme had been earlier applied in Aix-en-Provence, the second city of today's metropolitan area, 25 km north of Marseille. Here, the Cours Mirabeau articulates the old city of Roman and medieval origin in the north, with mid-17th century geometrical Mazarin expansion in the south. By the first national census in 1811, Marseille and Aix-en-Provence were still two independent, well defined entities: a compact port-city of 78,500 inhabitants and an administrative and university city of 17,000 in the hinterland. Both were nevertheless surrounded by a system of rural villages and, most peculiarly, closer to the established cities, by a belt of villas, the *bastides*, organising rural domains around

differently articulated main buildings hosting the families of the urban elite during their leisure time. The relationship with the outer landscape was strong for Marseille's general population, too, regularly escaping the dense city to enjoy small informal shacks (*cabanons*) on the coast or in the countryside (Bonillo, 1988).

The economic and demographic development of the 18th century accelerated during the 19th century, which saw the upgrading and migration of the port north of the old city, and the development of modern industry. This time, though, no specific plan organised the rapid growth of the urban fabric. A *laissez-faire* approach by a cash-stripped municipal government, let the new urban growth be the sum of urban fragments, developed without much coordination by local and national investors (Bonillo et al. 1996, Roncayolo 1996) and adapting a local building type to their needs: the mid-rise 3-window building, used both for middle-class and working-class clients. First working-class neighbourhoods were created in North Marseille, close to the new port and the developing industry using townhouses with common courtyard (Bonillo et al., 1988).

Many French cities, like Lyon or Bordeaux, went through a "haussmannisation" phase during the second half of the 19th century, emulating at a smaller scale the morphological and technological modernisation that Haussmann operated in Paris (Pinon 1996). This was not the case in Marseille, where Haussmann-like operations resulted in isolated fragments (like today's Rue de la Republique) or even in failed attempts of destruction-reconstruction (Bourse neighbourhood). Haussmannisation in Marseille thus resulted in the very contrary of the coherent large-scale reorganisation of urban form it had produced in Paris: by severing the old city with the new avenue or with empty blocks, the overall result was even more fragmented urban space.

The fragmented expansion went on during the beginning of the 20th century, integrating working-class Austrian-style blocks and specific forms of garden city, either through self-construction or by public-led programs (HBM). However, many authors agree on the fact that a fundamental disruption was produced in the second after-war when the *bastide* domains were quickly developed according to modernist precepts to produce a massive amount of free-standing high-rise blocks (Bonillo et al. 1996, Roncayolo 1996, AGAM 2005). Le Corbusier built his first *unité d'habitation* named Radiant City in Marseille between 1947 and 1952. Its impact as an example of free-standing high-rise composition was enormous. In the following decades, to resorb urban slums, give a dwelling to the 100 000 former French colonists from Algeria and offer a new, modern, way of life to the middle-class, modernists projects were built almost everywhere in and around Marseille, both as social housing neighbourhoods (often in the north and the east) or as high-standing condominiums in the park (in the south). The second after-war also saw the development of a network of motorways and the creation of the new container port in Fos, 40 km north-west of Marseille. Heavy industry, social housing and an airport platform were built in the cities around the Berre lagoon, between Marseille and the new port. Thanks to the transportation network and the interconnectedness of economy between Marseille, Aix-en-Provence and the new industrial and logistic developments, a new geographic entity emerged: the metropolitan area (Bonillo et al. 1992, 1996).

But other, less noticed, powerful trends were already in place to produce the most important form of development after modernist high-rise went out of fashion in the late 70s. The rooted appeal of the country-side and its *cabanons* as well as unsatisfaction with the modernist forms fuelled a massive urban sprawl, both within the boundaries of the municipality of Marseille and in the larger metropolitan area, swallowing pre-existing old villages and taking advantage of the presence of a motorway exit, the proximity of a commercial area or just available land for development. Eventually, self-construction became less frequent (although still important in some districts), superseded by professional development of residential subdivisions. The term of urban or metropolitan archipelago is currently used to define the reality of Marseille (Viard, 2014), where the functional interconnectedness of its components and the appealing mix of natural and urban areas go hand in hand with accentuated social segregation (Centi, 1996), car dependency, urban dereliction (Bonjour, 2019), crime, privatisation of public space (Dorier and Dario, 2018), loss of landscape quality and identity.

The analysis of the multi-faceted functioning of metropolitan life in Marseille goes beyond the scope of this paper. However, it seems that these phenomena are differently affecting the sub-spaces of the metropolitan area. The built environment may play an important role in them, begging the question of the physical forms of the metropolitan archipelago. Identifying and characterizing morphological regions within the city and the metropolitan area of Marseille is a first step in this direction and will be dealt with in the following sections.

3. Methodology: geoprocessing urban form through Multiple Fabric Assessment.

Several computer-aided geoprocessing protocols exist today to analyse urban form over vast spatial extents. They are conceived with different conceptualization of urban form and have comparative advantages and drawbacks making them more or less pertinent according to the analysis needs of the research. Bioclimatic aspects of urban form have been analysed through geoprocessing relatively early. Closer to our research goals, SpaceMatrix (Berghauser Pont and Haupt, 2021) is particularly focussed on the multi-variable definition of density on the urban fabric, works on space units like urban blocks or urban fragments, and is particularly well-suited for planning. The different protocols of Space Syntax (Hillier, 1996, Turner, 2001), on the contrary, focus on the topological relations within the graph of the urban grid. They allow multi-scale network configurational analysis but pertain only indirectly to the analysis of the form of the urban fabric. In this paper, we opted for Multiple Fabric Assessment (MFA, Araldi and Fusco, 2019) a streetscape-based urban morphometric protocol for morphological regionalization of large urban areas. First presented at ISUF 2017, MFA has already been successfully applied to the metropolitan areas of the French Riviera (Fusco and Araldi 2017), Osaka (Perez et al. 2019b) and Brussels (Guyot et al. 2020). MFA uses the street segment as the basic unit of analysis with its pertinent strip (a proximity band of urban land reminiscent of Caniggia and Maffei's, 2001, *banda di pertinenza*). Morphometric indicators are then calculated along the street segment to describe the elements of urban form (buildings, streets, plots, site) as they can be visually perceived by a pedestrian walking along the segment. The morphometric description is relatively simple as it uses a 2.5D

vector urban dataset corresponding to LOD0+ of the CityGML data model (Biljecki et al., 2016). For Marseille, we used the 23 indicators in table 1, calculated from the BD TOPO by IGN in its 2016 version. These indicators allow a description of the skeletal streetscape (Harvey et al. 2017) produced by the urban fabric: street corridor effect, open space width, height-to-width ratio, land coverage and presence of different building types in the proximity band, local connexions, length, geometry and acclivity of the street segment, etc. 8 relatively large families of building types were previously identified in Marseille using the same LOD0+ data model, simple morphometric description of buildings and multivariate Bayesian clustering (Perez et al., 2019a). Within the MFA protocol, a phase of network-constrained geostatistical analysis of these indicators is needed to identify statistically significant spatial patterns. The LINCS approach is used (Local Indicators of Network-Constrained Clusters, Yamada and Thill, 2010). Types of the urban fabric are later identified and characterized by Bayesian clustering of the significant patterns produced by the geostatistical analysis. The Bayesian approach allows urban types to be characterized as sharing key common features, that can be different from type to type, without forcing homogeneity on all morphometric descriptors.

The MFA protocol was applied twice. First to the 33,345 street segments within the municipality of Marseille, later to the 337,493 segments within its metropolitan area, defined as the whole of the Bouches-du-Rhône Department and the western section of the Var Department (7000 km2 and 2.6 million inhabitants in 2018). In both cases, a random-walk search of the optimal clustering in parameter space (constraint by a minimum content of 2% of the street segments for each cluster) produced an 8-cluster solution. Bayesian clustering allows clusters to be described and interpreted through their probabilistic profiles and the relative contribution of each morphometric indicator to the cluster in terms of mutual information. The urban fabric types detected through MFA are finally compared to the expert-based classification of 36 urban fragments produced by the metropolitan planning agency (AGAM 2005). These were classed by AGAM according to floorage intensity index (FSI), a main morphometric parameter in French urban planning, but correspond to different urban forms, well identified and documented in the individual description sheets.

Table 1. Morphometric indicators for the analysis of the form of urban fabric in Marseille.

Street Network	***Building-Street Relationship***
Street Length (Network length of the street segment)	Building frequency (Nb. Buildings / street length)
Nodes1 (% of nodes of culs-de-sac)	Corridor effect (length parallel façades / street length)
Nodes4 (% of 4-way intersections)	Coverage ratio (building coverage ratio in proximity band)
Nodes3_5 (% of degree 3, 5 or more)	Visible open space (average sightline length along the street)
Windingness (ratio Euclidean distance / segment length)	Open space variability (std dev of sightline length along the street)
Building Types	Height/Width Ratio (avg building height / avg open space width)
%T1 (big villas of complex shape)	Vertical alignment (std dev of building height along the street)
%T2 (big houses and small buildings of compact shape)	Building height (average building height along the street)
%T3 (detached/semidetached small townhouses)	Setback (average building setback along the street)
%T4 (adjoining mid-rise, mid-sized compact buildings)	***Street-Site Relationship***
%T5 (mid-rise, mid-sized, isolated buildings of different shape)	Slope (% of surface with slope more than 0.3 in proximity band)
%T6 (mid- to high-rise isolated buildings of different shape)	Acclivity (average acclivity along the street segment)
%T7-T8 (mid-sized - complex low-rise big specialized buildings)	

4. Results and Discussions

MFA detects 8 well-defined families of urban fabrics with clear morphological specificities both in Marseille proper and in its metro area. Contingency table fit is used to evaluate the capacity of the 8-cluster solution to reflect the information given by the spatial structures of the 23 morphometric indicators. This is 48.1% for the city and 61.2% for the metro area. Table 2 summarizes the correspondences between the clustering of urban fabric types at the two scales. The same colours are attributed to the most similar urban forms. A class covers all the street segments in natural space, accounting for 10.3% of the city (C8) and 31.2% of the metro area (M8). These are easily recognised by the clustering algorithm, increasing the quality parameter for the metro area, where they are the most numerous class. The other seven clusters can be interpreted as follows.

Traditional Compact Urban Fabrics

C1 in Marseille proper are the traditional compact mid-rise urban fabrics of adjoining buildings forming perimeter blocks, with organic layout or geometric grid. They correspond to the 19th century mosaic of Marseille downtown (Bonillo et al. 1996), including the few remaining fragments of the old city and the Haussmannian fragments (figure 1c). They make up 9.2% of the street network of the city. C2 are traditional *faubourg* strips and irregular semi-discontinuous fabric, like in the hilly coastal districts of Endoume and Bompart, south of the old port. They account for 12% of the urban street network. Of the 16 urban fragments of Marseille investigated by AGAM (2005) and characterized as being traditionally compact, 10 fall entirely in the C1 category, and 5 completely or predominantly in C2. The fragment on Victor Gélu square is rightly characterized as a mixture of compact traditional and modernistic discontinuous fabric: it is indeed part of the 1950s reconstruction of the port north bank, after WW2 destruction. Ilot M5 and Opérations Lodi are the only contemporary urban fragments proposing the compact composition rules of the traditional fabrics. The paucity of vernacular cores (the little Panier neighborhood in Marseille is all that is left of the medieval city) doesn't allow MFA algorithms to detect a specific urban fabric, contrary to the results of the French Riviera (Fusco and Araldi, 2017). C1 and C2 are grouped in M1 at the metropolitan scale, together with the most compact fragments of modernistic urban fabrics. Despite this larger definition, compact fabrics are limited to 8.7% of the metropolitan street network, mainly in the central districts of the big cities (Marseille, Aix-en-Provence, Toulon) and in the old villages scattered in the metro area. The 16 aforementioned fragments, plus the contemporary ZAC Défensions, outside of Marseille, are almost exclusively attributed to M1.

Suburban and Garden City Fabrics

Provençal garden cities (C3) are characterized by geometrical street grids and free-standing houses with gardens. Contrary to their planned northern European counterparts, they have no picturesque composition but geometrical obedience of streets, plots and houses. Typical of the first half of 20th century, they are often allotments with self-construction. In Marseille, they make up 8.5% of the street network. They are found in several neighborhoods in the Beaumont, Montolivet, St Barnabé districts of East Marseille. The Saint-Just garden city in North Marseille analyzed by AGAM is recognized as a mixture of garden city, in its southern

section, and irregular semi-discontinuous fabric (C2) in its northern fringe. At the metropolitan level, the corresponding M3 cluster includes also a few regular and contemporary residential subdivisions, like Baumandariel. C4 are suburban residential fabrics with tree-like streets and loops, bungalows, villas or terraced houses. They have free plot composition and no geometric obedience. They correspond to self-construction on big plots and subdivisions produced by a single developer in the second half of the 20th century. They are more peripheral than the provençal garden cities, but can also be at the margin of the compact city, accounting for 23.3% of the municipality. Les Ombrée, in East Marseille, is a typical example (figure 1e). It is correctly attributed to C4, but to M2 (garden cities) by the metropolitan clustering. The preponderance of suburban forms in the metropolitan area allows to detect a third peculiar urban form: the ex-urban dispersed fabric (M4), like the Tuilerie district in Roquevaire. The three suburban forms account for 39.2% of the metropolitan street segments. Six fragments identified by AGAM as being residential, garden city and/or suburban are attributed to one or more of these three categories. The seventh, on Bd Gavoty, is less clear, as it is made of only two street segments within a more heterogeneous morphological context.

Discontinuous Modernist Urban Fabrics

Modernist urban fabrics are particularly important in Marseille (36.7% of the street network). Three types can be distinguished. C5 is high-rise discontinuous fabric with some geometric street/building obedience and street-corridor effect. Examples are housing projects Prado-Mezargue in the pericenter, Frais Vallon (not in AGAM, 2005) and Bois Lemaître in the North East. Les Petites Maguelone is a mid-rise version of C5. C6 regroups different realities sharing common forms. First, the radiant city projects with a free composition of towers and slabs in the park within mega blocks, no geometric obedience between streets and buildings, and extremely low coverage ratio. Le Corbusier’s Radiant City (not in AGAM, 2005) is the perfect example, as well as the southern part of Le Roy d'Espagne (towers in the park), La Rouvière (mega-slabs, figure 1d), La Cadenelle (also including some natural areas). Secondly, logistic and industrial areas (ex. the port in North Marseille), campuses (ex. Luminy in South Marseille), concentrations of big box stores, etc. These functional fragments are completely absent in AGAM (2005). The third type, C7, regroups graveyards and other artificial parks with low-rise modern residential parks. The latter are a low-rise version of the Radiant City model, like the northern section of Le Roy d'Espagne in South Marseille, with free-standing small buildings and modern villas. The 9 modernist fragments in AGAM (2005) are all attributed to one or more of these three categories, with the Castellane housing estate presenting a mix of the three. Modernist fabrics are less important in the metro area (21%). M5 includes discontinuous and radiant city models, with the most compact fragments converging in M1. The commercial and logistic techno-fabric (part of C6 at the municipal level) are identified as M6. C7 disappears, while artificial connective fabrics, with few or no buildings, are identified as M7. Interestingly, the low-rise modern residential parcs of C7 are attributed to ex-urban fabrics M4. The municipal clustering is clearly more accurate, but it is worth noticing that despite the differences in building types and production process, the low-rise modernist parcs are associated with scattered ex-urban forms.

Table 2. Correspondence of urban fabric types in Marseille according to the two clustering applications.

City	Metropolitan Area M1	M2	M3	M4	M5	M6	M7	M8	Total	
C1	3 057	1			3				3 061	
C2	3 616	415			6				4 037	
C3	448	2 338	3		2				2 791	
C4	589	3 221	2 028	1 266	633	67	1	1	7 806	
C5	1 991	251	33	131	2 987	203			5 596	
C6	3	1	3	68	1 660	842	88		2 665	
C7	1	4	68	1 970	686	230	564	426	3 949	
C8				394	18	3	421	2 604	3 440	
Total	9 705	6 231	2 135	3 829	5 995	1 345	1 074	3 031	33 345	street segments

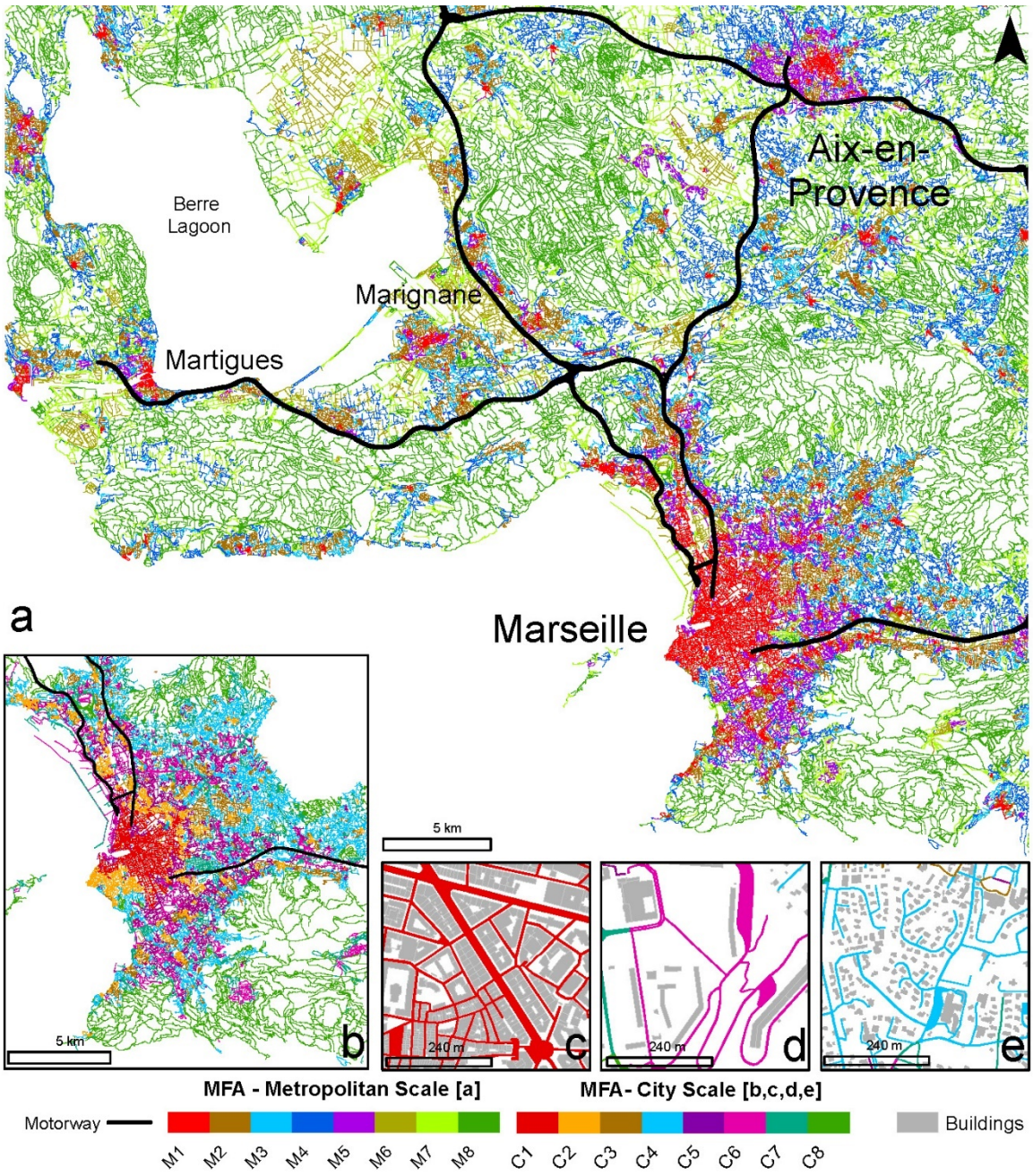

Figure 1. *Morphological regions in Marseille Metropolitan Area (a), City (b) and selected fragments (c, d, e).*

Finally, MFA characterization of 3 urban fragments in AGAM (2005) is more problematic. ZAC des Vagues is possibly still well characterized as it is a contemporary operation made of smaller fragments of different

forms. Castors Isabella is a dense garden city with organic street layout. Density, land coverage and adjoining relations resulted in M1 assignment, setbacks in M5. Paul Strauss is an Austrian-style housing project of the 1920s, presenting hybrid features between traditionally compact and modernistic fabrics. Overall, beyond the different grain of the analyses (streetscapes vs urban blocks) and the coarser description of MFA, we find very good agreement between the expert-based and the computer-aided classifications of the 36 fragments.

Figure 1a and b are projections in geographic space of the 8 urban fabric types identified within the metro area and the city. Through them, we can describe the geography of morphological regions in Marseille. The central area is almost uniformly made up of traditional compact urban fabrics. Paradoxically, this corresponds to the overstated mosaic produced by the uncoordinated 19th century expansion. Despite the lack of regularity of the overall layout, it corresponds to a unique morphological region, shaped by an informal cultural coordination of century-old schemes of adjoining buildings and architectural types. The only exceptions are the small fragments of modernistic fabric (Bourse, Joliette, etc.) within it. The real mosaic is around this central area. It is made up of different morphological regions of a few dozens or hundreds of hectares: traditional semi-continuous *faubourgs*, suburban and garden-city fabrics, modernistic fabrics. Different axes of older urbanisation concentrate most of the *faubourgs*, and the suburban residential fabrics are more present within a second peripheral belt. Nevertheless, the overall spatial pattern is one of splintered urbanism (Graham and Marvin, 2001) taking the form of a patchwork of morphological regions selectively connected by urban highways. Natural areas are also part of this patchwork. At the metropolitan level natural areas are the background matrix where the urbanised fragments are cast. Secondary centres are characterized by cores of traditional compact fabrics, while ex-urban forms add to the complexity of the patchwork, at the interface with natural land. Commercial and logistic techno-fabrics are over-represented in the north-west, around the Berre lagoon. This is the material form of Marseille's urban archipelago.

5. Conclusions and Perspectives

MFA produced a new morphological regionalization of Marseille and its metropolitan archipelago. It showed the fragmented nature of its 20th century developments and put in perspective the overstated fragmentation of the 19th century urbanisation. The application of the urban morphometric protocol to the city proper and its metropolitan area showed that the change of spatial extent has consequences on the analysis results. On the one hand, urban fabric types detected at the two scales show a precise pattern of correspondences. On the other, each scale allows a finer description of its most preponderant morphological regions, detecting more specific types which are bundled together at the other scale. This is the case for the traditional urban fabrics of the compact city at the municipal scale, and for the suburban fabrics at the metropolitan scale.

Some inconsistencies were nevertheless found in the analysis, suggesting the need of further methodological improvements. These would include a finer detection of building types, beyond results by Perez et al. (2019), a more accurate implementation of geostatistical analysis of morphometric indicators, further distinguishing

homogeneity and heterogeneity, and minor modifications in the set of morphometric indicators (always staying in a theory-led selection and keeping them between 20 and 25 to let the analyst manage the interpretation). Slight differences in the protocol do not forbid comparison of the results obtained for Marseille with previous research on the French Riviera (Fusco and Araldi, 2017), Osaka (Perez et al., 2019b) and Brussels (Guyot et al. 2020). The implementation of the same MFA protocol on homogeneous datasets would however open the way to wider comparative analysis at the national and international levels.

References

1. AGAM (2005) *Densité & formes urbaines dans la métropole marseillaise* (Imbernon, Marseille).
2. Araldi, A. and Fusco, G. (2019) 'From the street to the metropolitan region: Pedestrian perspective in urban fabric analysis', *Environment and Planning B: Urban Analytics and City Science*, 46(7), 1243–1263.
3. Berghauser Pont, M. and Haupt, P. (2021) *Spacematrix. Space, Density and Urban Form* (Nai010, Rotterdam).
4. Biljecki, F., Ledoux, H., Stoter, J. (2016) 'An improved LOD specification for 3D building models', *Computers, Environment, and Urban Systems*, 59, 25-37.
5. Bonillo, J.-L. et al. (1988) *Atlas des formes urbaines de Marseille. Volume 1 - Les types* (INAMA, Marseille).
6. Bonillo, J.-L. et al. (1992) *Marseille, ville et port* (Paranthèses, Marseille).
7. Bonillo, J.-L. et al. (1996) 'Marseille'. In *Atlas historique des villes de France* (Hachette, Paris) 174-203.
8. Bonjour, K. (2019) *Rue d'Aubagne – Récit d'une rupture* (Parenthèses, Marseille).
9. Caniggia, G. and Maffei, G. C. (2001) *Architectural composition and building typology: interpreting basic building* (Alinea, Firenze).
10. Centi, C. (1996) *Le laboratoire marseillais. Chemins d'intégration métropolitaine* (L'Harmattan, Paris).
11. Dorier, E. and Dario, J. (2018) 'Les espaces résidentiels fermés à Marseille, la fragmentation urbaine devient-elle une norme ?', *L'Espace Géographique*, 2018/4 (47), 323-345.
12. Fusco, G. and Araldi, A. (2017) 'The Nine Forms of the French Riviera: Classifying Urban Fabrics from the Pedestrian Perspective', in Urios, D., Colomer, J. and Portalés, A. (Eds.), *24th ISUF International Conference: City and territory in the Globalization Age* (Editorial Universitat Politècnica de València, Valencia) 1313-1325.
13. Graham, S., Marvin, S. (2001) *Splintering Urbanism. Networked Infrastructures, Technological Mobilities and the Urban Condition* (Routledge, London).
14. Guyot, M., Araldi, A., Fusco, G., and Thomas, I. (2020) 'The urban form of Brussels from the street point of view: the role of vegetation in the definition of the urban fabric', *Landscape and Urban Planning*, 205(2021) 103947.
15. Harvey, C., Aultman-Hall, L., Troy, A., and Hurley, S. E. (2017) 'Streetscape skeleton measurement and classification', *Environment and Planning B: Urban Analytics and City Science*, 44(4), 668-692.
16. Hillier, B. (1996) *Space is the machine* (Cambridge University Press, Cambridge).
17. Perez, J., Araldi, A., Fusco, G. and Fuse, T. (2019b) 'The Character of the Japanese Urbanization: Overview of Osaka-Kobe's Cityscapes', *Urban Science*, 3(4), 105, 1-22.
18. Perez, J., Fusco, G., Araldi, A. and Fuse, T. (2019a) 'Identifying Building Typologies and their Spatial Patterns in the Metropolitan Areas of Marseille and Osaka', *Asia-Pacific Journal of Regional Science*, 4(2020), 193–217.
19. Pinol, J.-L. (ed.) (1996) *Atlas historique des villes de France* (Hachette, Paris).
20. Roncayolo, M. (1996) *Les grammaires d'une ville. Essai sur la genèse des structures urbaines à Marseille* (Editions de l'Ecole des Hautes Etudes en Sciences Sociales, Paris).
21. Turner, A. (2001) 'Angular Analysis', *3rd International Symposium on Space Syntax* (Georgia Institute of Technology, Atlanta), 1-13.
22. Yamada, I. and Thill, J.-C. (2010) 'Local indicators of network-constrained clusters in spatial patterns represented by a link attribute'. *Annals of the Association of American Geographers,* 100(2), 269–285
23. Viard, J. (2014) *Marseille, le réveil violent d'une ville impossible* (L'Aube, La Tour d'Aigues).

APPENDIX

Table 3. Urban Fabric Types in the 36 urban fragments studied by the metropolitan planning agency (ADAM 2005).

			Municipality of Marseille								Metropolitan Area of Marseille							
			C1	C2	C3	C4	C5	C6	C7	C8	M1	M2	M3	M4	M5	M6	M7	M8
Compact Urban Fabrics	FSI	street segm.	% street segments in urban fabric type															
Ilot Grignan	5.32	5	100								100							
Ilot du Passage de Lorette	4.91	10	100								100							
Ilot place des Pistoles Panier	3.96	5	100								100							
Ilot du lotissement Bernex	3.34	4	100								100							
Ilot du quartier Cinq-Avenues	3.32	5	100								100							
La Grande Corniche	3.17	4		100							100							
Ilot du square Victor Gélu	2.80	11	64				36				100							
Ilot M5	2.68	4	100								100							
Domaine Ventre	2.53	6	100								100							
Opérations Lodi	2.00	7	100								100							
Ilot noyau village Ceyreste	1.70	17									100							
Ilot noyau village Saint-Marcel	1.55	14		100							100							
Ilot des Chartreux	1.48	14	100								100							
ZAC des Défensions*	1.40	24									92				8			
Ilot de Mazargues	1.28	17	18	82							100							
Ilot Fenouil-Puget - L'Estaque	1.08	10	10	90							100							
Ilot des Goudes	0.84	16		100							94	6						
Suburban and Garden City Fabrics																		
Les Terrasses de Cassis*	0.38	39									23	15	36	10	5		10	
Cité-jardin de Saint-Just	0.37	37		49	49	3					11	89						
Quartier Boumandariel*	0.36	89										74	11	15				
Lotissement Les Ombrées	0.28	20			10	90						70	30					
Ilot du boulevard Gavoty	0.27	2			100						50	50						
Le Jaï*	0.19	16												69		31		
Quartier La Tuilerie*	0.04	104										3	20	76				1
Discontinuous Modernist Fabrics																		
Opération Prado-Mazargues	1.80	21					76	24			5				95			
Cité de la Castellane	1.71	28					32	21	46		4			32	64			
Les Jardins de Thalassa	1.32	8						13	50	38				25	75			
La Rouvière	1.25	26						77	19	4				19	62	15	4	
Unité de voisinage Maurelette	0.96	36				22	28	33	11		8	8		3	81			
Les Petites Magalone	0.83	4					75	25							100			
Cité de Bois-Lemaître	0.68	32				13	72	16				3	3	19	69	6		
La Cadenelle	0.59	13					8	46	15	31				8	92			
Le Parc du Roy d'Espagne	0.40	74					11	38	36	15				35	54		8	3
Intermediate/Hybrid Fabrics																		
Groupe Paul Strauss	2.39	7		29		29	43				71				29			
ZAC des Vagues	1.38	15		20	27		27	27			7	60			27	7		
Castors Isabella*	0.53	62									48	3			44		5	

* Urban fragments outside of the Municipality, whose urban fabric types are attributed only by the metropolitan-wide clustering.