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Accessibility as urbanity measurement method in a metropolitan framework.

A socio-territorial analysis of the metropolitan cities of Milan and Lyon

Cognome / Surname Caiello Nome / Name Simone

Matricola / Registration number 723953

Tutore / Tutor: Prof. Matteo Colleoni (Università degli Studi di Milano-Bicocca)

Coordinatore / Coordinator: Prof.ssa Lavinia Bifulco

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A papà

Introduction

The city embodies one of the most ancient social products. Its history dates back to thousands of years, even if its relevance has been affirmed materially all over the world only relatively recently. If the city's origins can be found approximately in the X millennium BC, with the emergence and development of the mesopotamic civilizations, the strongest urbanization processes (migration of population from small villages and the countryside), took place massively just in the last two centuries of human history.

Not all the cities anyway can be considered identical, a huge distance separate in fact, not only in geographical terms, an urban center (or better metropolis) like Milan, from one like Durban, and the same could be said for Turin and a smaller center like Gubbio, or between this last one and an international metropolis like New York. Although all these centers share, in our opinion, some characteristics, that allow them to be recognised as cities, and to be distinguished from a small and peripheral center, located in open countryside. It is intuitive, and a matter of common sense, to recognise some elements as *urban* at first sight. Landscape is usually the main one: a strong presence of buildings, the absence of green or agricultural spaces are usually attributed to an urban environment, while an area with a scarce concentration of households or infrastructures, were open and natural spaces are predominant are immediately recognised as rural. However the landscape on its own cannot explicit nowadays the sociological and functional aspects proper of a territory, in particular in an era, like the current one, in which deep transformations are impacting on it, changing its connotations.

But: what these characteristics or aspects are?

This work will present a reasoning on the city nature and on the characteristics that the literature on the topic has proposed as distinctive of this specific *social* product. It will start from the last theoretical proposals addressing the issue, inscribed in the legacy of the Urban Question debate, in order to highlight the main critical points in the current understanding of the urban phenomenon.

The "explosion" of the city and the loss of distinctiveness of the various contexts nowadays impacted by the urbanization process has determined an impressive flourishing of literature on the city itself, aiming at finding the best interpretation of its current development. The task is relevant, since understanding the nowadays dynamics of city's evolution means finding the tools for its management, or at least the critical points on which to act to influence that evolution.

Our proposal will be based on a specific interpretation of the nowadays city: we will distinguish in fact between two different elements composing the city, the concept of *Urban* (that regards the cultural dimension of the city as a social environment) and that of *City* as a physical structure. In our view if it is true that the nowadays city and its influence is diffused in the territory and embodied by a various range of urban structures, produced by the sprawl phenomenon

(suburbanization, peri-urbanization, rurbanization) that assumes different shapes, not all the forms in which this process manifests itself can be as well considered to be homogeneous in terms of urbanism degree.
We would like to stress the fact that only specific spatial conditions are capable to generate a properly urban environment, able to produce what we call *urbanity,* the *condition* of being urbanized and living an urban culture[1]. For this reason we will work on two different levels: a micro/meso, and a macro one.

Micro/meso level

We will present a proposal for the identification of these spatial conditions in the second chapter of this work, where the concept of accessibility and proximity will be analysed as potential keys for urbanity detection, highlighting their relevance in shaping the ways in which spaces can be lived by people and consequently the different meanings they can acquire for them.
A focus on the concept of walkability and its relevance in the current debate on city planning and social sustainability is then carried on in the third chapter, in order to better understand its potential to design a better and more human-scale urbanism, able to improve the urbanity of spaces.

Macro level

Beside the micro and meso scope, our research will assume also a macro scope, in order to better analyse and locate the *urban* inside the nowadays *city*. The current form of the city, at least in the western world in which our research is based, is characterized by a metropolitan structure, where the traditional boundaries of the old cities have been overcome by the city and city's functions expansion. Called with many names (Metropolitan City, Megalopolis, City-Region, etc…) today cities are more and more often part of conglomerations or networks of centers, functionally interrelated, inside more or less blurred territorial contexts defined as Metropolitan Areas. These contexts are far from being universally defined through due to manifold issues (in data availability, comparability, territorial peculiarities, theoretical differences, etc…). We will analyse some of the main and, in our opinion, most relevant proposals (both in national and international contexts) in chapter 4.
There we will introduce two case studies on which test our assumptions: Milan and its Metropolitan City for the Italian context, and the Lyon Metropolis as a foreign case study.
The choice of Milan is due to the will of working again, going deeper in the analysis, on a known case on which a previous work has been done in the past, in order to stress the variations occurred in the time interval that separates that analysis (based on 2001 census data) and the data today available (2011 census data). Milan is one of the most dynamic Italian cities, core of one of the most urbanised areas of the country, easily comparable with other foreign centers of a similar level.

1 Where the *urbanism* is the content of such a condition, that can be in this way the attribute of both individuals and places.

Lyon has been chosen as a comparative case study, in order to have a reference case to better evaluate Milan's condition. Lyon in fact is the 2nd biggest and most relevant city in France, after the capital city Paris, as well as Milan in Italy. Both share a similar economic structure, characterised by an important even if declining industrial sector, and an always more and more relevant tertiary sector. Both belong to countries with a similar administrative and territorial structure, facing, even if with different success and timeline, important attempts of territorial restructuring.

After having reviewed in chapter 5 the main methodological proposals for the identification of the urban characteristics we will present a personal one based on the combination of the two levels of analysis distinguished in our approach. We will present an urbanity measure method, based on pedestrian accessibility detection, and a metropolitan area delimitation method. Combined, the two dimensions will produce a metropolitan zoning of the Milan Metropolitan Area, of which we will then analyse the differences in terms of population characteristics living the various contexts drawn thanks to it.

The same approach will be applied on the French case, but limited to the definition of the metropolitan areas (see chapter 7 for further details).

As a further methodological exercise a walkability index will be presented and applied on the two case studies, in order to analyse its level of precision compared to the pedestrian accessibility index adopted in the previous phase, and to introduce a different, but similar, instrument for urbanity detection.

Chapter 1

The Urban Question: a quest for the city

Introduction

> "Each generation, it seems, defines the urban question after its own fashion, as an articulation of social challenges, political predicaments and theoretical issues reflecting the current conjuncture of urban society" (Scott, Moulaert, 1997, p.267)

This sentence by Scott and Moulaert, two of the main scholars in the urban studies field, embodies synthetically the path produced by the research about the urban question in the last century, starting from its first protagonists (Weber, Wirth), passing through their renewal theorists (Castells, Lefebvre, Harvey) and coming to the last (Saunders, Soja) and most recent contributors (Scott, Storper, Brenner and Schmid).

Addressing the study object of the discipline, on what is the nature, connotations and social role of city and urban spaces, the urban question has been always a highly debated issue. Cities and urban realms, with their historically changing shape and phenomenological declinations (both synchronic and diachronic), made extremely difficult to give an ultimate definition of them, or to delineate universal and somehow stable characteristics.

As common in Social Sciences, and in science in general, every historical period has brought different perspectives through which look at the urban question, due to the specific causes that risen the attention to the topic. The discipline somehow abandoned the idea of looking for an ultimate answer to it, pragmatically concentrating on the phenomena taking place in the city, in order to give an answer to them.

Anyway seeking for an answer to the question has received renovated interest in the last years, in particular after the publication of a series of contributes by prominent scholars in Urban Studies theory like Neil Brenner and Christian Schmid, promoters of the Urban Theory Lab, an ambitious working project born at the Graduate School of Design of Harvard, dedicated to the construction of an open laboratory of theoretical research and discussion on the urban question, based, among others, on the scientific legacy of Henry Lefebvre. We would like to start from their contribute on the debate in order to address the issue under the last theoretical arguments, reconstructing the useful insights provided on the topic and confronting them with the past ones, in order to form a theoretical toolbox able to guide our reflection and empirical work on the urban realm. This work would like to represent a further attempt to find a route inside such a complex context, without any presumption of giving an exhaustive answer to the issue.

We will start so from the last contributes of the cited authors, analyzing critically their approach, using also the arguments proposed by other prominent scholars in the response to their statements.

In particular a focus on the contributes of Scott and Storper and the Los Angeles *school*'s representatives will be done, as considered useful sources for the critique to the Urban Theory Lab theorization.

A final proposal is then presented in order to theoretically combine the useful components of both the positions, bridged through the lens of the Capabilities Approach, based on Amartya Sen's work.

The need to distinguish between the concept of *city* (as the area touched by the urbanization process) from that of *urbanity* (as the property of places in which an urban experience can be fully generated) will be affirmed, where the latter is included into the former but without overlapping it.

1.1 The Urban Question

1.1.1 The origins

The debate on the nature of cities has started more than one hundred years ago, producing a series of different analyses and approaches, conceptualizations and theoretical frameworks. As common in history the scientific approaches and theories followed in a parallel journey the transformations of the society. Born in the first years of the last century the Chicago School epistemological approach was built on what we could name a *modern and positivistic* stance, where the city was read as a living organism, or better, as a natural environment, following *natural* and mechanical laws and schemata. The populations settled in it, well defined and inscribed in a particular environment, were conceived as natural populations, living one close to the other and occupying in succession the urban spaces according to the changes of the social structure of the city (Mela, 2006).

The image of the city proposed by this theoretical tradition held a central position in the urban studies for a long period, contributing to the constitution of a study object well defined and consistent, represented by a specific spatial realm, characterized by peculiar social structures and culture. Among the most famous and representative images of that research tradition we can cite the *Zonal* scheme of the city of Chicago consistent in a concentric set of circles proposed by Burgess (Park et al. 1925), each of which embodying a different realm, according to the function exerted in the city's ecological structure. It was conceived as an idealtypical representation of the city functioning, not just fitting the specific case of Chicago, but suitable for the description of the generic urban settlements (of that time and that context we would add). Five zones were defined: the *central business district*, where the direction managerial and productive activities were concentrated, the *zone in transition*, inhabited by the poorest populations (mainly first generation immigrants) due to the closeness to the work areas (and for this reason characterized by low quality housing stocks), the *zone of workingmen's homes*, inhabited by second generation immigrants with a higher social status (but still close to the work areas), *the residential zone*, whose population was composed by middle class inhabitants, and *the commuter's zone*, where highest were the commuting costs, but highest the housing stock quality too (suburbs).

In that historical moment the fordist city was emerging and consolidating, even if with different characteristics in the American and European contexts: a strong distinction was appreciable between the urban and rural realms, in physical, functional and social terms, contributing to the reinforcement of the urban-rural clivage, before the discussion on it brought to question its consistence (Pahl, 1966). Important distinctions were evident between two different models of city's structure, where the city center got transformed into, in one case, a forgotten space of urban marginalization (the American experience), or into, in the other case, the urban elitist populations and functions nucleus (the European experience). Such a difference produced a distinctive morphological development of the American

city, that, since quite soon if compared to the European case, saw the development of the suburban settlements around the main urban centers, putting the bases for the affirmation and expansion of the urbanization tradition based on the car-dependence, and of the metropolitan city, before, and the sprawled city, after.
The two contexts (American and European) lived similar processes of metropolitanization of the cities, but in different moments: the United States recorded an increasing trend of growth of the main urban centers and their surrounding counties since the beginning of the XX century, due probably to the specificity of the territorial context (rich of empty spaces in which the city could expand and settlements grow) and of the higher level of industrialization of the country if compared to other European countries. If we look at the different sub areas of the metropolitan districts we can see as the central cities gained in the decades always a lower percentage of population, while the rest of the districts have performed always above that growth rate (a decrease in the trend can be seen in correspondence to the first World War and in the last decade here displayed, the years belonging to the '29 Crisis period):

Tab. 1 - percentage increase in population in 44 metropolitan districts in the United States, 1900-1940

Years	Central City	Rest of the districts
1900- 1910	33,6	38,2
1910-1920	23,4	31,3
1920-30	20,5	48,7
1930-40	4.2	13

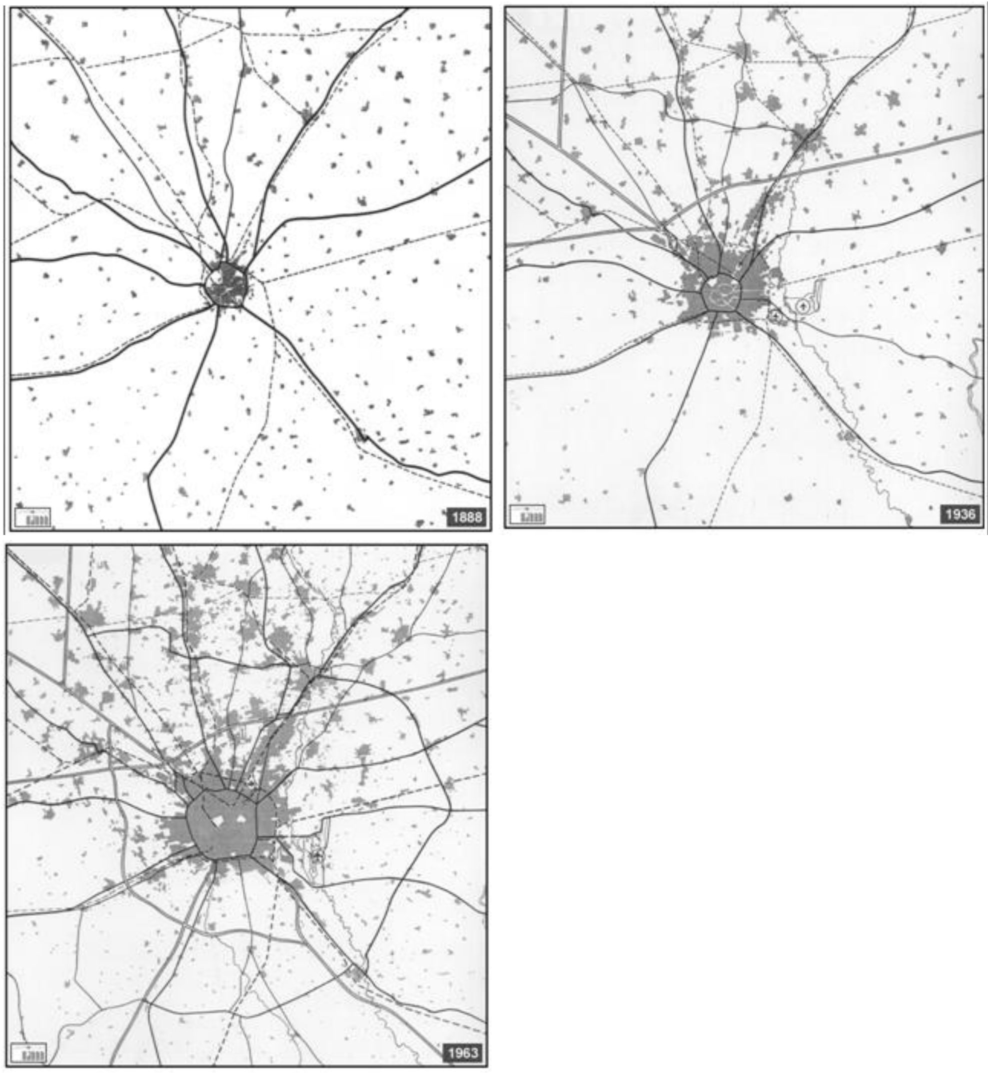
Source: W.S.Thompson, *The growth of metropolitan districts in the United States, 1900-1940*. cit. in Davis (1955).

The European city showed at that time still, on average, a compact structure, that would have changed progressively in the next years.

The transition to the metropolitan city (from the *compact city* to the *first generation metropolis* as defined by Martinotti, 1993) was produced by the massive migration from the countryside to the cities, occurred in many European countries mainly after the second World War. If we look at the morphological structure of Milan, one of the most advanced (economically speaking) cities in Italy since the birth of the country, we can see bigger similarities between the 1888 city and the 1936 one, while in 1963 the territorial landscape was strongly changed[2] (Fig 1).

[2] It is not by chance in fact that the first steps towards the definition of the Piano Intercomunale Milanese (Milanese Inter-municipal Plan), both an association and a planning coordination institution, was born in 1961, in order to face the challenges raised at that time by the Milan metropolitan development, that was impacting on the surrounding municipalities. (http://www.pim.mi.it/storia/).

Fig 1 – Milan and its surroundings. Evolution, years 1888, 1936 and 1963.

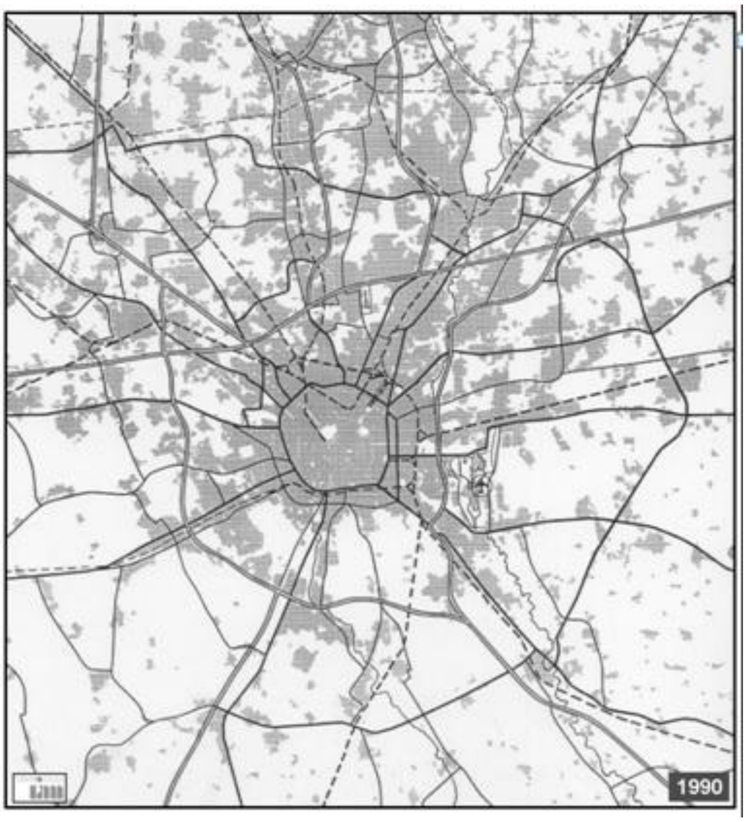


Source: PIM (http://www.pim.mi.it/)

If in 1888 the city was still enclosed in the traditional and historical nucleus and the territory around it showed just an almost regular diffused set of rural centers, the urban morphology in 1936 changed due to the birth and extension of the peripheries and the start of the increase of the first secondary centers around Milan. But is the 1963 image to show the real shift towards the metropolitan city model, due to the increased density in the territory around the central city and the growing relevance of the smaller settlements of the peri-urban band along the main transportation axes.

Thirty years later the territorial transformation of the area would have been dramatically changed, following the sprawled structure of the *late-modern* era: the diffused city (Indovina, 1991), where the previous peripheral settlements progressively become new nodes of a networked urban system (Fig. 2).

Fig. 2 – Milan and its surroundings in 1991.



Source: PIM (http://www.pim.mi.it/)

The new blurred morphology of the last phenomenological form of city generated further debate on its nature, opening to various interpretations of its characteristics and peculiarities, translated into a variegated set of new definitions for it. The need to understand a fast changing study object was the base for the flourishing of a new scientific scenario.

1.1.2 The New Urban Sociology

An important shift in urban theoretical scheme was brought at the end of the ‘60s, with the emergence of a new sociological stream of contributes (named *new urban sociology* or *radical geography*, Brenner, 2011), elaborated by marxist authors like Castells (1968; 1972), Lefebvre (1970) and Harvey (1973), critically questioning the role of the city concept as defined by the previous tradition. Each in a different way and with different reasoning paths, stressed the inconsistency of a conceptualization of city as a bounded and delimited context, focusing on the contrary on the dynamics at the base of its development, or at the core of its functional role inside the hegemonic capitalistic framework, conceived also as the basic engine for its latest evolution.
Castells (1972) in particular aimed to emphasize how the phenomena at work in the city could be conceived more correctly as broader social phenomena, exemplification and embodiment of the social reproduction schemes built by the capitalistic mode of production. As the author states clearly, there was nothing

urban in those processes, since the city was just one of the contexts in which they could be found, asserting the centrality of the analysis of the forms of mass consumption and labour power reproduction as the drivers of the urbanization, since located mainly in the cities, but determined by the broader mechanisms of production linked to the specific capitalistic framework in which they take place. In particular what is called urban culture is nothing more, for Castells, than the results of the unfolding of the industrial society, that have as specific place of development the city and urban spaces (*ivi*). It was not the space the generator of that specific culture, while a peculiar system of social production and reproduction, on which a cultural construct (the urban culture) was built, in the frame of an ideological concept of city that brought to consider it as a distinct element.

The deconstruction of the city concept and its definition as a fetishist element, is a common characteristic in the thought of the authors inscribed in the tradition of the new urban sociology. This tendency is due to the effort in distinguishing between the actual forces of the capitalist urbanization (as a specific manifestation of urban, historically determined) acting in the real world and producing the actual urban patterns (the many forms in which cities evolve), and the multiple, contested interpretations of that process and of its role (and as last result, the many definitions of city that can be found in the literature and common public debate).
As stated by Brenner: "On the one hand, the urban question refers to the role of cities as *sociospatial arenas* in which the contradictions of capitalist development are continually produced and fought out. On the other hand, the urban question refers to the historically specific *epistemic frameworks* through which capitalist cities are interpreted, whether in sociological analysis, in public discourse, in sociopolitical struggles or in everyday experience." (2000, p.362, *italics* added)
According to such a view what is relevant in the new approach to the urban studies was the acknowledgement of a distinction between two levels of analysis: the one of the real phenomena (the urban as a product of practices, see paragraph 1.3.2) and the one related to its representations (the urban as a discourse) and epistemological paradigms used to study it.
Saunders, in his famous contribution to the debate *Social Theory and the Urban Question* (1981), in particular reaches an extreme position, overpassing Castells in this deconstruction and de-legitimization of the city concept, since he highlights as the phenomena under the recent development of cities are of a *superurban* nature, and that the city scale at which they get visibility is just a contingent fact, not necessary for their analysis and comprehension.
Trying to look for an interpretative key to such an evolution of the theoretical contributes and views in the urban studies, a relevant role must be attributed to the rapid transformation occurring at the end of the '60s and beginning of '70s in the urbanization dynamics (as we started to see in the previous paragraph). The theoretical shift is of course due to a radical change in the reasoning on the issue, but it has also enhanced by the progressive complication of the urbanization

phenomenon, linked to (1) the transition from the *metropolitan city* to the *sprawled* or *diffused city*, with (2) an increasing role of the supranational and global relations between centers, in a double direction evolution (horizontal and vertical). These transformations would have been accompanied by corresponding theoretical and epistemological reasonings and changes.

1.2 From the city as an object to the city as a process

The break of the boundaries and functional delimitations of the city has brought to the emergence of a new set of conceptualizations looking for a new way of analyzing and detecting the Urban under a new perspective: from one based on the hypostatization of the city (city as an object) to one more prone to the study of the generative forces under its development, proposing to look to the city as a *process*, and so to the urbanization dynamics and their social and economic engines. This is the main result of the contribute of Lefebvre's reflection on the urban question, that will be analysed deeper later.

1.2.1 The Lefebvre's legacy

Lefebvre is probably the first of the authors belonging to this paradigmatic radical (in all its meanings) shift in addressing the new course of urban social studies. His main observation was linked to the identification of a new course, coming to life in those years: looking at the fundamental mechanisms governing society at large he understood that the current capitalistic mode of production, that was expanding all over the world, was strictly intertwined with the urbanization process that was operating as its *material vehicle*. This was not a surprising or new observation actually, since the bond between industrial and capitalistic society and urban spaces development was clearly highlighted in the works by K.Marx and F.Engels in the late XIX century, but what Lefebvre wanted to stress was the capacity of the urban realm to boost and at a certain point generate industrialization on its own, furnishing the condition for the development of capitalistic forces and, in the end, for the reproduction of the production factors themselves. From the cities the effects of capitalist forces distributed all over the world, touching different contexts, in a process that at that time was just at the beginning (since concentrated mainly in the developed countries), but that the author saw to be the next future of the whole planet: the urbanization of the world. For this reason it becomes less and less meaningful to distinguish between spaces that are purely urban and those that are not urban: the social processes at the base of the urbanization, being so intertwined to those at the base of the global economic development (the capitalistic production system) are increasingly touching and shaping all the territories and contexts.

From this statements, as highlighted by Merrifield, Lefebvre, "In *The Urban Revolution* (2003, p.57), emphasizes his claim that 'the city exists only as a historical entity', it 'no longer corresponds to a social object. Sociologically, the city is a pseudo-concept'. For this reason, he asks to stop using the term 'city', in

order to change the analytical terminology: he addresses a new object that is not a physical object in the usual sense of the term, a new object called 'urban society', or 'urban fabric'" (Merrifield, 2013, p.911). Urban fabric does not narrowly define the built environment of cities, but, says Lefebvre, indicates all manifestations of the dominance of the city over the countryside.
Such an expansion of the scope of sight, brought him to focus more and more on the interconnections growing between centers, able to produce a shift in the scale at which look at both economic and urban processes.

1.2.2 The scalar nature of urbanization

The concept of scale is central as highlighted by many other interpreters of Lefebvre's thought (Brenner, 2001; Brenner, Schmid, 2011; Merrifield, 2013): the strong transformation that were investing cities from the 1970s on, the growing expansion of urban functions, impacting on settlements' structure and morphology and on their territories, followed a double direction: horizontal and vertical.
On the one hand in fact the suburbanization, the shift from the traditional city to the metropolitan and post-metropolitan one (Soja, 2000), broke the traditional structure of the territories *of* and *around cities*, creating a blurred view, in which borders and delimitations started to lose meaning (horizontal dynamic).
On the other hand the growing complication of economic and social relations increased, due to the functional interconnections at supranational and global level (vertical dynamics) (Sassen, 1991).
If the analysis on the process is common to many authors facing the urban issues in that period, quite different are the conclusions derived from those observations.
The conceptualization of the scalar structure of urban processes itself is at the core of the argument, according to the different view of its nature: if for Castells and Saunders, but also Soja and other Los Angeles School scholars, a distinction between scale levels is present, each performing a different role in the global urbanization process, for Brenner, Schmid and the members of the Urban Theory Lab, there is no possibility to distinguish clearly between them without producing an arbitrary and faulty differentiation, being them strictly conceptually and functionally intertwined.
Castells for example describes scales as the differentiated 'spatial units' of which the capitalist system is composed (in Brenner, 2000), and among which city (the urban spatial unit) is a distinct level, to which corresponds a specific function or role (or social content, Castells, 1977, pp. 89, 235) in the scalar territorial articulation. According to Castells' famous argument (1977 pp. 235–7, 445) only collective consumption is *functionally specific* to the urban scale (while the same couldn't be said for the other functions considered: ideological, political-juridical and productive).
Soja is representative of a similar even if different interpretation of this role of the scale in the description of urbanization processes. With M.Storper and A. Scott and the contributors of the New Regionalism school of thought, he attributes to the regional scale the interpretative role of the current urbanization phenomena.

According to their approach the role of regional scale is made clearly central by the current transformations, at least evident in the United States in which this reflection has been rooted, impacting on the former metropolitan structures. They are in fact nowadays shocked by the territorial redevelopment produced by the urbanization extension (sprawl) and the parallel densification phenomenon, that breaks the former hinterland morphology and function, with as a final result to attribute it a new role, more integrated in the urban socio-economic structure[3] (Soja, 2015). The product of such an analysis brings to the consideration of the regions (or city-regions) as the best lenses through which look at the urbanization phenomenon, nowadays encompassing wide territories, thanks to the conglomeration of different former urban centers, more and more interconnected and networked due to the emergent infrastructural and functional relations.

But if in these conceptualizations the scale was considered still a functional distinct reality, allowing to give somehow to the city a boundary or at least an elective realm, the same is not accepted by scholars belonging to the more lefebvrian theoretical tradition.

In their view the scalar nature of city must be interpreted in a radical way, without any possibility of hypostatize it, confining it at a specific territorial level. If no specific functional territorial realms can be drawn without dividing what is functionally and conceptually not divisible, the scope that must be taken is the broadest possible: a planetary one.

This shift has been based on the theoretical contributes of the 90s, where the role of the cities and of the urban processes were interpreted in a global frame, where they acted as local nodes of broader city-systems on the global scale, managing and shaping the economic flows and interactions. The role of the national states were in fact being withdrawn, due to the globalization process, enhancing the relevance of supra-national institutions and organizations, defining the new development trends. In this framework the scale itself was put into question, as a structure of delimited territorial and exclusive levels, leaving room to a more blurred image and conceptualization, were the processes are at the core of the reasoning (Sassen, 1991; Graham, 1995; 1997; Friedmann, 1997; Mayer, 1994; Schmid, 1996; Jessop, 1997).

The strong processual view of urbanization phenomenon carried on by Brenner and Schmid has played an important role recently, due to its radical nature, and constitutes probably the most representative contribute of these last evolutions in critical urban studies. Greatly appreciated or strongly criticized, it rose relevant discussions, that we would like here to analyze in order to develop a personal approach.

[3] Through, for example, processes of *in-fill* and complication of the hinterland settlements structure and network.

1.3 Brenner and Schmid contributes to the Urban Question debate

1.3.1 The critique to the Urban Age rhetoric

The contribute of Brenner and Schmid has been particularly discussed in the recent debate on the Urban Question, due to the strong critique made to the tradition of urban studies and its conceptualization and empirical handling of the urban nature. The debate arose in particular from a famous article appeared in 2014 in which were questioned the attitudes and rhetoric built upon the so-called *Urban Age*, boosted by academic and non academic discourses on the current condition of the urban phenomenon. According to that rhetoric the acknowledgement that the current world is, for its majority, an urban one is due to the fact that more than the half of its population nowadays live an urban condition, because residing in an urban settlement. The authors' critique is focused on the fiction that underlies the concept of *urban* used by a consistent part of the scientific community, starting from the pioneers like Davis (1955), and that is in their opinion nowadays hegemonic.

In Brenner and Schmid reflection, this conception seems to be based on a technical/statistical definition of the urban, arbitrary delineated and also conceptually confused, since theoretically inconsistent. The argumentation proposed is not just a critique of the methodology adopted for the definition of the urban and the city, but it consists of a deeper epistemological debate about the ways in which the urban phenomenon must be conceived and, as a consequence, analysed.

The first observation carried out by the two scholars is that the distinction between urban and non-urban, and so the identification of the connotative elements adopted to identify the city, is commonly attributed to the size of the settlements considered, that should be higher than a specific threshold. But, they ask, what is this specific threshold? How is it defined? It is widely known that a common and universal definition of urban and non-urban does not exist, varying among statistical institutes and single studies. Even when a threshold is defined and shared, like in the studies and reports produced by the United Nations (United Nation Statistics Division), usually adopted as a reference in world demographic comparisons, it is clearly the result of an arbitrary decision, based on no theoretical nor empirical arguments (Satterthwaite, 2010).

The critique on this relevant aspect of the Urban Age discourse takes origin from the analysis of Wirth fundamental work on city and urbanism nature (Wirth, 1938): *Urbanism as a way of life*. In that essay the author lists and discusses the elements considered fundamental to distinguish that social and spatial environment called *city*, as characterized by a population sharing a common urban culture.

In their argumentation they highlight the aspects of the author's contribute usually less considered, like its critics to the empiricism characterizing the attempts of city definition focused only on the statistical measures of its specific dimensions (size thresholds):

> The characterization of a community as urban on the basis of the size alone is obviously arbitrary […] The situation would be the same if the criterion were 4.000, 8.000, 10.000, 25.000 or 100.000 population [...]
>
> (Wirth, 1938, p.4)

Brenner and Schmid have succeed in stressing this component of Urban Age rhetoric, basing their discourse on probably the most valuable and important contribute in the urban studies tradition. In their article they highlight the importance of abandoning an empirical (or better empiricist) approach in the study of the city nature, in favor of a *theoretical turn* in the field.

The main reason under such a position is the acknowledgement of the radical transformation of the *urban* in the current world: as affirmed by many urban scientists there is always less correspondence nowadays between city (as a delimited spatial object) and urbanism, having the urban phenomenon assumed different morphologies and reached a wide range of scales, on the physical, but also cultural and political point of view. Relevant are for example the contributes by Graham and Marvin (2001) on the splintering urbanism, scholars stressing the multifaceted and fragmented structures assumed by the recent urban development, but many other authors stress this aspects (Hall and Pain, 2006; Schmid, 2006; Soja and Kanai, 2006; Soja, 2010; Brenner and Schmid, 2012; Merrifield, 2011; Schmid, 2012).

We already saw (cfr. previous paragraphs) that if the awareness of the current blurred condition of the urbanization processes is quite widespread among an important part of urban scholars, the theoretical conclusions are significantly different. For Brenner and Schmid in fact, the necessity for the urban science's traditional approach of finding the boundaries and of individualizing distinguishable settlements brings scholars to "divide the indivisible" (Sayer, 1992), to put a limit to the urban and making it coincide with the city's, if existing, boundaries. It is clear and evident in the case of Davis' studies or the UN bulletins on demographic trends as already said, but it is also still present in the contributes of other scholars like Soja, Merrifield and Scott or Storper themselves, because focusing on delimited, even if blurred, spatial contexts like the city/urban-regions.

The shift for Brenner and Schimd must be more radical and for this reason they propose a complete different epistemological approach in another contribution inscribed in this debate, in which they articulate a set of 7 theses (Brenner and Schimd, 2015) aiming to give a different and new foundation to the urban studies. The different theses can be classified into four main groups: the first and the second one are intended to deconstruct the traditional definitions of the urban with a strong anti-essentialistic position, in a processual view. The third and the fourth, as we will see later, present the authors proposal for the understanding of the current urbanization process' dimensions giving new analytical tools. The fifth and the sixth, that we will just cite, are aimed to stress some peculiar characteristics of the urbanization process: its planetary extension and uneven outcomes. Finally the seventh summarizes their original definition of urban.

The need to deconstruct the essentialistic conceptualisation of the city is given by the consequences and relevance it embodies, since it is the base for the production of the concrete planning, governance and building strategies of the urban itself, in a reflexive circuit where concepts, and the ideology that they can produce, shape in the end the reality they should just represent. An example of the effects of this kind of approaches is the spreading of different "ideologies" or metanarratives on the city: the *urban triumphalism*, defining cities as the engines of human development and evolution (Brugmann, 2010; Glaeser, 2011); the *technoscientific urbanism* (Gleeson 2014), vehicle of urban social engineering and territorial control and de-politicization of the urban government; the debate on *urban sustainability*, able to enhance the effects of the technoscientific discourse (Satterthwaite, 2004), and on the *megacities* (Davis, 2006; Roy, 2005).

1.3.2 City as a multiscalar process

In the previous paragraphs we saw that nowadays the urban processes are shaped by the globalization dynamics and characterised by the multi-scalar nature of neoliberal mechanisms governing the urban development. Due to this nature the urbanization process is able to reach (through the consequential chain of phenomena it ignites) also areas once considered as isolated and almost not touched by the human footprint (like the Antarctica continent[4]) and, for this reason, must be considered as a planetary phenomenon: the city is everywhere because every environment is under the influence of its forces and of the activities that are generated there. Here we find the basis of Brenner and Schmid theorization of the *planetary urbanization*, given by the extension to the world of a specific human relationship's pattern or condition that is fundamentally socially built by human practices.

The city must in this sense be considered not as an universal form, that can be found in every context with the same characteristics, neither a container, but it is the product of a never stopping "process of creative destruction"[5], carried by the dynamics of capitalist mode of production and its consequential impact on the territories. From such a statement derives that the urban is not a specific settlement: the distinction among city, suburb, periurban and any other kind of "bounded spatial unit" is not significant if the condition of the urbanity is spreading everywhere and is always changing, they are just contingent "crystallizations" of that process at various spatial scales with "wideranging consequences" for the inherited socio-spatial arrangements (Brenner and Schmid,

[4] Until the "end of wilderness" (sic!) as stated in Brenner and Schmid (2011).

[5] It is clear here the echo of the Schumpeterian definition of Capitalism as a "process of creative destruction" in *Socialism, capitalism and democracy* (1942).

2015, p.165). The urban is not saturated by those categories but is the product of three different tendencies, all coexisting at the same time even if with various gradation of each of them (thesis 3): *concentration* (through the effect of the agglomeration processes), *extension* (through the diffusion of the influence of the agglomerations in other spaces) and *differentiation* (given by the continuous destruction and reconstruction caused by the capitalistic dynamics). The authors insist in highlighting the structural co-presence and interconnections of these tendencies or *moments*:

> Just as distant flows of material, energy and labor underpin the everyday dynamics of large metropolitan agglomerations, so too do the growth imperatives and consumption demands of the latter directly mediate the construction of large-scale infrastructural projects, land-use reorganization and sociocultural transformations in apparently ‘remote’ operational landscapes (p.169)

These three tendencies are produced by three different *dimensions* of the urbanization process, to whose unfolding they contribute to. Brenner and Schmid derive from *the Production of Space* by Lefebvre the identification of these three elements (thesis 4): a) Spatial Practices, b) Territorial Regulation and c) Everyday Life.

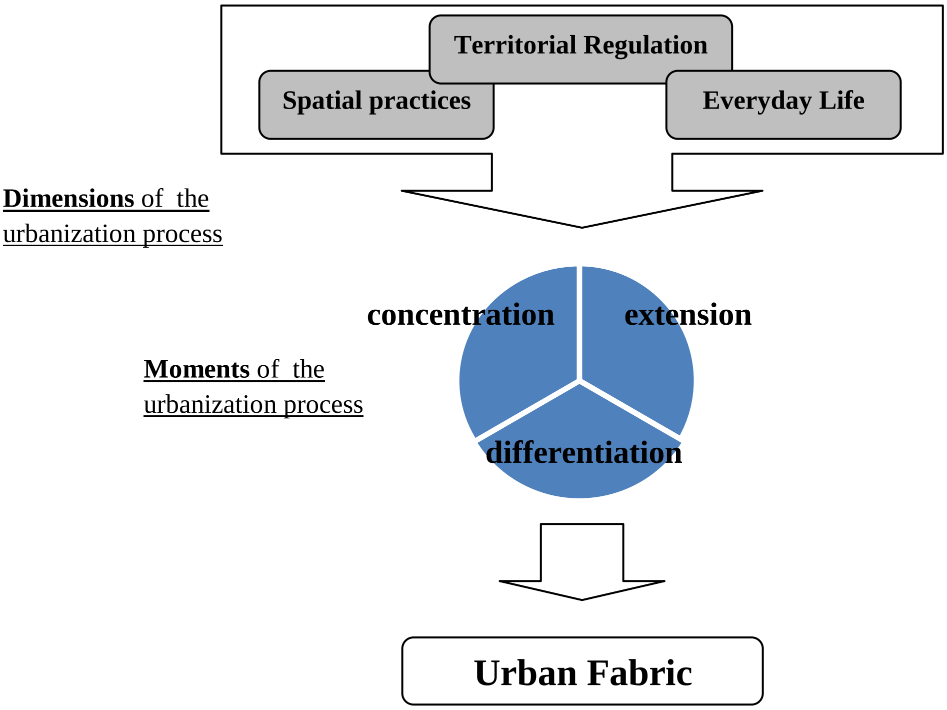
a) With **Spatial Practices** are considered all the ways in which the territory is exploited in order to build up the infrastructures and the connections useful for the unfolding of the capitalist processes.

b) **Territorial regulations** consist of the rules regarding the appropriation of resources among different territories, the planning procedures for the governance of investment patterns, and the management patterns of social production and reproduction mechanisms.

c) **Everyday life**, in the end, allows the appropriation and transformation of the urban fabric through the *critical* and also creative use that is made of it by the population, in the moment in which urban spaces are used by people, and so they appropriate and transform it through the daily routines and practices, that “frequently involve struggles regarding the very form and content of the urban itself, at once as a site and stake of social experience.” (p.171).

In order to summarize their conceptualization a schematization of their reasoning could be useful:

Fig. 3 – Scheme of the urbanization process unfolding according to Brenner and Schmid's theorization.



This is the only definition of the urban that can be found in the theorization of the authors, but such a position determines two significant epistemological problems or critical points, that we would like to stress here.

1.3.3 The secondary role of the space

First of all the *urban*, as conceived in their reasoning, seems to be the pure product of social relations, in a conceptualization where it (with its spatial components) is totally socially built. As stressed by different scholars (Castells, 1972; Saunders, 1981) the spatial element here becomes in this way absolutely secondary, if still present, or better: the spatial structures, as we already said before, become one of the results of the social relations in a radical culturalist approach. Such a definition does not consider the space as a, at least partially or in specific contexts, independent variable, bringing to an, apparently, evident paradox that the urban study field, that considers the city and its culture an independent and autonomous social context, loses his peculiar study object: the urban space. The urban nature is in fact nowadays extended to the whole globe, making the city and its context, as already highlighted above, no more fundamental to justify the phenomena that are always more non-local and interrelated at a planetary level (thesis 5). From a nominalistic point of view this shift appears as the overpass, if not the end, of the urban studies field, for the assimilation of the specificity of the subject by the whole social sciences discipline[6].

In the fifth thesis is asserted that all the urban processes are shaped by the dynamics of the modern Capitalism, the historical social structure, socially built, that gives urbanism the framework in which it unfolds itself and expands to the whole globe:

> Clearly, this is a broad conceptualization of urbanization: it involves a wide-ranging constellation of material, social, institutional, environmental and everyday transformations associated with capitalist industrialization, the circulation of capital and the management of territorial development at various spatial scales.
>
> (Brenner, Schmid, 2015, p.172)

As the authors admit, "this is a broad conceptualization of urbanization", but it shows also another critical point: here as highlighted also by Walker (2015) seems to lie an apparent confusion between a historical process and urbanism, since, from what the authors say, it is not clear if there is any **distinction** between Urbanism and Capitalism. More precisely, even if a distinction is asserted, it is hard to be seen:

> We would insist, however, on distinguishing urbanization from the more general processes of capitalist industrialization and world market expansion that have been investigated by economic historians and historical sociologists of capitalist development (e.g. Wallerstein 1974; Braudel 1984; Arrighi 1994). As understood here, urbanization is indeed linked to these processes, but its specificity lies precisely in materializing the latter within places, territories and landscapes, and in embedding them within concrete, temporarily stabilized configurations of socioeconomic life, socio-environmental organization and regulatory management.
> (Brenner, Schmid, 2015, p.172)

Urbanism is conceived here as the translation into real and concrete objects of capitalism forces and dynamics, producing the overlap of the *social* with the *urban* element. The spatial issue is in this way relegated in a secondary position, since spatial components are all ontologically the same thing, the physical expression of capitalistic forces, denying the existence of trans-historical basic elements to be found in all the epochs. This was one of the basic conditions for Wirth of a good definition of city, the trans-historical validity:

> In formulating a definition of the city it is necessary to exercise caution in order to avoid identifying urbanism as a way of life with any specific locally or historically conditioned cultural influences which, while they may significantly affect the specific character of the community, are not the essential determinants of its character as a city. It is particularly important to call attention to the danger of confusing urbanism with industrialism and modern capitalism.
> (Wirth, 1938, p.7)

[6] At the same time we could say that the urban studies have reached a higher relevance in the social sciences thanks to the fact that all society is urbanized.

The turn of the authors seems to be too much radical: starting from a cultural perspective, as well as Wirth, it comes to reduce the urban to an historical and social product, that is true, but what are its fundamental and stable characteristics that distinguish it from the rest of the reality?

1.3.4 Empirical stuck and implications of planetary urbanization

The theory supported by Brenner and Schmid stresses the relevance of the theoretical dimension, in a situation in which the reality seems to overpass the analytical concepts used until now, but leaves us without specific tools to operate according to such a new epistemological perspective. If the interpretative power of the theory is really strong, it still lacks of something, specifically a more concrete definition of the urban.

As Walker highlights in his answer to the article on the seven thesis:

> Processes produce objects and objects always presuppose and even internalize the processes that make and break them. These objects (things, structures, systems) may be more or less long-lived, but even if they are always changing to some degree, all is not flux.
>
> (Walker, 2015, p. 185)

For the founders of the Urban Theory Lab it is not of central importance the actual structure on which urban functions (or culture) are attributed, for example a compact and large settlement, a fragmented and low-density urban area, or even the Antarctica territory: the function, the same fundamental culture, is everywhere, even if unequally spread in these three urbanized forms.

Such a position brings us to the following question: but if the expansion of the urban functions (conceived here as practices, environments, etc…) is the element that makes the urban exist, what makes the urban functions? Are there specific and objective conditions that make this possible?

1.4 A pragmatic solution to the question: the contributes of the Los Angeles School

A look to the historical evolution of cities can give some useful insights to the present discussion. Without summarizing the history of the city, doing a proper archaeological reconstruction of its phenomenology, we would like to highlight some elements of this path, already analyzed recently by several authors like Soja (2000) or Scott and Storper (2015).

The historical facts that produced the birth of the city can be found probably in the agricultural revolution at the turn to the Neolithic Era (10.000 B.C.): as highlighted by Gordon-Childe (1950) the shift from hunting and gathering societies to one characterized by the cultivation of vegetables and cereals brought to the need of a sedentary life, and so to the birth of the first stable settlements.
Moreover the adoption of such a new system brought other epochal facts, such as the accumulation of a productive surplus and a more articulated division of labor, that caused also the emergence of a more complex society:

> Cities emerged historically only where a food surplus can be extracted. […] Moreover when the countryside generates an excess of production over subsistence needs, a cohort of non-agricultural consumers of the surplus can be maintained.
> (Scott, Storper, 2015, p.4)

These non-agricultural consumers are the constitutive elements of different classes managing the power in the settlements (political, military, religious, economical). Such a social milieu had the need to converge in a limited space (Childe 1950; Pirenne, 1952 [1925]; Bairoch, 1988, Braudel, 1995 [1949]) in order to better manage the increasing complexity and consequent growing division of labour: in a word the result was a *process of agglomeration*.
Agglomeration is recognized traditionally as the basic element under the existence of cities. Actually Brenner and Schmid don’t deny the importance of this force in their theorization of the urban, saying that “[…] the ‘power of agglomeration’ remains as fundamental as ever to the dynamics of industrialization […]” (Brenner, Schmid, 2015, p.154) but the new dynamics of the expanded urbanization, possible thanks to the development of the new information technologies and the expansion of communication infrastructures, question the strength of the agglomeration process itself.
Scott and Storper are clearly aware of such a condition, as they “concede at once that cities are strongly and increasingly intertwined with one another in relational networks” (Scott and Storper, 2015, p.7) and also that “there can be no rigid and absolute boundary between any given city and the rest of the geographic space” (*ibidem*). But what they propose is a pragmatic approach or solution to this situation:

> Once these points have been made however we still need to assert the status of the city as a concrete, localized, scalar articulation within the space economy as a

> whole, identifiable by reason of its polarization, its specialized land uses, its relatively dense networks of interaction (including its daily and weekly rhythms of life), and the ways it shapes not just economic processes […] but also socialization dynamics, mentalities and cultures. We might say that the city is to the space economy as a mountain is to the wider topography in which it is contained. In neither the case of the city nor the mountain can a definite line be drawn that separates it from its wider context, but in both instances, certain differences of intensity and form make it reasonable and *pragmatically* meaningful to treat each of them as separable entities.
>
> (*ibidem*)

It looks useful to adopt the same image of the urban as a mountain to reframe the Brenner and Schmid's position: what is relevant for the authors in this new metaphorical frame is not the level of elevation as a tool to distinguish the mountain (the city) from the plain (non-urban environment). They would refuse a pragmatic approach to the distinction because what matters in their theorization is the influence of this elevation on the environment (for example the weather), that impacts on a territory also far from the particular localization of the mountain itself. The physical territory is so more a product than a determinant of the characteristics of the environment.

This is again a result of the social foundation of the urban in Brenner and Schmid theory, since, as they highlight in the fourth thesis, constitutive of the urban are the practices: the physical interventions on the environment, the government institutions, and people daily activities. The urbanity is also made by the appropriation and constant transformation of the urban relations created by the unfolding of capitalist processes (thesis 7). Is a form of culture in a wide and general meaning, built in the everyday life. Such culturalist approach contains a paradox: if urbanization is diffused in the world by the expansion of capitalist processes and the behavior of people that conveys and reshapes it daily, is it enough the presence of a singular individual in a territorial context to consider that context urbanized? The presence of a firm manager in a isolated cottage on the mountains makes that place urban? For Brenner and Schmid maybe the answer would be affirmative, because the presence of that person in such an environment is made possible by the existence (even if only the influence) of a system of social structures that makes possible for him to stay there and live an urban experience, or a non-urban experience, in an urban way. Every person, because socialized to the urban life, brings with her/him this "sense of urbanism", an urban attitude or culture, contributing to its diffusion in the world, as a puzzle piece of the urbanization process.

Even if charming, this image brings with it some observations: is it purely the existence of an urban behavior that can create an urban environment? Intuitively we would answer "no", because without the presence of other elements able to activate these behaviors this urban potential can be difficult to be realized. The capitalistic processes need to take a concrete form and create the opportunities to make this possible, to create the *urbanity*.

At the same time, it is not enough that a context lives the consequences of the capitalist processes to be considered invested by the urbanization expansion: a

Sudanese farmer will not have urban behaviours only because he faces the impact of capitalist mechanisms on his daily life.
Without the existence of the opportunity to put into practice the urban potential attitude and behavior this cannot have an impact on the environment able to “urbanize” it. Such potential must be realized in concrete terms but with some conditions, like stressed by Scott and Storper.
This is not a solution to the question, but the proposal by Scott and Storper is to look at the *urban land nexus* (the localization criteria and mechanism of residences, activities and infrastructures, as the extensive expression of agglomeration) as the basic engine and *essential fabric of intra-urban space*, that shapes behaviours and creates the urban attitude and culture.
This conceptualization reminds Soja’s contribute in the definition of urban nature that can be found in his main opera *Postmetropolis,* where he introduces the concept of *Synekism*, conceived as “the economic and ecological interdependencies and the creative – as well as occasionally destructive – synergism that arise from the purposeful clustering and collective cohabitation of people in space, in a home habitat”, that resembles what economic geographers have called *agglomeration economies,* and a particular form of them: *urbanization economies* (Soja, 2000, p.12).

1.5 A bridge between two positions: the capability approach as a framework through which detect urbanity

The position embodied by the two American west coast authors is strongly economic-narrowed cause of their theoretical scope as economic geographers. But the remark of the need to find a way or definition able to distinguish better the *urban* from the rest of the reality seems to be valuable. If we go back to the previous definition of urban proposed by Lefebvre we can find some useful tools to the elaboration of a framework in which to include the observations made until now.

Lefebvre considers in his contributions the urban as the place of the dialectic between *centrality* and its negation: the essence of the urban is the possibility of the creation, of the expression of the potentials of people, and it is made possible by the concentration of the creative processes (Castells, 1972). Following this reasoning we can see as the development of the creative forces and so the realization of the urbanity is possible only if the *centrality* is reached. What does Lefebvre mean with centrality? It is not very clear actually, centrality could be considered here as a condition to act freely, or as the possibility to get access to the opportunities in an active way, of satisfying a need or express creatively something belonging to the person. What we seem to see in such a conceptualization is the proposition of an approach compatible to Amartya Sen's Capability Approach (1985b), that is based on the distinction of *capabilities* and *functionings*, where Lefebvrian *centralities* can be seen as the combination of these two components of social life.

As well known, with functionings Sen defines the parts of the state of a person – in particular the various things that he or she manages to do or be in leading a life, the important aims a person can have in his life. The capabilities of a person reflect the alternative combinations of functionings she/he can achieve, and from which can choose one collection, that is the means or the ways in which her/his aims can be reached.

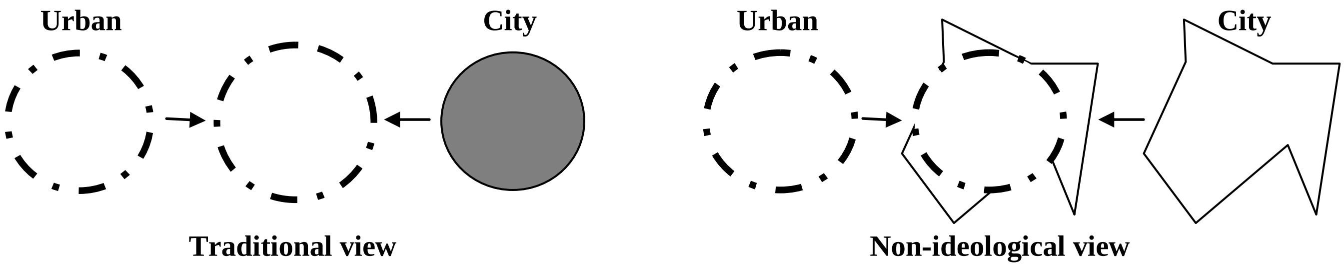
Adopting such a perspective, we could find a way to better understand and define the concept of urban, considering it today as the presence in a place of a high level of centrality, that can be translated, in our interpretation, into a high concentration of potential functionings and the relative capabilities. The research on the quality of life has since long time ago adopted the capability approach in order to better measure a property that for its nature is strongly subjective and difficult to detect. On this path we would assume that the presence of a high level of accessibility to functioning in a specific place could be considered as a way of detection of the urbanity of the place itself and of the population inhabiting it. The accessibility to the opportunities[7] is the mean through which a place can be actually considered urban, since "generator" of urbanity.

[7] With opportunities we refer to not only places or services but in general all the activities a person would like to perform according to its needs and preferences. It is a common term adopted in accessibility studies literature to address the *object* of the accessibility (Kwan, 1999; Dijst, 2001).

As said before to affirm a place to be urban only because of the presence of a person conveying an urban attitude is hard: the expression and diffusion/reproduction of the urbanity necessitate of a suitable environment in order to develop, of the possibilities (opportunity) to be born and expand. At the same time defining a Sudanese farmer as an inhabitant of an urban context just because touched by the capitalistic externalities sounds strange, if he has not access to a set of opportunities to express this urban attitude. The question following such a reasoning would consequently be: what are these opportunities and conditions? And so empirically: What should be the threshold above which consider a place urban? Brenner and Schmid would consider any answer to these questions as ideological or arbitrary. And maybe they are right. But it is a risk to be faced in order to produce knowledge: all knowledge is at least in part socially built, what is important is to be aware of that, and thanks also to their contributes we are.

In the next chapter we will analyze better the contribute that Capability Approach can give to our conceptualization of urban and urbanity: we will look at the relation between it and the accessibility concept, in order to understand its analytical and empirical potentials.

Conceptual diagram



Urban and **City**

as two different elements and concepts

URBAN

Urban Theory Lab

Brenner & Schmid

Lefebvre and relational nature of the urban

Urban = Centrality/non centrality
Dialectic of interests

Los Angeles School

Scott and Storper

Agglomeration principle and its impact on people behaviours

Urban nature = Land-nexus

Centrality as **presence/access of/to opportunities**

Urban **as places of concentration of** opportunities able to let people live and express their interests.

CAPABILITY APPROACH

as a framework in which interpret the urban environments level of urbanity and to detect it

Interests
↓↓
functionings

Presence and access to the opportunities
↓↓
capabilities

Chapter 2

Accessibility as a measure of capabilities in the urban realm

Introduction

In this chapter we will analyse how the Amartya Sen's Capability Approach could be considered reasonably at the theoretical base of the accessibility concept, not only conceived as a measure of the objective obstacles against the opportunities reach, but also as a measure of the social factors impacting on those.

The necessity to look through a bigger scope to the issue of accessibility is made evident by the consideration of another key concept, mobility, and its characteristics, as a medium through which accessibility is guaranteed. Mobility itself is recognized as strongly influenced by subjective elements, able to reduce its efficacy and effectiveness. The concept of Mobility Capital or *motility* has highlighted this aspect and the importance of evaluating the quality and not only the quantity of individual mobility for the measure of individual freedom, showing to share in this sense many elements belonging to the CA.
Due to the fact that a bigger mobility does not correspond to a better motility, or freedom to move, it seems to be useful to stress the relevance of proximity as a key element to guarantee an easier access also to the weakest subjects in terms of physical and social characteristics.
Without thinking of substituting mobility with it, proximity can be considered a property able to reduce the mobility's friction elements (in terms for example of time and distance), to overcome which unequally socially distributed resources are needed.
According to such a reasoning, if the concept of centrality (as a synonymous of urbanity) in the urban realm can be connected to a high level of urban capabilities, pedestrian accessibility is introduced as an useful tool to measure it.

2.1 Amartya Sen's Capability Approach

The Capability Approach is the product of a fruitful recent course in economics, rose in the '80s as a turn-point element in the welfare economic studies' tradition, thanks to the work in the field of the Nobel prize winner Amartya Sen. Sen developed at the beginning of the 70s the first contributes that will carry to what can be considered a wider ethical-political theory, rooted in the economics field (and in particular the economy of choice) and philosophy, specifically in the framework of Rawls' *Theory of Justice*. The legacy of Sen's theorization has become in the years more and more evident in the scientific production of many study fields, due to its capacity to stress the complexity in the evaluation of social-related issues. A look at the constitutive elements of this theory will show better such a characteristic.

2.1.1 A critique to utilitarianism

At the base of Sen's work lies a strong critique of the utilitarist approach to economics and to its basic components (*consequentialism*; *welfarism*; *sum-ranking*) (Sen, 1992), for which the evaluation of people well-being is obtained through the simple sum of their utilities, considered as the measurement tool for the detection of the property underlying it: the level of *happiness* they achieve.

If Consequentialism, conceived as the principle for which actions must be judged and evaluated according to their results and not the values they encompass, is a property of utilitarianism on which Sen agrees (even if with some distinctions), the other two elements are strongly contested. Among them in fact is rooted Sen's main object of critique, the *welfarist* tradition, hegemonic in the walfare studies of the last two centuries, whose approach is based on the detection and measure of welfare's level as the sum of individual income or expenditure (Sen, 1979), under an unidimensional scope. Sen contributes helped in showing as the individual welfare is on the contrary a multidimensional property, composed of many other aspects, encompassing cultural, relational, social dimensions, highlighting that "what was wrong with welfare economics" consisted in the lack of consideration of the *conditions* under which the individual choice is taken. What is relevant for the author for the individual welfare assessment is in fact also the "context" in which *utility* is defined: the level of freedom people can live in their choosing process impacts on the nature, variety and quality of choices available. The consideration of such an aspect is crucial in order for example to avoid the distortions in individual happiness and perceived well-being due to the adaptation of people's expectations to a specific deprived condition (corresponding to a lack of freedom in choosing), lowering for example the measure's references for the personal happiness evaluation.

Moreover also the nature of the object of the utilitarian evaluation can vary, including elements difficult to be measured empirically (like the acquisition of specific rights) or not producing a direct benefit for the people (this is the case of the *agency* concept). Some activities like the participation to a rally or a political demonstration can be in fact considered as an important element for the fulfillment of individual well-being even if they do not imply a direct gaining for them.

Another element of critique towards the hegemonic utilitarianism, and common also to the rawlsian Theory of Justice, consists in the rejection of the consideration of the goods' set (or sum) belonging to a person as a measure of their well-being (*sum-ranking* principle), since they represent, for Sen, just the instruments through which it can be reached and not the well-being itself. Different people can in fact obtain different levels of well-being from the same set of goods, highlighting the erroneous attitude of considering the mere possession as an assurance of benefit gaining. What is relevant so are, as partially already stated before, the *personal characteristics of people* and the *specific conditions* under which the goods are reached and can be used. This distinction is central in Sen's reasoning and conceptualization of freedom and justice, since the actual acquisition and access to the opportunities is produced by the *conversion* of their mere existence into real availability, of the resources into freedoms and, in the end, well-being. As Sen exemplifies: "With the same boundle of primary goods, a pregnant woman or one with infants to look after has much less freedom to pursue her goals than a man not thus encumbered would be able to do." (Sen, 1992, p.27).

2.1.2 Functionings and Capabilities

In its theorization Sen stresses so the fundamental difference between achievements (as realization of the desires and aims: commodities gained or used) and freedoms (the set of achievements reachable), formalizing them into an original approach. The author defines the two elements of achievements and freedoms (to achieve) respectively with the terms *functionings* and *capabilities*[8].
Functionings consist in *all the states or activities a person could be or do*, the actual realizations of potential states, like moving, get nourished, feel self-satisfied, etc… they are defined in this sense "constitutive of a person's being" (Sen, 1992, p.39).
Capabilities are *sets of functionings a person can really achieve* (states a person can embodies or activities they can really do), and depend, on the one hand, on the availability of the resources and, on the other, the capacity of the person to convert them into actual functionings. A person on a wheelchair can for example live in a neighbourhood with a park, but since there are no well maintained paths they cannot access it.
Togheter functionings and capabilities compose the *space of people's well-being*, combining what they achieve with the freedom to choose between different potential achievements. The inclusion of the *space of possibilities* in the measure

[8] More precisely Sen talks of *achievements* as a vector (or specific set) of functionings, and capabilities as a set of vectors (or set of sets) of functionings a person can actually achieve (Sen, 1992).

of well-being can change the evaluation of the person's final achievements: taking as an example two not educated people, they can present a different well-being, even if sharing the same educational level in the end. If, in fact, such a condition is the result of a free choice in a context of presence of educational opportunities really accessible, the level of well-being is higher than in the case it is due to the lack of opportunities themselves.

2.1.3 Opportunities' conversion factors

The concept of conversion (transformation of resources into functionings) is central in the capability approach, since it is at the base of the evaluation of the real well-being of a person.
The elements influencing the conversion can be distinguished into three different groups (Kuklys, 2005, p. 11):

1. personal factors (such as sex, physical disabilities, intelligence)
2. social factors (e.g. legal regulations)
3. environmental factors (e.g. climate, level of pollution, …)

All these elements have a role in the shaping of the space of well-being, impacting (empowering or obstructing) the reaching of achievements. Different achievements can be influenced by a different set or combination of the conversion factors, due to the extreme human heterogeneity.
In our reasoning we would like to focus on the third kind of factors, opening a specific discussion on the components of the environment that can facilitate or reduce the access for people to their functionings. Our scope is keen on a specific context: the urban one, and so on the urban environmental factors able to shape individual capabilities. In this sense we will talk and discuss of the *urban* functionings and capabilities as specific subsets of the broader functionings and capabilities conceived by Sen, since influenced by the peculiar structure and organization of the city (Talu, 2014), defining what an individual can do *in* the city and *with* the city.

2.2 Urban capabilities

Under such an approach the possibility to access to the opportunities present in the quotidian space and their richness and variety (but also their peculiar relevance for the specific individual) is central for the measurement of the functionings and capabilities of urban inhabitants. Physical access is the first and most immediate dimension of accessibility that can be considered, but it is also fundamental since determine the inclusion or exclusion of the opportunity in the individual's space of possibilities[9]. The possibility to access can be in this way defined as the capacity to convert potential urban functionings (because present in the urban realm) into actual urban functionings, it represents the set of

[9] Also economic power or individual fitness are relevant, but without the physical closeness to the opportunities those cannot even be taken into consideration.

individual's urban capabilities. It represents for sure the first and most basic dimension of capabilities, but it is anyway the fundamental attribute of an opportunity or resource in order to be included in the individual space of capabilities. The concept suitable for the detection of such a property is the one of *accessibility*, whose relevance in the last decades has increased due to the strong emphasis put on it for the enhancement of social equality in the urban realm, for its adoption as a tool for the fight against social exclusion. A brief look at its components will be useful to highlight the connections with the capability approach.

2.2.1 Accessibility as a measure of capabilities in the urban realm?

Accessibility is indeed a complex notion, "a multifaceted concept" (Curtis and Scheurer, 2010). Usually with accessibility is conceived the easiness for an individual or a group to get to a place or a location (spatial accessibility), considering both the infrastructure network used and the barriers obstructing the access. This first conceptualization of accessibility was proposed by Ingram (1971), describing accessibility as the access to a place from an origin[10](*relative accessibility*), and as the access to all the possible places in a specific spatial frame (*integral accessibility*), since every destination can be considered also as a successive origin for further travels. The focus of the first attempts of defining and measuring accessibility was on the physical distance, considered as a friction element capable of reducing the access to amenities. A further evolution of such approach introduced also a measure of the relevance of the amenities (attractiveness) able to shape differently their catchment areas and as a consequence the degree of accessibility (Hansen, 1959) for example through the so called *gravity models*.

A broader conceptualization of the accessibility was brought by a change in the theoretical and analytical approach, embodied by the *activity-based* study tradition (Dalvi, 1976) (cfr. Chapter 3 for further discussion on the topic), which produced a shift of the attention towards not only places (as locations) but to the activities occurring in those spaces. Such a change in the approach allowed to take into consideration in the analysis also the decisions on which mobility choices are performed (since every movement is aimed to reach a place to act or do something) and the consequences of actions themselves for individuals and their mobility strategies (Borlini, Memo, 2009). All these elements are believed to be relevant in the analysis of people's travel behaviour, opening the field to the study of the subjective dimensions of mobility. The basic element on which the approach is focused are so not just *places* but *opportunities*, whose variety and relevance are usually measured in order to better understand the mobility choices of people. The most common tools for the measure of Activity-based accessibility are founded on two different kinds of methods for accessibility operationalization: (1) the *opportunities' weighting by impedance* method, for which a score is given to every opportunity present in a territory according to the travel cost or time

[10] since the level of accessibility must be considered according to both an origin and destination in order to detect the specificity of the path available.

needed for reaching them, starting from an origin; (2) the methods addressing the *opportunities accessibility areas* included in a time or distance threshold surface. The most known in this last class of methods is the *isochrone mapping*, by which the number of opportunities that could be reached within a given travel time "x" is computed.

At the core of the accessibility studies anyway lies the relation between an opportunity (and as a consequence its spatial location) or a set of them and an individual (or a group of people). The Accessibility cannot be considered in this sense just as a property of a space or activity location, but it acquires meaning only in relation with the Actor, the person (or group) who needs to perform that activity and so to access it. Social actors are those who live in fact the easiness or lack of access to material or immaterial resources, offered by the territory, and only studying their methods of resources' appropriation is possible to fully understand the level of accessibility to the relevant needs they aim to (Borlini, Memo, 2009).
For this reason recently a great part of accessibility studies narrowed on the disaggregated methods to measure the specific accessibility of particular populations or detect the relevance of individual properties and characteristics on the access to opportunities. Accessibility is then, as highlighted by Cass, Shove and Urry (2005), constituted both by an objective component, since shaped by spatial and time constraints, and a subjective one: people ability to face and negotiate those constraints, according to their characteristics, aims, needs and desires.

Addressing the subjective components of accessibility is much harder than measuring the objective ones, for which, for example, distance or time friction variables can be easily computed. The focus on the subjective aspects brings to the consideration of individual life-style, and relative different needs/desires linked to the specific characteristics of people like gender, social class and status, age, physical conditions, etc…, that are also vehicle of specific cognitive and perceptive schemes. This produces as a consequence an important complexity in the individuals' *action space* structure conceptualization (as developed in the time-geography tradition[11]), the spatial frame in which people activities are inscribed. As proposed by Djist (1999) in fact, individual action space can be conceived as a tripartite concept, composed of three different types of space: (1) *actual* action space; (2) *potential* action space and (3) *perceived* action space. The first one is constituted by the spatial extent in which actions are *actually performed* by people, and by the space of opportunities really reached. The potential action space is given by the spatial extent of activities that *can be* visited by a person during a given period of time. The perceived action space is the area in which *known* activity places are located, and corresponds somehow to the concept of *mental map* developed by Lynch (1984). Conceptually the three spaces can overlap, but usually they have different extensions and intersections: the

[11] The tradition of studies started from Hägerstrand contribution of 1970

potential action space by default includes the actual one (being the latter the realization of the former, according to the time constraints), while it is not specified by the author if can intersect or just include the perceived action space (if for example in the individual mental maps are known but potentially not reachable places). Similarly to what is described in the case of Sen's conceptualization, there could be an important shift or lack of overlap between the different kind of spaces (actual or potential), and also between actual, potential and perceived through the individual's look. It depends on the conversion potential proper of each person, in relation to a specific context.

2.3 From the Capability Approach to the Motility concept

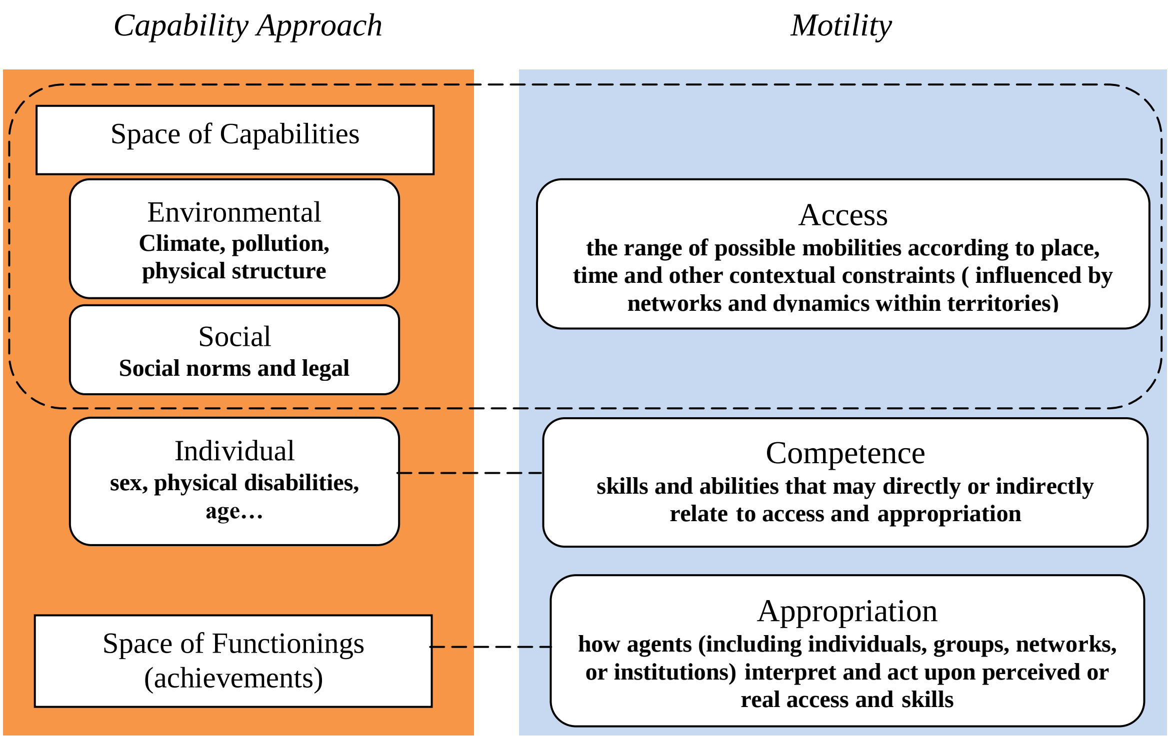
Accessibility literature has insisted on such an aspect since long time, focusing on the main aspects impacting on the different levels of access to opportunities, and on the phenomenon of social exclusion consequential to them (AA.VV. 2006; Cass, Shove e Urry 2003; Farrington 2007).
The mechanism through which social exclusion is produced acts on the interconnection and uneven relation between opportunities existent, real access to them and individual perceptions and preferences/desires: local service desertification and their low quality, concentration of social issues, low control on public spaces contribute to isolate urban areas, from which if no escape is provided the relegation to the local deprived context produces or enhances social inequality conditions (Borlini, Memo, 2011).
The access to the network of spaces and infrastructures that compose the city is shaped by the resources available to people: economic, cultural, relational, organizational and mobility-related. If the distribution of opportunities is unequal in the urban environment, due to its concentration for example in cities' more central areas, mobility can partially avoid such a situation, reducing the dependence on the residential context. In this sense the *mobility capital* is central for the evaluation of the social exclusion faced by a person. The concept of mobility capital has been developed by Kaufmann et al (2004) who defined it with the term *motility*: it represents "the capacity of entities (e.g. goods, information or persons) to be mobile in social and geographic space, or as the way in which entities access and appropriate the capacity for socio-spatial mobility according to their circumstances" (Kaufmann, 2004, p.750). Three elements in this definition are particularly interesting for our discourse: capacity, access and circumstances. The concept of motility is in fact linked to the potential of the entities to be mobile (*capacity* to access to the mobilities' opportunities), according to the declination of their characteristics in particular conditions. It reminds somehow the concept of *conversion*, proper of the Capability Approach (cfr. Previous paragraphs), specifically addressed to the mobility realm. Motility is in fact a multidimensional concept, composed of three dimensions (*ibidem*):

- *Access*, "refers to the range of possible mobilities according to place, time and other contextual constraints, and may be influenced by networks and dynamics within territories". These constraints can be synthesized in *options* and *conditions*, where the formers represent the mobility opportunities (transportation means) existent, and the latter the accessibility of the options in terms of location-specific cost, logistics and other constraints. Together they embody something similar to the sennian *space of capabilities*, where options could be considered as the functionings (in the specific field of mobility functionings) and the conditions the capabilities (functionings actually accessible given a specific context). What lacks in this case are the more subjective conversion factors (perceptions and desires), that can anyway be included into the last dimension listed here.

- *Competence*, includes skills and abilities that may directly or indirectly relate to access and appropriation. They embrace *physical ability*, *acquired skills* (relating to rules and regulations of movement like driving licenses) and *organizational skills*, (e.g. planning and synchronizing activities). They somehow correspond to the social and individual conversion factors highlighted by Kuklys (cfr. paragraph 2.1.3).

- *Appropriation*, refers to how agents (including individuals, groups, networks, or institutions) interpret and act upon perceived or real access and skills. It represents the perceived and subjective interpretation of the possibilities and the individual values, desires and needs on which choices are taken (the *individual conversion factors* in Kuklys' classification) and the specific results (final functionings achieved).

If we would like to translate into a schematic representation this reasoning:



What is relevant to underline is the fact that motility does not correspond or overlap to the amount of mobility (distance covered or time spent on moving) proper of an individual. It is linked to the *freedom* of choice and the variety of alternatives, to be taken according to oneself desires, preferences and needs. On the contrary a high amount of mobility is not compulsory linked to an increase in social inclusion or advantage, since it can be accompanied by negative spillover effects like congestion, stress, time consumption, etc…what should be pursued is a bigger freedom in choosing, including its negative declination, of not to be forced to move to perform specific activities (Borlini, Memo, 2011). This could be addressed reducing the "imposed mobility", agglomerating activities and settlements, and re-allocating services at the local level. This does not mean to obstacle mobility but just to increase the possibility to choose whether to practice it or not as much as possible, focusing for example on the accessibility of transit infrastructures and enhancing soft mobility practices. As Handy (2002, p.4) states: "Policies to increase mobility will generally increase accessibility as well by making it easier to reach destinations. But it is possible to have good accessibility with poor mobility" and viceversa. For this reason a focus on mobility is not sufficient to guarantee the assessment of freedom level of a population: "Planning efforts that focus on enhancing accessibility have very different consequences than planning efforts that focus on enhancing mobility. To plan for mobility is to focus on the means without direct concern for the ends: can people move around with relative ease? The traditional emphasis on road building in the U.S. is consistent with a planning-for-mobility perspective in that the aim is to accommodate growing levels of travel and increase the potential for movement." A clear parallelism with both sennian and motility approaches is evident in Handy's words.

2.3.1 Low mobility as social exclusion?

In the tradition of social exclusion studies related to mobility an important effort has been put in the definition of the main individual characteristics impacting on the level of Mobility Capital. Taking into consideration the relations between this dimension with the others having an impact on the accessibility and mobility of individuals (social dimension and environmental dimension), specific attention has been given to gender issues and age issues. Elements that can impact on individual motility are for example gender and age. A broad set of works showed for example as the spatial range of women's daily mobility is smaller than men's, in relation for example to travels to and from workplace (e.g. Blumen and Kellerman 1990; Song Lee and McDonald 2003; Hanson and Johnston 1985; Hanson and Pratt 1991; Cristaldi 2005; and Schwanen, Dijst, and Dieleman 2002; Rosenbloom, 2006; Crane 2007). As Creswell and Uteng (2008) highlights, these differences are mainly due to the differentiated social roles attributed to males and females, able to shape their mobility behaviours through time and space constraints: "gender-differentiated roles related to familial maintenance activities

place a greater burden on women relative to men in fulfilling these roles resulting in significant differences in trip purpose, trip distance, transport mode and other aspects of travel behaviour (which includes different times, to different locations over different distances) (Erickson, 1977; Andrews, 1978; Hanson and Hanson, 1981; Howe and O'Connor, 1982; Fagnani, 1983; Fox, 1983; Pas, 1984). " (Creswell and Uteng, 2008, p.3).
Age as well has been, in particular recently, taken into specific consideration in the mobility and transport studies, due to the ageing process of contemporary developed countries (see e.g., Lanzieri, 2011; Rosenbloom, 2001). Active ageing (see next chapter) is probably the most relevant policy issue nowadays developed to address the needs of this part of the population, that usually suffers for the reduction in physical abilities to be mobile, for difficulties in performing efforts, withdrawal of driving licence, etc (Schwanen and Páez, 2010). Most of elders' difficulties in mobility are related to the spatial and technical characteristics of the transport system and its travelers (Norbakke, 2013): the findings suggest that the most common barriers to walking and using public transport are related to the built-up infrastructure (e.g., uneven pavements, high curbs and few benches), vehicle design (e.g., difficulties boarding), qualities of the public transport system (e.g., long distances to public transport stop, convoluted routes), anxiety about overcrowding and lack of seats, fear of traffic, potential accidents or conflicts with other road users, and fear of crime.
If, as highlighted also by Kaufmann (2002, p.58), a higher mobility does not correspond directly to a higher degree of freedom, "Mobility gives new freedom to those people who would not otherwise have any", but at the same time "a 'freer' mobility is often the sign of people having assigned the degree of freedom that they have to their mobility rather than to something else", in order to compensate for the lack of otherwise available opportunities. This could, as already affirmed, bring to a constrained mobility instead of a constrained lack of it.

2.4 Proximity as an important component of accessibility

The more subjective elements are the most difficult components of accessibility to be measured, cause of their variability linked to people *individual characteristics* (and the shades of them that can be detected) and to *their dynamic nature*, causing their diachronic variation (changes in preferences due to, for example, people's ageing processes) (Haugen, 2011).
Other kind of constraints are usually easier to be assessed, since rely on more objective properties (like distance and time), but their interpretation in terms of relevance and impact on people travel behaviour are often questioned and debated.
The basic way to define accessibility is, as already seen, founded on actors' distance detection from opportunities, or on the time needed to reach them. Under such a conceptualization, considering all the opportunities having the same value for individuals and the same level of utility, amenities located in proximity to

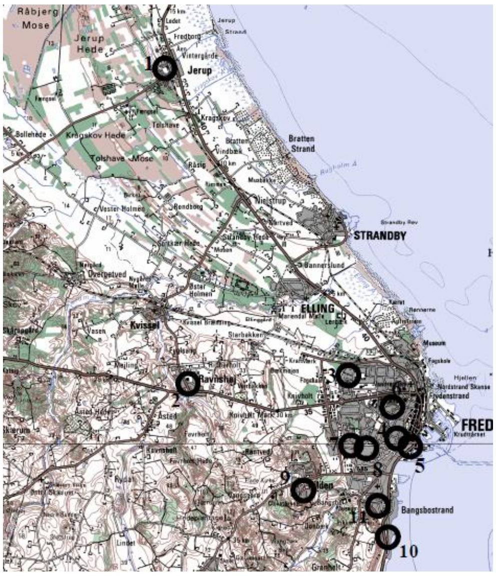
people's residence should be considered more accessible than others farer away. If it is clear that, as many authors highlight, "Proximity (or distance) is a component of place-based accessibility measures, but is on its own not a sufficient or universally relevant criterion for accessibility" (Haugen, 2011), since amenities vary in concentration, size and importance (in a world they have different levels of *attractiveness*), its relevance is anyway confirmed by several studies that have found distance to be an important explanatory variable (Prashker et al. 2008). Moreover, mobility itself has become a tool able to reduce more and more the distance friction, reducing the relevance, in terms of obstacles, of the distance in impacting the access to opportunities (Urry, 2000).
Such a phenomenon is also linked to the emergence of the consideration of mobility as a value in itself, pushing people to move just for the desire to do that (Mokhtarian & Salomon 2001, Jain & Lyons 2008), since mobility is valued as a proper end on its own and not just as a derived demand (as a mean to access other opportunities like conceptualized by the *activity-based* approach). This can be surely true for some specific situations and travels, like travelling for vacation or for biking or walking, and in general travels performed with non motorised means (Handy, 2005), due to the positivity linked to spending time travelling (enjoying nature and landscape for example or for the pleasure of the physical effort in itself). In these cases travel is by no means necessarily 'dead time that people always seek to minimize' (Sheller & Urry 2006, p. 213).
Proximity to opportunities can be considered anyway as an advantage for practical reasons (due to the absolute easiness to access it entails), and because mobility requires, as highlighted for example by Kenyon, Lyons, & Rafferty, (2002) and Cass, Shove, & Urry, (2005) but also by Haugen (2011), specific resources (personal vehicles, public transportation and transportation infrastructure) that are unevenly distributed across sub-groups (e.g., according to gender, age, economic prerequisites and disabilities), hence influencing their distance-bridging ability (Lynch 1981; Kaufmann, 2004; Knowles 2006). Proximity can in such a way work as a leverage to reduce the impact of individual differences on which inequalities in mobility opportunities are produced, eliminating the need to have access to specific prerequisites useful for the usage of means of transport, like driving license (this is the case of younger or older people), or given economic resources.
If mobility (in the case is considered as the amount of distance travelled) in fact can empower people behaviours and extend their set of choices (or *capabilities space* if adopting a sennian vocabulary, or level of *access* in a motility theoretical framework), it can also produce in some situations a reduction in the overall well-being. This is the case in which just one specific mean of transport (for example the car) allows isolated settlements to be connected to amenities' locations: mobility is increased, but the variety in mobility's choices is not given, producing an *imposed* mobility pattern (with all its externalities and potential negative effects e.g. in time allocation, physical issues,…).
An example of this kind of circumstances can be seen analyzing the findings of a recent research run in Sweden, addressing the different perception and evaluation

of proximity among Swedish population, and comparing subjective evaluations with objective and real behaviours (Haugen, 2011). The research addressed the individual satisfaction with the perceived accessibility of opportunities from their households, compared with the actual accessibility, and the overall satisfaction with their residential location. As a preliminary phase respondents were asked to define their *proximity preferences*, that means to indicate which opportunities they considered important to be close to. Controlling answers according to the residential location typology (rural or urban) a relevant divergence in priorities was found, highlighting the different conditions (in terms of motility) lived by those inhabitants: for rural dwellers the most important proximity opportunity was the petrol station, showing in this way a peculiar accessibility pattern, that we could define of *indirect* access to opportunities, since strictly dependent on the private motorised vehicle, that fundamentally mediates the relation with amenities. Urban dwellers highlighted the relevance of services and amenities: urban centre[12], grocery store, gym/sports centre, shopping centre and leisure/recreational area, showing indirectly the lower relevance of the mobility constraints.

Such a differential condition is not strictly a disadvantage (since the conversion factors of the spatial conditions can reduce their potential negativities), but it highlights potential negative constraints, due to the inequalities in potential accessible resources and their overall conversion ability.

Another study run in the town of Frederikshavn, Denmark, a small center of 35.000 inhabitants 60 km from Aalborg, the main city in the region, highlighted the relation between spatial localization of dwellers and travel behaviours (Naess et al., 2004), showing how spatial characteristics and structure of the settlements can impact on people's potential and actual mobility.

Fig. 4 – Location of the 11 residential areas considered in the study run by Naess and Jensen (2004). Scale approx. 1:110.000.



Source: Naess, Jensen, 2004, p.5

[12] Operationally defined as "various establishments and services not explicitly included in the survey: a relatively wide range of commercial facilities and public services" (Haugen, 2011, p.372).

The average amount of km travelled was showed to be directly correlated with the distance from the city center, adopted here as a measure of the differentiation of the built up structure of the households' residential areas[13]. Residents of more central (and denser or more accessible) neighbourhoods were found to travel less km by car, while more prone to the adoption of alternative (non-mothorised based) behaviours. Similar relations between spatial characteristics of the settlements and the travel choices or behaviours adopted by people have been found also in other studies (Chatman, 2009; Frank *et al.*, 2007; Salon, 2006; Schwanen and Mokhtarian, 2003; Schwanen and Mokhtarian, 2005a; Schwanen and Mokhtarian, 2005b; Cao, 2008; Zhou and Kockelman, 2008). Residential self-selection and socio-demographic variables were controlled for, in order to avoid a mis-interpretation of the results or the individuation of spurious effects (see Chapter 3.3.2 for further discussion on the issue).

The qualitative interviews run in the study confirmed the impressions given by the quantitative data, highlighting how important is to have a car when living far from the city center, where lower is the density of opportunities and amenities of interest, in order to perform the daily activities. Of course inhabitants of the central areas have always the possibility of travelling by car, but they don't **rely** on it like the residents of the suburbs: they, in this sense, have a greater *motility*, their space of capabilities in terms of mobility choices is larger. These people can, as already stated, rely on non-motorised means of transport, like biking and walking. By walk they can access a set of amenities or opportunities suburbanites inhabitants cannot access to in the same way, but only by car.

This case is clearly a peculiar one, and represents a very specific and paradigmatic model, for the particular characteristics in terms of size and spatial structure of the city and its surroundings, but we think it could be useful to stress the strong relation between accessibility and urbanity level.

2.4.1 Accessibility in urban sprawl literature

Other authors highlighted the role of accessibility to measure the degree (and in some cases implying also the quality) of urbanization and we would opt for such a position. In particular studies on the *urban sprawl* adopted accessibility as a leverage to distinguish between different kind of territories, according to the distribution of that property in space (Ewing, 1994; Sohn et al, 2012). Based on the consideration of urbanization as a spatial continuous process impacting on the

[13] Such a methodological choice of the independent variable has been made possible by the specific case study, characterized by the small size of the urban center and the consequent regular structure of its morphology: the urbanized area is highly compact and is not included into a policentered networked urban agglomeration. In this way it represents the monocentric reference core for the surroundings, all characterized by a low level of both density and attractiveness. A strong overlap and correspondence between centrality (distance from the city center) and the values of density and accessibility to service or shopping facilities were found in the authors' analysis. In the final regression model adopted, density and accessibility were not included due to the strong collinearity between those variables and *distance,* and to the greater r^2 derived from the inclusion of the latter in the model itself (r^2=0.19 with distance, r^2=0.17 with density or accessibility).

territory, sprawl is conceived as a complex phenomenon characterizing the nowadays development patterns of western urban areas, strictly linked to the suburbanization process and urban diffusion (cfr. Chapter 3). Sprawl has been defined in many different ways (Galster, 2001) and as a term "it has been attached to *patterns* of residential and non-residential land use, to the *process* of extending the reach of urbanized areas (UAs), to the *causes* of particular practices of land use, and to the *consequences* of those practices" (Galster, 2001, p.681), creating as a consequence a huge variety of methods for assessing and measuring it[14]. The main dimensions that are highlighted by researches and collected by Galster are:

- *density* (of population per built-up area),
- *continuity* (the degree of interruption of built-up land),
- *concentration* (the degree to which development is located disproportionately in relatively few square miles of the total UA rather than spread evenly throughout it),
- *clustering* (the degree to which development has been tightly bunched to minimize the amount of land in each square mile of developable land occupied by residential or non-residential uses),
- *centrality* (the level of closeness to concentrations of central urban functions),
- *nuclearity* (pattern of development of an urban area: monocentric vs policentric),
- *mixed uses* (variety of uses of the land) and
- *proximity* (degree of closeness between different land uses)

In accord with Ewing (1994) we think that accessibility could be adopted as an useful tool to include or take into considerations the effects of various different dimensions of sprawl:

> Ultimately, what distinguishes sprawl from alternative development patterns is poor accessibility of related land uses to one another. The concept of accessibility is central to urban economics (in simple models of urban form) and travel demand modeling (in gravity-type models of trip distribution) […] In scattered or leapfrog development, travelers and service providers must pass vacant land on their way from one developed use to another. In classic strip development, the consumer must pass other commercial uses (usually on crowded arterials) on the way to the desired destination. Of course, in low-density development, everything is far apart due to large private land holdings. This suggests that sprawl might be characterized generically as any development pattern with poor accessibility among related land uses. Poor accessibility may result from a failure to concentrate development and/or to mix land uses.
>
> (Ewing, 2008 (1994), p. 521)

As Ewing highlights, accessibility implies other dimensions, stressing the multidimensional nature of sprawl and urbanization processes. A higher level of accessibility can be found most probably when the highest co-presence of the

[14] Among the first and most complete see: Malpezzi, S. (1999), *Estimates of the Measurement and Determinants of Urban Sprawl in U.S. Metropolitan Areas*. Unpublished paper, University of Wisconsin, Madison Center for Urban Land Economics Research. And also: Burchell, Robert W., N. A. Shad, D. Listokin, H. Phillips, A. Downs, S. Siskin, J.S. Davis, T. Moore, D.Helton, M. Gall, and ECONorthwest, (1998), *Costs of Sprawl—Revisited.* Washington, DC: National Academy Press.

various elements listed is recorded: density (often accompanied by concentration and clustering), land use mix, built-up land continuity, centrality and proximity.

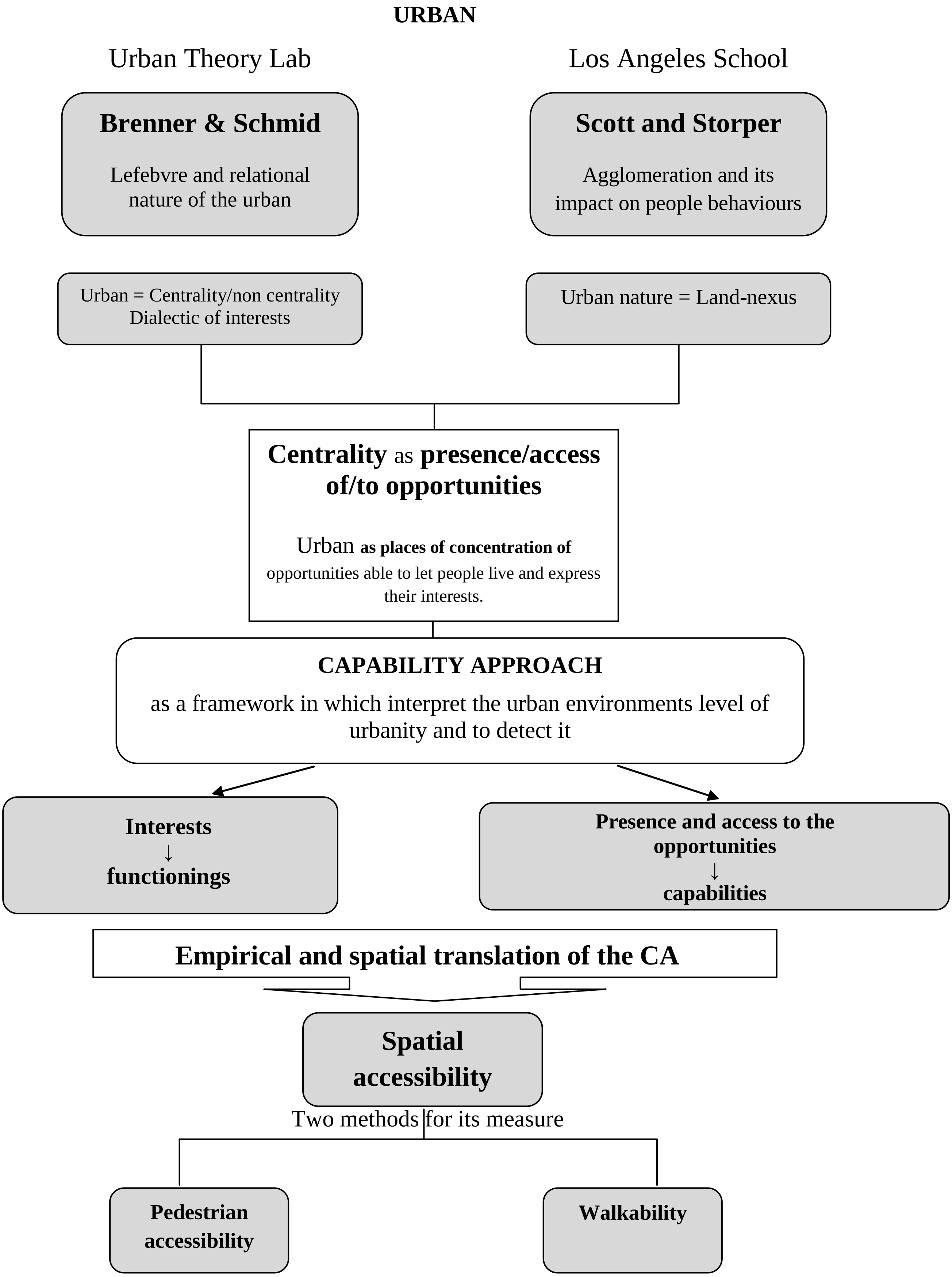
2.4.2 Pedestrian accessibility as a key for the detection urbanity

In our view pedestrian accessibility in particular could be considered as a tool for the definition of the urbanity of places. If the city realms nowadays have expanded on an always wider scope and territorial context, due also to the increased (physical and virtual) mobility potential allowing to reduce the distance and time frictions (Castells, 1996; Urry, 2000), did the generative elements of the *cityness* (what in the previous chapter we defined as *urbanity* generators) expand too? The answer could be both affirmative and negative. It is affirmative if we consider a high scale of spatial relationships, considering distances as not influencing that property: in this case the fact that places are virtually and physically reachable has the result of making elements generating urbanity close, since they are virtually contiguous. In this sense Wirth's elements able to distinguish city from other contexts (density, diversity and size) are seen under a different perspective, on a different territorial level: *density* has no more strong weight, and *variety* is ensured by the possible multiple connections allowed by mobility choices, while *size* is pretty much ensured by the extent of mobility potential area. But (1) such a view does shift the focus from places and spaces to individuals, since the mobility scope is strictly linked to the individual characteristics and mobility capacity, able to create this virtual closeness' condition, under a process-a-like view (cfr. chapter 1.3.2). (2) We would like to keep our definition of *urbanity* as a condition determined by living in *places* with a high density and variety of opportunities, since this allow to consider the phenomenon under a more human-scale level, that is accessible to the widest amount of people possible. Historically these places are the *sources* of that *urbanity,* then expanded and diffused anywhere through the physical embodiment of capitalist processes. We will thus conceive a context surely urban if really able to produce *urbanity* at the easiest conditions: only looking at a local scale this properties can be ensured at the maximum degree and for the widest range of population possible.

The concept of pedestrian accessibility has been investigated broadly in recent years (Zielstra & Hochmair, 2011; Tal & Handy, 2012; Achuthan, Titheridge, & Mackett, 2007; Olszewski & Wibowo, 2005; Aultman-Hall, Roorda, & Baetz, 1997), in particular in relation to the needs of a new course in planning policies for the enhancement of the places' quality of life (Tight, Kelly, Hodgson, & Page, 2004). It opened also the path to another specific field of studies, strictly related to it, and highly overlapping: the *walkability* studies. Walkability differs from accessibility for the major focus on the aspects enhancing the walking behaviour of people, relative to both physical aspects of the environment, their attractiveness, and subjective characteristics of the individuals and their perception of the physical elements of the environment itself. In this sense it

appears as a deeper and more comprehensive evaluation of the pedestrian accessibility of spaces. For this reason we will try to distinguish in our work the two, applying in the analytical section two different methods of urbanity evaluation: one based on a simpler measure of accessibility (already adopted in an our previous work on the topic, Colleoni, Caiello, 2013) and another one based on a more complex and detailed measure of *walkability* (see chapters 5-6-7 for their descriptions), even if our focus will be on the more objective aspects of that property.
We will give a general overview of the origins and role of walkability in the current scientific debate in the next chapter, in order to highlight its peculiarity.

Conceptual diagram
(updated)



Chapter 3

Walkability and pedestrian accessibility

Introduction

Walkability defines the property of a space to be live by pedestrian, encompassing dimensions like safety, cleanness, pleasure, access. For Southworth it "is the extent to which the built environment supports and encourages walking by providing for pedestrian comfort and safety, connecting people with varied destinations within a reasonable amount of time and effort, and offering visual interest in journeys throughout the network." (2005, p. 248) A walkable environment has been connected conceptually with specific properties, that are included implicitly in its nature. As Forsyth states (Forsyth et al, 2008) relevant and most common dyads are the following:

> **Walkable** as **close:** A walkable environment involves a short distance to a destination, particularly where driving is inconvenient or people are without cars—this is the perspective in transportation planning. This definition has a great deal to do with an individual's cost-benefits calculation—are the costs of driving or taking transit great enough to provoke an individual to walk?
> **Walkable** as **barrier-free:** A walkable environment is traversable, without major barriers. Walkability can be refined to mean traversable to children, elderly, handicapped or those wearing high heels.
> **Walkable** as **safe:** A walkable environment is safe in terms of perceived crime or perceived traffic.
> **Walkable** as **full of pedestrian infrastructure and destinations:** A walkable environment visibly displays full pedestrian infrastructure such as sidewalks or separated trails, marked pedestrian crossings, street furniture and street trees.

Walking is clearly the most common way to move, since it is a natural activity, and very close to the automatic actions of the human body (Solnit, 2000). It is considered one of the most affordable ways to access to daily opportunities, due to the lack of need of any particular (in "normal" conditions) tool or skill to be performed, and it is affirmed to be able to enhance healthy active behaviours. In the last researches it has also been highlighted to be sustainable for the city metabolism, contributing to the reduction of environmental damaging elements produced by motor-vehicle use and abuse, and to bring with itself economic value (both for savings in health expenses and for land value increase) (Moura et al, 2017). An important impact on community and social interactions patterns is also attributed by the literature to places where walking and more intense use of public space is found.

This chapter will offer an overview of the discussion about the main dimensions usually related to walkability and, on the one hand, the factors impacting on it, and, on the other hand, the potential effects produced by the presence of walkable spaces in the urban realm. Walkability can be considered in fact a lens through which measure the likeliness of urban spaces to be lived in an active an more, emotionally and socially, intense way, producing also a relevant set of positive externalities. Could it be intended as a tool to enhance urbanity of spaces?

We will present at first a picture of the current trends in mobility and related planning, considered the main causes of the decline of walking habits and of the attention to their protection, taking as reference contexts the United States, as the most representative example of them, and the European Union countries (with a focus on Italy when possible), because closer to our research case studies.

We will analyze deeper the relation between travel behaviours and Built environment characteristics, in order to better understand the impact of objective and subjective elements in modifying mobility choices.

A focus on the forms of institutionalization of the walkability discourse will be held in order to have a picture of its integration into policies on one side, and into planning professionals' discourses.

A specific look will be given to the literature debating the positive effects of more walkable spaces, in order to better assess the relevance they can have for environmental problems linked to car-dependent society, for the health issues due to sedentary life-styles and environmental pollution, and for the social improvement of neighbourhoods and community life.

Finally the debate on the economic impact of walkability will be presented, with a review of the most famous market services developed for the walkability assessment.

3.1 The rise of a research object

The attention to the pedestrian viability of urban spaces has risen in the last decades after a long period of carelessness. This new phase of interest is due principally to a global cultural shift, strictly linked to economic-connected reasons. Actually two different trends and study approaches of this phenomenon can be found (Beverlej and Zambotti, 2013): one emerged mainly in the anglosaxon and, in particular, in the North American countries, the other in the European context.

This is due to the differences in the territorial structures and in particular in the urbanization processes faced by the two macro-areas: the North American countries realized the need to reshape the way of designing urban spaces in the ‘60s, when the effects of the Urban Sprawl and of the car-dependent society, that had been created in the first decades after the second world war, started to be questioned, in particular those linked to the sedentary life style, joint-cause of the health issues increase in the population.

On the European side, the issue of rethinking the urban spaces as more human-scaled environments was mainly due to the increasing sensitivity to environmental preservation necessity and the need to face the energy crisis exploded in the ‘70s. It was also the beginning in the Old Continent of the sprawl process that, with some delay, and also different evolution patterns, if compared to the US one, started to impact on its territory.

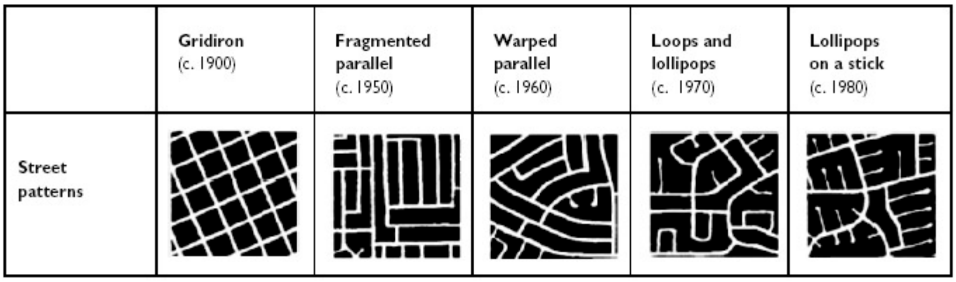
In general the urban planning behaviour of the years before the ‘70s has been mainly focused on a car-centered philosophy, both fueled by and producer of a fast growing economic development. Since the first engine in this kind of tendency has its origins in the United States, a focus must be done in particular on that context, in order to address the causes of decline of the walking activity and its consequences.

3.2 The suburbanization: origins and characteristics

First suburbs were born in England, around London and Manchester, in the XVIII century in order to allow merchant families to separate the house from their economic activity. This was a first product of the industrial revolution and of the birth of the modern Bourgeoisie class: the separation between workplace and home brought to the need of looking for a new settlement for the family, different from the former. Based on a cultural vision of the modern city as a place of noise, sin and dangers, the choice fall on extra-urban areas, where the possibility to enjoy the greenery of the environment was accompanied by the finding of a safe place. The new residences embodied the reproduction of the nobles’ houses and manors located traditionally in the countryside (Fishman, 1987), but with a strong and relevant difference: noble manors were structured as (functionally) independent settlements, including also local production activities (carried by employees), while that was not the case for the bourgeoisie choosing those places

as new home, locating and bringing in those environments just residential functions.
Such a phenomenon was not carried out in a planned manner, since it consisted, at that beginning, in a spontaneous tendency, stimulated by class belonging behaviours. The suburbanization was then carried out in USA and all the anglosaxon countries, characterizing from that moment on the planning model of urban centers.
As highlighted by Forsyth and Southworth (2008, p.1), "Street patterns of most residential areas in the US built after 1950 (and emulated in new development worldwide) are based on the discontinuous cul-de-sac or loop pattern rather than the interconnected grid".

Fig. 5- Evolution of street patterns since 1900 showing gradual adaptation to the car



Source: Southworth, 1997.

This generated a structure of buildings' blocks in which the size was "too large to permit a range of route choices and land use patterns are coarse with activities widely spaced and segregated by type" (*ibidem*). For this reason streets became over-scaled, sometimes lacking of sidewalks, in order to reduce construction and maintenance costs, as well as pedestrian interconnections, able to increase walking mobility behaviours.

The end of the *golden era* of the walking in the US is strictly linked to this change in the residential structure of the American population: in 1970 the US Census certifies that the most part of the national population was a suburban inhabitant (Solnit, 2000). A recent study by Angel et al. (2011) shows how the level of density in many American cities had progressively decreased for the whole 20th century: the study covers a period going from 1910 to 2000 and collect data on 20 cities, showing that all of them (except for Los Angeles) experienced the highest level of density at the beginning of the data collection. Los Angeles, as highlighted elsewhere by Soja (2010), is an *unicum*, recording the highest, nowadays, level of density of all the country (just few points lower than New York), and increasing too. The decline in density has slowed in the last years, due probably to physical constraints, bringing anyway to a situation in which the densities of all the cities considered are very close and similar, showing a clear convergence in the urbanization patterns.
A parallel trend has been shown to have a similar structure, but not homogenously for all the cities: the transit sustaining area change rate. It describes the change in the amount of land that can host and support a transportation system (due to a

population density of more than 30 persons per ha). Even if this metric is not really reliable due to the change in time in the population density able to sustain a transportation system, it allows to understand the relevance of the density change, and somehow its distribution differences in the territory. In 2000 only 27.3% of the 20 cities studied was settled in a transit-sustaining area.

3.2.1 Urban Sprawl and car-dependent society

The sprawl phenomenon was clearly pushed and accompanied by the increased level of motorization of the households: suburban planning, engine of the consequently suburban culture, was strictly linked to the car-dependent society consolidation.
The car dependence can be detected looking at the increase in traffic jam issues. As reported by Langdon: “According to the Texas Transportation Institute, the number of urban areas suffering from serious traffic congestion grew from ten in 1982 to eighteen in 1988. The greater the population or jobs growth in a metropolitan area, the worse the traffic congestion became. The average speed on freeways in the Los Angeles area has fallen precipitously in recent years, and paralysis is being predicted on many important commuter routes.” (Langdon, 1997, p.175).
The issue was not reduced years later, and still today it represents a key problem for urban areas in America. As the TTI reports in 2011:

> In 2010, congestion caused urban Americans to travel 4.8 billion hours more and to purchase an extra 1.9 billion gallons of fuel for a congestion cost of $101 billion. […] Prior to the economy slowing, just 4 years ago, congestion levels were much higher than a decade ago. (p. 29)

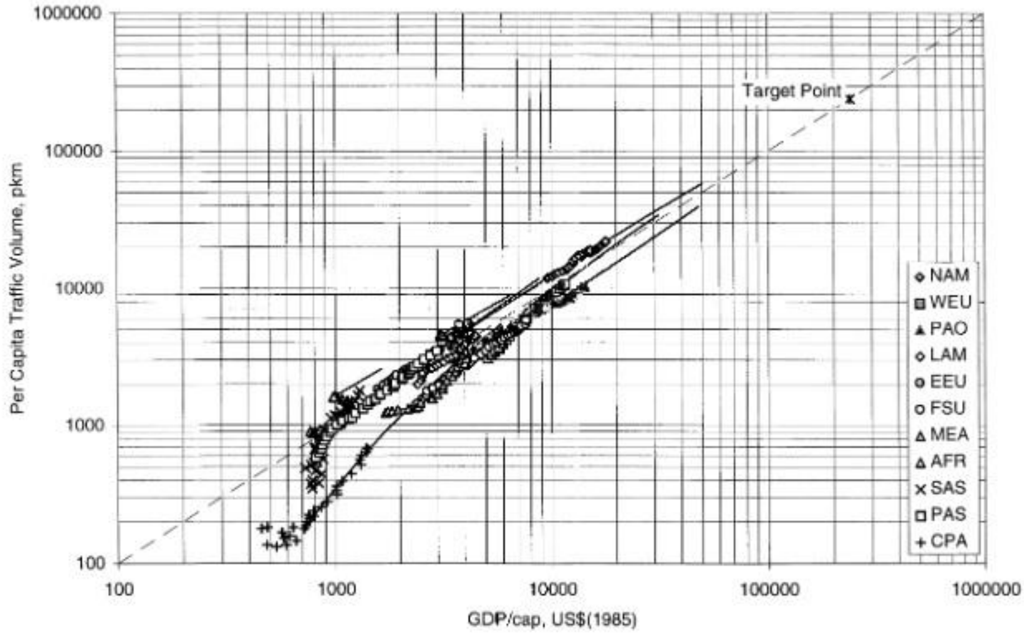
Americans travel extra hours today 5 times more than in the 80s, waste almost 5 times more fuel and 5 times more economic resources for commuting by car. And this trend occurred even despite of the increase in public transport investments, and policies, that were able to reduce the overall costs due to the congestion. The effect was clearly bigger in large urban areas, due to the higher efficiency of public transportation systems.
Only in 2008 a general traffic reduction took place, due to the effects of the financial crisis, but the institute estimated an increase in the following years as soon as the economy would have recovered[15].

The growth of traffic volume per capita is common to all the world areas, even if with different trends and structure in the modal share composition. As Schafer et al highlight, this is due to the increase of country’s GDP: a direct and positive correlation is shown by data, with all the countries considered in the study converging towards a common volume amount (

Fig. 6 and Tab. 2).

[15] Economic crisis produces a reduction of resources to be used for travelling and also of purposes of moving: job loss, reduction of leisure activities, good purchasing, etc…

Fig. 6 - Scenario for mobility and income for 11 regions, 1991±2050. A hypothetical ``target point'', to which all trajectories converge, is shown. For comparison, historical data (1960±1990) are shown with symbols.



Source: A. Schafer, D.G. Victor (2000), p.180.

Tab. 2 - Per-capita and total mobility for 11 regions (and share of global total) in 1960, 1990, 2020, and 2050 for the reference scenario.

	1960			1990			2020			2050		
	Absolute			Absolute			Absolute			Absolute		
	pkm/ cap	bill. pkm	%world	pkm/ cap	bill. pkm	%world	pkm/ cap	bill. pkm	%world	pkm/ cap	bill. pkm	%world
NAM	11,854	2384	43.5	22,078	6193	26.7	40,432	13,929	25.9	58,149	21,073	20.0
WEU	3074	1106	20.2	10,622	4696	20.2	20,819	10,116	18.8	34,022	16,827	16.0
PAO	3025	323	5.9	10,294	1482	6.4	24,307	3787	7.0	39,559	5859	5.6
IND	4400	3813	69.6	14,276	12,372	53.3	28,221	27,832	51.8	43,537	43,759	41.5
EEU	1824	181	3.3	5389	666	2.9	6913	915	1.7	11,640	1642	1.6
FSU	1419	295	5.4	5796	1631	7.0	8207	2887	5.4	13,672	5396	5.1
REF	1550	477	8.7	5672	2297	9.9	7853	3802	7.1	13,137	7039	6.7
MEA	1222	140	2.6	4546	1244	5.4	5976	3440	6.4	8800	8134	7.7
AFR	898	193	3.5	1614	811	3.5	1862	2014	3.7	2573	4466	4.2
CPA	152	109	2.0	637	805	3.5	1810	3102	5.8	5464	10,842	10.3
SAS	349	200	3.7	1778	2015	8.7	3008	5357	10.0	5952	13,578	12.9
PAS	587	125	2.3	3470	1459	6.3	5896	3664	6.8	11,665	8755	8.3
LAM	1980	424	7.7	5094	2228	9.6	6722	4536	8.4	10,459	8771	8.3
LDC	582	1191	21.7	2125	8562	36.9	3429	22,113	41.1	6406	54,545	51.8
WOR	1814	5481	100.0	4382	23,231	100.0	6787	53,747	100.0	10,476	105,343	100.0

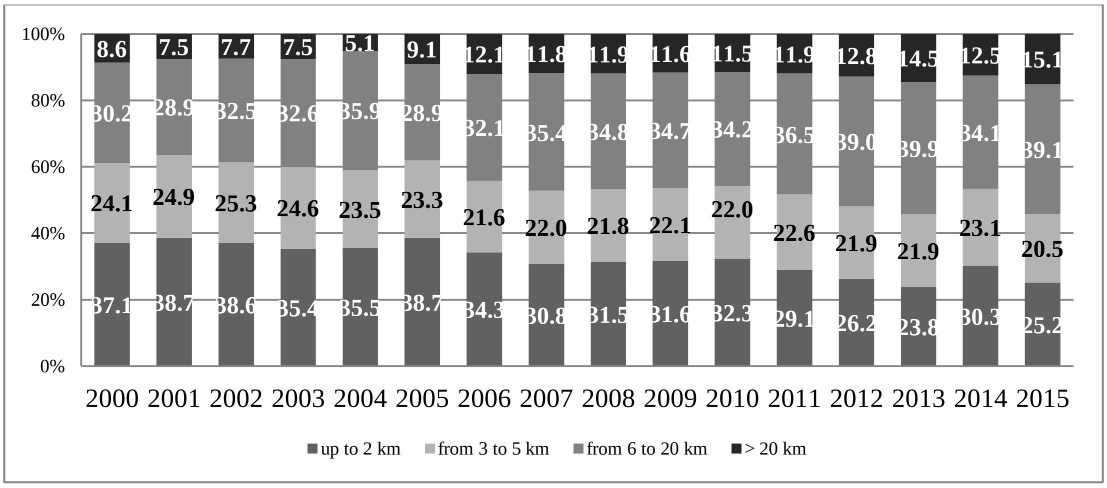
Source: A. Schafer, D.G. Victor (2000), p.184.
Industrialised regions: NAM (North America), WEU (Western Europe) PAO (Pacific OECD), IND (*Average Industrialised countries)*.
EEU (Central Eastern Europe), FSU (Former Soviet Union), REF (*Average Reforming Regions*).
MEA (Middle East North Africa), AFR (Sub Saharan Africa), CPA (Centrally Planned Asia), SAS (South Asia), PAS (Other Pacific Asia), LAM (Latin America), LDC (Low Developed Countries).
WOR (*Word Average*).

3.2.2 The mobility trends in Italy

What seems to be clear from these figures is that the appearance of the automobile and its widespread has not freed people from travelling but, on the contrary, has just increased the distances possible and actually travelled.

In Italy from 2001 to 2008 the km run per person every day increased from 26,5 to 38 (ISFORT). As well as in US the economic crisis effect reduced its amount to 32,4 in 2011, but a new increasing trend is recorded since then (in 2013 it reached the 38,7). The center of the country, the North-East and South and Islands record the highest values equal or above 40km in 2013. A parallel decrease is found in the walking behaviour, gone from the 23,3% in 2001 to 16,3% in 2011, and it is still decreasing.
Moreover, a small increment in the share as a modal choice of the public transports (from 8,8% to 10,9%) is counteracted by a bigger growth in the car use (59% to 65,8%).This is due to the relation between distance to be covered and convenience perceived: public transports are able to reduce car appeal only for trips longer than 20km (probably in this case the regional railway system starts to be considered in the mobility modal choice). Percentage of trips for length is growing for travels above 20km of distance, while decreases the proportion of movements for shorter displacements: the highest reduction is now reached by local trips (below 2 km) decreased from 38,7% to 29,1% of the total movements in 2011, but the trend is changing in the very last years, due to a slightly increase in local trips (up to 25,2%).

Graph 1- percentage of travels for length (years 2000-2015), whole Italy.



Source: Isfort, 2015, p.11.

What is interesting in the Italian data is that the amount of systematic movements is decreasing in a relevant degree (8 percentage points from 56,6% to 48,2% between 2001 and 2011) counteracted by an increase in the occasional trips of almost 9 percentage points (from 29,8 to 38,1%), these usually made by car. What can be inferred is that, if the km and distances have increased in this period, the time spent for travelling on average has not increased between 2001 and 2011. It appears as the higher efficiency in transports is not linked to a reduction of the time allocated for trip purposes, but instead it produced a widening and expansion of the spaces covered by them. Time is not freed from mobility, but it is still allocated for the same purpose[16]. The same trend is recorder in other countries (Schäfer, 2007), fact followed by a demand for faster means of transport (e.g. high speed trains or airplane connections also for short-distance travels), that are usually more polluting and energy-consuming.

[16] This is also due to the adjustments made by society as a response to the increased efficiency and speed of transports: occupying more space/land and increasing as a consequence distances to be covered (TERM, 2016).

3.3 Walkability and active mobility as strategies to change current trends?

If a trend such the one showed just above will continue in the next years, it could bring to important concerns about general environmental issues since the Bureau of Census estimated an increase of 100 million inhabitants by the 2050, whose settlement choices and so consuming footprint will determine the future of energetic impact of American population. It’s enough to think that the gas emission due to transports are the 30% of the total emissions of the country, among these 62% is due to private cars or motorbikes (U.S Census Bureau, 2004). In order to face the risks due to a similar evolution a different planning pattern should be considered, able to impact on such a share.
Some critiques have also been risen towards these kinds of alarms, contesting that the technological development of transports would contribute in the future to drop down the environmental externalities of motorized traffic. What was progressively counterposed is a different view: changes in planning habits would produce broader positive effects, and co-benefits like healthy behaviours’ spreading and social improvements in the public space management.

3.3.1 The need to rethink the role of public space

The relation between human beings and environment is at the core of the Urban Studies as natural, but in particular urban design has been always interested in this scientific field. Walkability studies, being focused on the aim to analyse the propensity of space to be suitable for pedestrian use, are clearly inserted in this tradition.
The first observations referred to modern cities’ problems and their new way of develop living spaces came from pioneering authors like Jane Jacobs, who, in the ‘60s, stressed the need to rethink urban space in a more human-being focused way. The first studies are strictly linked to critical analysis of what *public space* is intended to be, since, due to the great transformation already cited, those environments as experienced before were progressively disappearing in favor of a complete different conceptualization of them. The sprawl and car-dependence culture had in fact transformed spaces not occupied by buildings, what was left as residual space (Solnit, 2000), in simple passing-by areas, designed especially for cars, restricting them to just one use and so to a smaller group of users, producing a progressive specific form of social exclusion. Mono-functional spaces could then be lived otherwise just breaking the common rules and forcing a re-appropriation of the public environment.

3.3.2 Built Environment as a contributor of mobility behaviours patterns

The role of design and of Built Environment has been studied since long time. Travel Behaviour studies in particular focused the attention on the relation between mobility behaviours and spatial characteristics of the environment in order to measure the impact that the last can have on the travel choices of people. This is clearly important when it comes to decide which models of planning and development are to be implemented in order to modify in a virtuous way people behaviours and life-styles linked to travelling and mobility issues.

Environmental Psychology and Urban Design had focused since the ‘70s on dimensions not just belonging to physical aspects of environment but also on the perception of them experienced by people, that is shaped by many different factors, partly linked to the socio-demographic characteristics of people themselves and partly by the social environment and culture in which they act.

Taking into consideration many different dimensions has broaden the scope and complexity of research on travel choices, overcoming the limits implicit in the tradition of *Utility Maximization* approach carried by McFadden (1974) and the following authors belonging to that school, who elaborated models excluding subjective attitudes, providing a wide set of empirical results.

The main indicator of mobility habits adopted in the literature on Travel Behaviour are VMT (vehicle miles traveled), a measure of the magnitude of miles travelled by a subject by motorised transportation modes. The aim of the researches is usually to understand the role of Built Environment elements in impacting on this measure. Among the others, studies found that higher density and better access to transit are usually linked to fewer VMT (Holtzclaw, 1994), the same happens in more pedestrian friendly neighbourhood (1000 Friends of Oregon, 1993). This is particularly true if neighbourhood of traditional structure (compact) are confronted with suburban ones: the total trips result to be less, and higher the use of transit and the pedestrian travels recorded (McNally & Kulkarni, 1997). Time spent on travelling by public means is also 2/3 times more per person comparing different kinds of neighbourhoods (compacts vs sprawled) according to a study carried by Ewing et al. in Palm Beach County, Florida (1994). A more complete site design (more mixed-use) with better sidewalks and street crossing is also found to be correlated to a higher pedestrian activity (Hess et al., 1999). These findings support the idea that a more walkable urban space can produce a lower amount of traffic and as a consequence, improve the living experience of inhabitants.

The self-selection bias

The relation between Built Environment (BE from now on) and Travel Behaviour (TB) has been questioned in terms of causal relationship recently: the main issue is linked to the so called *self-selection bias* in the studies on the topic (Litman, 2005). It is argued in fact that the differences in behaviours between people living in more or less walkable neighbourhoods could be due to their personal attitudes and preferences toward mobility practice, that is reflected in their residential choices. The conclusions of such a reasoning is that the relation found between BE and TB would be spurious, if not faulted by this property (personal attitudes and preferences).

Describing this relation between BE and TB with a function (Cao et al., 2009):

$TB = f(BE,X)+\varepsilon$

where TB=travel behaviour, BE=built environment, X=set of other variables and factors, ε=error (correlation of BE and X with other factors not considered).

Critiques assert that X variables are at the base of the main changes in Y, despite the characteristics of BE.

Studies on residential selection measurement generally agree on the fact that, if a part of the BE effect on travel behaviour can be attributed to the spurious relations, there is also a *pure* BE effect, that varies from study to study, and, according to the different approaches applied (in Cao et al.), different ones are identified.

Looking at the literature on the topic, some researches state that BE effect is stronger than other factors' one (Chatman, 2009; Frank *et al.*, 2007; Salon, 2006; Schwanen and Mokhtarian, 2003; Schwanen and Mokhtarian, 2005a; Schwanen and Mokhtarian, 2005b; Cao, 2008), while others affirm the opposite (Kitamura *et al.*, 1997; Bagley and Mokhtarian, 2002).

Even when a measure of this effect is computed, the variance of combined effect of BE on TB is very wide, from 0,52 (Salon, 2006) to 0,90 (Zhou and Kockelman, 2008).

It seems that empirical results partially confirm the expected relation between space and behaviour, even if many variations in strength and direction exist and are due to 1) the specific case studies' variety, 2) the research design characteristics, 3) the data adopted and operational definition of the property studied.

Assessing and measure the causal relation between the BE (as more or less walkable) and TB (reduction of motor vehicle usage) is not the strict aim of this work, and for this reason we accept as a fact just the existence of a correlation between them, conscious of the difficulty and complexity of such an argument.

The different purposes of the trips can be another relevant dimension to be considered, since they can be affected in different degrees and ways by the physical properties of the environment: travels for leisure and for work have different elasticity values, being the first higher than the second, and bringing it to be more modifiable according to the characteristics of the space (Cerin et al., 2006).

3.3.3 Individual characteristics and beliefs and Travel Behaviour

Among the various elements considerable the characteristics of the pedestrians (age, gender, sex, disability) and also cultural aspects can impact.

Theory of Planned Behaviour, developed by Ajzen, based on the earlier Theory of Reasoned Action developed by Ajzen and Fishbein (Ajzen 1988; Ajzen 1991; Montano and Kasprzyk, 2002), has stressed these aspects, highlighting the role of beliefs in the production of TB. According to this approach three kinds of beliefs can be defined: a) behavior beliefs, b) normative beliefs, c) and control beliefs. These factors respectively influence attitudes, subjective norms, and perceived behavioral control (Handy, 2005):

a. **Behavioral beliefs** are beliefs about the likelihood of possible outcomes of a behavior; attitudes about a behavior are so determined by behavioral beliefs about each possible outcome weighted by the individual's evaluation of those outcomes, whether positive or negative.
b. **Normative beliefs** are beliefs about whether important referent individuals (e.g., a friend, partner, parent, or boss) approve or disapprove of performing the behavior; subjective norms about behaviours depend on normative beliefs for different referent individuals weighted by an individual's motivation to comply with those referent individuals.
c. **Control beliefs** are beliefs about the likelihood of possible factors that could facilitate or obstacle a behavior; perceived behavioral control depends on control beliefs for different factors weighted by the perceived power of each factor to facilitate or inhibit the behavior.

Environment comes into consideration just for the third kind of beliefs, where, among the possible elements able to intervene in the planned behaviour there are: sidewalks existence or conditions, traffic level of the road, etc…

The image so is much more complex. Individual perception can change in a relevant manner "objective" highly pedestrian environments: Gebel, Bauman, Sugiyama, and Owen (2011) developed a study aimed to check whether people's perception of the environment as more or less suitable for walking, once considered the objective level of walkability, was able to impact on their behaviour significantly. They found that, in a general framework in which, compared to a past survey, the walking behaviour had decreased: "those who perceived objectively measured high walkability as low, decreased their walking for transport significantly more than those whose perception matched the objective measure ($b= -55.7$, $p<0.001$). The same applies to misperceptions of dwelling density and land use mix." (p.521).

An important factor in modifying this perception effect can be played as guessed by other authors by the *self-efficacy* of beliefs (Bandura, 1986), expressed as "[…] people's sense of personal efficacy to exercise some control over events that affects their lives.". Self confidence in the possibility to overcome the potential obstacles is for this reason extremely important.

What is clear is that the elements shaping the travel behaviour are numerous and impact at different levels. Among the various study traditions we would like to cite also Social Cognitive Theory (King, Stokols et al. 2002; Sallis and Owen 2002), that developed a synthetic framework in which summarizes these dimensions and scales: a) intrapersonal level, b) the interpersonal level (social environment and social norms), and c) the community level of influence (physical aspects of the environment).

What emerges from this review is that built environment alone is not enough to define the active travel behaviour of people, but it has although an important influence on it and can enhance those kind of behaviours (Handy, 2005, Naess, 2005).

3.4 Institutionalization of the active travel behaviours discourse

The relevance to put attention on the environmental and urban design elements in order to face the risks linked to the suburban life style and car dependent society was acknowledged and appropriated by the public institutions in the second half of the XX century, in particular in the US where the effects of the dominant planning tradition were stronger.

Already in the '70s John Fruin (1971) developed a pedestrian spaces' measurement system (based on the European debate on the walking in the public space), focusing on the need to transform and conceive the street not just as a passing-by place and a flow space but as a social environment. The work listed a series of dimensions to be considered in order to build up an urban environment more suitable for walking activity, acting on: stairs design, ramps, parking location, distances from travel system stops, transit stations design,…

But the change was not immediate and in the late '90s there were still low levels of awareness about the actual needs of pedestrians among public institutions.

In its guidelines for 2004, AASHTO[17], defined for US new design rules and standards in order to avoid the dangers for pedestrians: land use zoning, parking requirements, …,often forbidding roads to pedestrians (Shoup 2005, p. 58, Levine 2006), with the result of creating environments mainly car-oriented, out of human scale and characterized by prohibitively long walking distances between destinations. A strong idea of separation between users and not one of integration was dominant.

Anyway, on a parallel course, from 2000 the consideration of the Level *of Service* (LOS) for pedestrians, given by the street structure, was inserted in the Highway Capacity Manual[18], where strong were the influences derived by John Fruin's work of 1971, and new rules, limits and requirements for built environment characteristics narrowed on pedestrians started to be included in planning decisions. LOS is intended in planning literature and language as a measure to determine the quality of street functioning, due to the density, speed, magnitude, etc of traffic flows. Originally designed for motor-vehicles traffic it had been translated more recently to assess the needs and condition of weak street users like pedestrians and bicyclists in order to include a wider scope of actors and obtain a more complete image of street conditions.

The Highway Capacity Manual anyway showed also some limits: it did not consider the framework in which sidewalks were located, and for example conceived busy spaces as negative elements, when, as otherwise stated by the literature, a busy space means a place rich of encounters and life. And it also limited the elements relevant for pedestrians to the sidewalks, being them the predetermined places in which walking activity was considered to have to take place.

[17] American Association of State Highway and Transportation Officials, organism working for the coordination of the US states' Transportation Departments.

[18] Published since 1950 almost regularly every 10 years by the National Academy of Science and its Transportation Research Board, a global reference for the field, it measures the quality of US streets infrastructures and their use.

More recently experiences of innovation of LOS’s standards appeared: the New York City Department of City Planning (2006) further adjusted the HCM pedestrian LOS standards to incorporate personal characteristics such as gender, age, person size, distraction (like talking on a cell phone), group size, and trip purpose.

3.4.1 New Urbanism

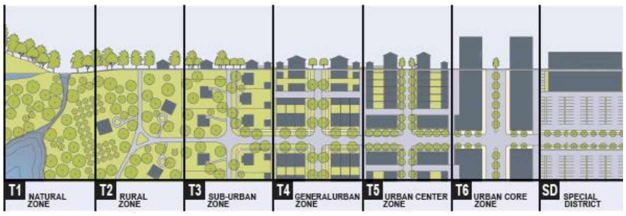
The new sensitivity to pedestrian and other weak street users’ needs has been boosted by the diffusion of a new planning paradigm and philosophy, that made the fight against the suburbanization and sprawl process, and the planning culture they conveyed, its main objective: the New Urbanism.
New Urbanism can be considered a planning school born in the 80s, upon earlier work of neighborhood designers such as Clarence Perry to emphasize the transportation and physical design aspects of urban communities as a predicate of walkability, in addition to seeing walking as a predicate to sense of place. Authors, architects and designers such as Peter Calthorpe, Andrés Duany, Elizabeth Plater-Zyberk, Stefanos Polyzoides, Elizabeth Moule, and Dan Solomon adopted New Urbanist principles to design transit-oriented developments or neo-traditional neighborhoods.
Their goal to propose a more sustainable development orientation, is strongly rooted in the purpose of revitalizing the characteristics of traditional development, typical of the beginning of 20th century American cities, in order to enhance the community life and dynamism through a more enjoyable neighbourhood design.
These neighborhoods provided *design clues* to reinforce the goals of traffic calming, transit ridership and pedestrian activity, rather than simply relying upon altruism and legal traffic signs for these purposes. Significantly, many of the designs were defined in form-based codes that dictate various aspects of the street design and building form, while providing flexibility and diversity in land use (Calthorpe 1993, p. 17; Southworth 2005,p. 249; Schmitz and Scully 2006, p. 16). With the codification of their principles in alternative land-use rules, the New Urbanists challenge the prior pedestrian performance metrics and their consequent discourse. One of the main products of the movement, that created a sort of trademark in planning projects, is the SmartCode (2003), a planning guide in which the principles of new Urbanism and Smart Growth merged, based on the *Transect Zones* scheme. Developed by A.Duany (2000), the Transect model consists in a panning methodology whose aim is to differentiate between 6 different kinds of planning patterns (see BOX1), located conceptually along a rural to urban *continuum* in which each zone is developed without a specific functional destination, avoiding the euclidean model (based on the functional differentiation of the areas).

The criteria at the base of the zones distinction are the density level, the presence of natural elements, the shape and height of buildings, etc… bringing to a six area model.

It's important to stress that the discourse of the New Urbanism movement has been strongly criticized by scholars highlighting the various contradictions found between their theses and the actual implementation of *Neo-traditional* settlements. A strong ideological imprint in fact is attributed to the NU philosophy, where an aesthetic revival of the traditional architectural style of towns seems to be the principal core of the projects, with low success in addressing the other usual objectives of the movement (accessibility, specifically pedestrian). Focusing on specific examples of NU projects implementation, authors (see Southworth, 1997) showed that sometimes, this is the case of Kentlands, Maryland, and Laguna West, California, distances are still too big to push people to walk, since the traditional structure of the suburban neighbourhood is still strongly present. The market providers had succeed in locating the mall in a separated area obliging people to use the car: only recreational walking is encouraged and public transit is also not frequent. The author states:

Box 1

The 6 *Transect Zones* according to the SmartCode (v. 9.2)



A Typical Rural-Urban Transect, with Transect Zones

• **T-1 Natural Zone** consists of lands approximating or reverting to a wilderness condition, including lands unsuitable for settlement due to topography, hydrology or vegetation.
• **T-2 Rural Zone** consists of sparsely settled lands in open or cultivated state. These include woodland, agricultural land, grassland, and irrigable desert Typical buildings are farmhouses, agricultural buildings, cabins, and villas.
• **T-3 Sub-Urban Zone** consists of low density residential areas, adjacent to higher zones that some mixed use. Home occupations and outbuildings are allowed. Planting is naturalistic and setbacks are relatively deep. Blocks may be large and the roads irregular to accommodate natural conditions.
• **T-4 General Urban Zone** consists of a mixed use but primarily residential urban fabric. It may have a wide range of building types: single, sideyard, and rowhouses. Setbacks and landscaping are variable. Streets with curbs and sidewalks define medium-sized blocks.
• **T-5 Urban Center Zone** consists of higher density mixed use building that accommodate retail, offices, rowhouses and apartments. It has a tight network of streets, with wide sidewalks, steady street tree planting and buildings set close to the sidewalks.
• **T-6 Urban Core Zone** consists of the highest density and height, with the greatest variety of uses, and civic buildings of regional importance. It may have larger blocks; streets have steady street tree planting and buildings set close to the wide sidewalks. Typically only large towns and cities have an Urban Core Zone.

> "There is little urbanity in the New Urbanism. Like the other suburbs the neotraditional models are essentially anti-urban, sanitized versions of the small town, and they exclude much of what it takes to make a metropolitan region work. Real towns must do much more than house middle-income people; they usually include housing for the less well-off, as well as commercial and industrial space, cemetery, waste disposal sites and many other uses that planned suburbs systematically exclude" […] "The tendency has been for designers to superimpose an image on a development […] providing a scenographic setting

that is fixed and unchangeable and that occupants and users cannot shape over time" (Southworth, 1997, p.43)

Other authors highlighted the difficulty in applying all the principles proposed by the movement, probably due to the resistances coming from the final developers, at least in the Canadian context where these issues were highlighted. While the quality of the design, attractiveness of places and walkability have been enhanced, they have had less success in establishing viable commercial districts, increasing urban densities, providing affordable housing, or reducing reliance on automobiles (Grant & Bohdanow, 2008).

Opinions on the real effect of NU projects differ hugely, according also on the specific cases considered. Any would be finally the judge on the actual implementation of NU, it has been a rich source of debate on urban design and planning approaches: beside NU in fact new concepts of *Smart Growth* and *Transit Oriented Design* were born and widespread into the academic debate.

3.4.2 Smart Growth

Founded in 1996 the Smart Growth Network, constituted by public and private institutions, works to encourage a development able to balance economy, community and the environment, in order to contrast the negative effects of sprawl and of the traditional development approach, based on land consumption and automobile dependence. It functions as a discussion forum for "raising public awareness of how growth can improve community quality of life; Promoting smart growth best practices; Developing and sharing information, innovative policies, tools and ideas and Cultivating strategies to address barriers to, and advance opportunities for, smart growth" (SGN website). It has been gaining increasingly attention in the years, being promoted also by the EPA (Environmental Protection Agency) in the USA, that established a national award (National Award for Smart Growth Achievement) from 2002 and 2015, aimed at recognizing the efforts made by local communities towards the achievement of SG objectives and sustainability.
As can be seen the purposes and mission mainly overlap with the NU ones: this is particularly evident looking at the SG principles:

- Mix land uses
- Take advantage of compact building design
- Create a range of housing opportunities and choices
- Create walkable neighbourhoods
- Foster distinctive, attractive communities with a strong sense of place
- Preserve open space, farmland, natural beauty, and critical environmental areas
- Strengthen and direct development towards existing communities
- Provide a variety of transportation choices
- Make development decisions predictable, fair, and cost effective
- Encourage community and stakeholder collaboration in development decisions

SG can be considered the material tool through which the aims of New Urbanism are pursued: walkability, mix land use, density and compactness, reduction of car dependence, are all elements common to both the concepts.

3.4.3 Transit-Oriented Development

Both New Urbanism and Smart Growth are strictly linked to another recently debated concept, since they develop common elements that are base for its possibility to be implemented: Transit Oriented Development. The increase in accessibility and density, are in fact commonly considered elements able to empower, or at least to contribute to enhance, the viability of public transportation systems and the travel behaviours alternative to cars (Ewing, Cervero, 2010). Transit-oriented development, or TOD, is a term used to define a type of development that occurs around transit nodes (usually train stations), and results in a compact, mixed use, pedestrian oriented type of neighborhood. It also offers a mechanism to create efficient communities, and provides a choice for development with a lower carbon foot print than traditional development.

Density is in fact the base for a supportive transit demand, and it allows at the same time a potentially easier access to transportation system, due to the reduction of distances to stops. If properly enhanced, walkability is the key to make the access real and consistent, promoting in this way also a more sustainable and healthy life style.

3.4.4 Pedestrian plans

3.4.4.1 Pedestrians in the US context

The first effort in acknowledging the role and valuing the position of pedestrians in the urban realm from a planning point of view has been (as already cited above) John Fruin, who in the 1971 published what would have been a landmark in the literature on the issue. A renovated emphasis is put on walking as a fundamental element of urban experience:

> Walking has been interwoven into all aspects of human development. The first cities were organized to concentrate the means of survival within a convenient walking distance. Even in the mechanized society of today, walking is the primary means of internal movement within cities. It is the only means of attaining the necessary face-to-face interaction involved in all the commercial and cultural activities that comprise the urban milieu. With the exception of cycling, walking is the only means of human movement by which we can dramatically experience the sensory gradients of sight, sound, and smell that define a place.
> (Fruin, 1971, p.212)

In his work he applied, translating it from a different realm, the principles at the base of the highways Level Of Service calculation to the pedestrian urban experience, in order to evaluate the LOS for this specific category. Standards for personal space availability in different contexts like walkways, transit platforms, stairs, elevators, etc., are discussed, in order to define indications for the assurance of safety, comfort and effectiveness during the walking experience.

In the north American context an important change, from an institutional point of view, took place in 1991 with the approval of the “Federal Highway Program’s Intermodal Surface Transportation Efficiency Act” and the 1998 “Equity Act for the 21st Century”. In particular in relation to the first legislative act, they are considered as landmarks and turning points in the transport policy approach inside the USA, marking the shift from a focus on highway transportation to inter-modalism, connecting different means of transport like air, road, rail and marine ways and increasing foundings for mass transit systems and also bicycle and foot pathways (Dilger, 1992). As a consequence from that time a flourishing in the US of pedestrian plans as recorded: the thematic website Smart Growth America lists[19] today 78 pedestrian plans (at the city, county or regional level), regulating the pedestrian experience in the various urban contexts. In the literature different models of pedestrian planning can be found, following an historical evolution from the beginning of their appearance until the most recent experiences, all based and animated by a different main principle: 1) instrumental rationality, 2) communicative rationality, and 3) phenomenology.

As Stangl highlights Instrumental rationality has been at the base of the planning approach since the professionalization of the discipline at the beginning of the 20th century, and is based on a positivistic and empiricist method to planning, in which the use of engineering and statistical models are applied in order to measure and forecast travel demand and to maximize mobility.

With the 1960s a more critical view got centrality, contesting the objectivity of the purposes sustained by the hegemonic instrumental rationality (Willson, 2001). As an answer to this new planning sensitivity a new paradigm emerged, based on the communication and participation in planning processes: communicative rationality.

A more recent approach is focused on the representation and perception of spaces by the actors rather than the rational calculations. Phenomenology qualitatively explores the world of everyday human experience, seeking to understand subjectivity, complexity and uniqueness. The planner here plays the role of “interpreter and manager of place” (Stangl, 2008, p.762).

The attention to the subjective perceptions and evaluations of the potential users and walkers have been highlighted by many studies as central in defining and influencing walking activity (Kim, Park, and Lee, 2014; Ewing et al. 2013; Gebel, K., Bauman, A. E., Sugiyama, T., & Owen, N. 2011; Manaugh, K., & El-Geneidy, A., 2011). The specific weight and the priority of the different elements (objective and subjective dimensions) is still debated, but the acknowledgement of the importance of considering both in the definition of planning prescriptions is widespreading.

Sensitivity to the pedestrian planning issue and to the specific dimensions composing it varies very much according to the main national context (presence and strength of national juridical frameworks regulating the issue) and to the local implementation context (municipality or local administrative level government).

[19] https://smartgrowthamerica.org/program/national-complete-streets-coalition/policy-development/policy-atlas/

A recent research run in the USA on a group of experts (managers in pedestrian planning of the 50 American Metropolitan Areas and other cities equipped with a pedestrian plan) produced an hierarchical list of the main elements impacting on walkability, from the most to the least important. The study offers a picture of the acting scheme and priorities followed by those professionals who are in charge of the construction of pedestrian plans in the USA (Fig. 7).

Fig. 7 – Ranking resulting from the survey on U.S. planners.

Rank		Most important	Least important	Considered in Plan
1	Connectivity of pedestrian network	34	0	39 (74%)
2	Presence of basic pedestrian infrastructure	19	0	40 (75%)
3	Pedestrian intensive land uses	16	0	36 (68%)
4	Connection to mass transit	12	3	37 (70%)
5	Mix of land uses	7	1	31 (59%)
6	Security issues/safe-scape	7	3	16 (30%)
7	Buffering between pedestrians and autos	4	3	26 (49%)
8	Traffic calming	2	2	20 (38%)
9	Density	2	3	25 (47%)
10	Aesthetics/visual interest	2	3	16 (30%)
11	Education and enforcement	2	4	23 (43%)
12	Cleanliness and maintenance	3	7	14 (26%)
13	Demographics	0	5	16 (30%)
14	Social space	1	12	13 (25%)
15	Street furniture	1	15	17 (32%)
16	Quantification of pedestrian flow	0	21	4 (8%)
17	Quantification of sidewalk capacity relative to flow	0	21	3 (6%)

Source: Stangl, (2011), p. 293.

What is interesting here is that the first and most important elements are clearly physical components, while perception/subjective properties come from the 6th position on, and are not very often included in plans analysed by the author (2/3 of the plans don't consider them).

3.4.4.2 Pedestrians in the EU context

Also European Union defined at the end of the 80s the first law framework aimed to the improvement of pedestrian experience and life. The first legislative product consisted in the "European Charter of Pedestrian Rights" (1988), in which the protection and role of pedestrian is acknowledge as a central planning goal to be achieved and where the various dimensions (environmental, social, health) of pedestrian experience are considered and also the various subjects, with their specific needs, composing the pedestrian population are distinguished: adults, children, elders, disabled. A series of rights are enlisted going from the right

I. to an healthy, free and safe environment,
II. to a human-scaled living urban space (not centered on cars and motor-vehicles,
III. to a space reducing the limits for the mobility of weak pedestrian categories (the already cited children, elders, disabled),

IV. to urban areas limited to pedestrians but organically included into the general organization of the town
V. to specific design and traffic management decisions aimed to improve the mobility experience and the environment of the pedestrians

A final point touches the aspects of education and information of the population about their rights as pedestrians, to be ensured since the children's first school career.

These principles have been developed more broadly in the EU legislation of the 90s and 2000s years, during which a strong emphasis has been put on the need to ensure a sustainable urban development strategy in order to face the environmental and social issues linked to the city growth and evolution.

Starting from the Green Paper of 1990, a first indication can be found about the need to build a mixed use of transportation modes, in order to create coexistence among the different users of the public space, and to reach both environmental and social-health sustainability. The role of pedestrian is in particular highlighted, stating that: "Walkers must be put back into the planning equation — not as an endangered species to be set aside in special pedestrian areas, but as major users of the city's streets."(p.64). The observations are further developed in the green paper of 1995, where the focus is put more strongly on the need to find strategies for the reduction of urban traffic congestion and pollution, through the creation of integrated networks of transport, joining individual (including walking and bicycling) and public transport modes, and presenting some good practices to address the issue.

In the first years of 2000s the first concrete disposition towards the objectives developed in the previous green papers were produced: the Sixth Environment Action Programme of the European Community in 2002, introduced the concept of Thematic Strategies, policy making tools based on the idea of developing integrated actions encompassing different policy goals and fields in order to control for the reciprocal influences existing between action areas (eg: waste, air pollution, natural resources, etc…). Among the 7 themes listed at that time found its place also Urban Environment TS, designed explicitly "To improve the environmental performance and quality of urban areas and to secure a healthy living environment for Europe's urban citizens" balancing the search for environmental sustainable policies with economic and social needs. The strategy was followed in few years by a set of norms inviting the member states to create environmental plans at national and regional level, providing guidelines for the definition of operational tools useful to their implementation. In 2004 a Communication by the European Commission defined as a central tool for the APEC implementation the realization of Sustainable Urban Transport Plans, for all the cities with at least 100.000 inhabitants. A parallel programme of data collection on environmental urban conditions was developed in order to measure and monitor the actual implementation and impact of these policies on urban environments in EU member states.

Milan PUMS is an example of this kind of actions, working for the development of an integrated and sustainable mobility plan, where specific initiatives are planned for the enhancement of pedestrian mobility conditions, the so called *Visione Zero Rischio* (Zero Risk Vision, derived from the analogous *Zero Vision action* developed in 2014 in New York City to face the street safety issue[20]). Among these can be cited the institution of *Zone a traffico pedonale privilegiato* (pedestrian preferential traffic zones), distinguished in:

1) pedestrian areas (areas where only pedestrian traffic is allowed)
2) restricted traffic areas (areas where only specific vehicles are allowed to transit, or at specific times of the day)
3) limited speed areas (streets or areas with a low speed limit for vehicles)
4) reorganization of traffic flow schemes

The reclassification, in the hierarchical structure, of the existing roads, the predisposition of stronger controls on street code’s violations, access’ fares for vehicles transit and educational initiatives cooperate as well to the fulfillment of the policy goals.

[20] See http://www1.nyc.gov/site/visionzero/index.page for further information on the policy.

3.5 Built environment as an important contributor to climate change

The impact of urban growth and in particular of urban sprawl on the environment conditions, have been recognized by a huge and long tradition of studies. Different dimensions and issues have been highlighted as products of last decades' urbanization trends, based on soil consumption and sprawling process. I) Land cover alteration, due to the reduction of farmland and of the permeability of soils, with the consequential obstacle to groundwater regeneration, and the disappear of forests, is one of the strongest and most evident phenomena that can be detected as a result of urbanization (Camagni et al., 2002; Ewing, 1994; Scalenghe and Marsan, 2009). Between 2000 and 2006, for example, 46 % of the land newly occupied by urban and other artificial land development in 37 European countries was agricultural (EEA, 2013). With the diffusion of built‑up areas in the landscape, natural and semi-natural areas are divided into smaller portions and reduced in size. This fragmentation affects the resilience of ecosystems, since the smaller the habitats, the more prone they are to isolation, lack of sufficient food resources and reduced variability in habitat structure (Fischer et al., 2006). For this reason an always stronger emphasis is addressed to the need of preserving urban agriculture, even if this could impact just on a limited and local context.

II, III) Geomorphological alterations, **local climate modifications**, through the alteration of evapotranspiration of the soil and warming of surface temperature, are relevant phenomena too (Taha, 1997; Zhou et al., 2004; Stone et al., 2010). A recent study on climate change in urban areas showed a higher risk and potential to develop heat islands in the most sprawled areas of the Federal German State of North Rhine-Westphalia (Kuttler, 2011). At a similar conclusion brought also a study run on the US metropolitan regions, that showed a doubling of the annual number of extreme heat events in the most sprawled cities in comparison with the most compact cities (Stone et al., 2010), showing the higher exposure to the phenomenon for people living in less dense settlements.

IV, V)Energy consumption and **climate change effects** are the nowadays most discussed issues, both institutionally and commonly, for the direct impact of urbanization and transport on the GHG (GreenHouse Gases) emissions, enhanced in the recent decades, and indirectly through the reduction of the contrasting action of natural soil and vegetation (Kenworthy et al., 1999; Lal, 2003; Bart, 2010).

VI) Air and noise pollution are other relevant hazards produced by extension of urban land use, for the indirect consequences of road traffic increase (cfr following paragraphs) (Borrego et al., 2006; Moudon, 2009).

VII) Hydrological alterations accompanied by overall **VIII) modification of flora and fauna habitats,** through their reduction due to built up land pressure on ecosystems and the consequential **IX) change of landscape sceneries,** are also products of the urban expansion (Alberti, 2005; EEA, 2006b).

3.5.1 *Transportation-related pollution*

Due to all the negative effects of urban development in the last decades a strong awareness has emerged globally and pushed international organizations (UNO, EU, etc…) to find new tools to face such a global threat. The main attention has been attracted by the GHG emissions, the factors at the base of the world heating process, that increased of the 70% globally between 1970 and 2004 (Metz & Intergovernmental Panel on Climate Change, 2007). GHG emissions are product of different consumption sources: Energy supply, transportation, industry, land use and forestry, agriculture, and buildings. Each source had a different impact, according to the specific context considered as well, with the energy supply one leading with an increase of 145%, followed by the transportation activities with the 120% of increment, while industry recorded the 65% and land use, land use change, and forestry (LULUCF) 40%.

Even though many strategies have been developed in order to face and reverse the current trend[21] the future is not surely made safe at all. As stated by UN: "Transport activity is expected to grow robustly over the next several decades. Unless there is a major shift away from current patterns of energy use, projections foresee a continued growth in world transportation energy use of 2% per year, with energy use and carbon emissions about 80% above 2002 levels by 2030". (*ibidem*, p.48)

A strong contribution to such a process would be given by the potential increase in motor vehicle ownership in the developing countries, nowadays well far from the 5 to 8 cars every 10 people recorded in the developed countries. As an example 33% of China's population (more than 400 million people) still do not have access to all-weather transport. But this prospect is also more aggravated by the fact that "the most attractive form of transport for most people as their incomes rise is the motorized personal vehicle, which is seen as a status symbol as well as being faster, flexible, convenient and more comfortable than public transport" (*ibidem*, p.328). In 2004, the share of transport to total energy-related GHG emissions was about 23%. Transport sector CO2 emissions have increased by around 27% since 1990 and its growth rate is the highest among the end-user sectors.

In the EU context the values of GHG emissions are similar to the world ones, with transport being responsible for a quarter of the EU's present-day GHG emissions, and it is the only economic sector in which the value is higher than in the statistic reference year 1990 (European Environment Agency, 2016). In fact GHG emissions produced by transport growth substantially in 2014, after a period of decrease between 2008 and 2013, due probably to the economic crisis. From 2010 to 2050 passenger transport is estimated also to keep growing reaching an increase of about 40 % (*ibidem*).

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[21] From integrating climate policies in broader development policies, imposing regulations and standards and taxes and charges for polluting behaviours, creating tradable permits and financial incentives for emission reduction, Voluntary agreements, information instruments and investments in RD&D.

3.5.2 Transport demand in EU

Passenger transport demand in the EU-28, measured in passenger-kilometres, experienced in fact a relevant period of strong growth until 2005, reaching a peak in 2009 (9% higher than in 2000), when it lived an only slight general reduction due to the economic recession (as seen for the world trend), then followed by a moderate increase since 2012. In 2014, total passenger demand was 10.5% higher than in 2000, exceeding even the level of the 2009 peak by 1.5%. Car passenger travel remains still today the main mode, with a share well above 70%. Air transport grew by 4.5% in 2014 and has a share of 9.2% of the total passenger-kilometers. Rail passengers' share has slightly diminished in 2014 and accounts for 6.5 % in 2014. “Partly due to a saturation of car ownership in the EU-2015, the REF2016 expects that private road transport (private cars and motorcycles) will grow less rapidly, i.e. by 30 % between 2010 and 2050.” (ivi, p. 33). Even if a reduction to 69 % share of all passenger-kilometers will be probably reached according to last forecasts in 2050 (from 75 % in 2010) private transport will remain the dominant mode.
Moreover freight transport is estimated to grow faster than passengers transport: “The REF2016 shows an increase in the total freight transport activity by about 58 % between 2010 and 2050. The highest growth in road freight transport activity would take place in the EU-13 (almost doubling 2010 figures by 2050) where a strong correlation with GDP growth can be expected” (*ibidem*).

3.5.3 Contrast policies

A complex strategy needs to be defined in order to predispose an efficient counteraction, that cannot be limited to the increase in the technology and efficiency of means:

> Technological developments will largely determine the future environmental performance of the transport sector. However, many past technological advances in the transport sector have historically been offset by the ever increasing demand for transport. Previous TERM reports have addressed this issue and have concluded that technical solutions alone are not enough to ensure that environmental impacts from transport will be reduced. Other measures, such as demand optimisation in the form of **better vehicle utilisation, avoidance of unnecessary trips** and **modal shift,** will therefore be indispensable.
>
> (ivi, p.6 , bold added)

It is not strange so if the land use control is recognized by EU as an important sector needed to work on in order to achieve the emissions reduction goals. The financial and technological developments have changed land use patterns in recent decades: with the decrease of car transport costs, coupled with improved transport infrastructure, longer distances became easier to be covered for commuters and this has generated problems in terms of increasing congestion and pollution. “Measures such as urban planning for higher urban densities, varied land use mixes, removal of financial incentives that encourage commuting, improved public transport connectivity and better accessibility can help reduce commuting distances travelled.” (ivi p.7)

EU in particular has been working since long time on these issues, defining recently relevant policy frameworks. European Commission proposed in July 2016 for example a binding GHG emission reduction programme for Member States for the non-Emission Trading Scheme (non-ETS) sectors (i.e. including transport, as well as buildings, agriculture, small industry and waste) to be achieved in a 2021–2030 timeframe. According to this proposal, known as the 'Effort Sharing Regulation', transport should contribute towards the 30 % reduction by 2030 compared to 2005 emissions and 60% reduction compared to 1990.

Nevertheless a change need to be taken soon since the forecasts show that overall, by 2050 transport emissions are more than 15 % above 1990 levels, still consistently far from the aspired 60 % reduction (compared to 1990 levels) as defined by the EU policies goal.

This always stronger awareness of the effects of current planning development and transport models has worked as a stimulus for the change in policy planning all over the world, also because of the direct link between environmental issues and health issues that constitutes another relevant base for the call to action.

3.6 Health impact of land use patterns

The relation between health conditions and land use patterns can be conceived as twofold, encompassing direct effects and indirect effects (Younger, 2008). The first ones are easily understandable: as showed in the previous paragraphs land use influences consistently the environment, bringing to different levels of energy consumption and, as a consequence, GHG and other pollutant elements' emission. The indirect effects are more complex and strictly involve people behaviour and lifestyles, as shaped by the physical conditions of the living environment.

3.6.1 Direct effects

Air pollution in urban settlements is a vehicle of relevant diseases, increasing the probability of their manifestation in the population (or directly generating it), especially among children and the elders, and all the most fragile populations. Important relation between air pollution exposure and diseases are found for obstructive pulmonary disease hospitalizations, respiratory and cardio vascular morbidity and mortality, acute asthma care events, diabetes mellitus prevalence, lung cancer risk, birth defects, lung impairment, ecc.

Jackson and Kochtitzky (2001) report for example that in the US asthma diffusion in children more than doubled from 1980 to 1995, a period that also saw more cars on the road and increased urban congestion[22]. But asthma is not only exacerbated by air pollution: McConnell et al. (2002) show how it is also directly generated by pollutant substances.

World Health Organization estimates that in 2016 more than 80% of world population was exposed to a level of pollution exceeding the WHO limits (WHO, 2016), even if this percentage was strongly different when controlling for country location (developed or not developed nations), showing respectively 56% of cities and 98% cities with a excessive pollution level.

This situation is cause of serious health effects: it increases the rate of death and anticipates it in an unnatural manner. Air pollution is often addressed and studied in fact through the detection of premature deaths, deaths that occur before a person reaches an expected age[23], and years of life lost, defined as the years of potential life lost owing to premature death[24]. A study run by the WHO in 2013 (WHO, 2013b),on the effects of air pollution on health in Europe, showed that among the 41 countries analysed, 467.000 premature deaths are attributed to $PM_{2.5}$ exposure, 71.000 to NO_2 and 17.000 to O_3, three of the main pollutants

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[22] They cite also a serendipitous experiment during the 1996 Atlanta Olympic Games, in which is highlighted that driving decreased 22.5% as cars were restricted in the downtown area. At the same time, emergency room and hospital admissions for asthma decreased 41.6%, while the occurrence of other medical events was unchanged.

[23] This expected age is typically the age of standard life expectancy for a country and gender. Premature deaths are considered to be preventable if their cause can be eliminated.

[24] It is an estimate of the average years that a person would have lived if he or she had not died prematurely. YLL take into account the age at which deaths occur, giving greater weight to deaths at a younger age and lower weight to deaths at an older age. It gives, therefore, more nuanced information than the number of premature deaths alone (Guerreiro et al., European Environmental Agency, 2016).

produced by human activities (in particular industrial and transport activities). In a smaller cluster of countries, the EU-28, the premature deaths attributed to $PM_{2.5}$, NO_2 and O_3 exposure are 436.000, 68.000 and 16.000, respectively, while the YLL (years life lost) attributed to $PM_{2.5}$, NO_2 and O_3 exposure are 4.668.000, 723.000 and 179.000, respectively.
A recent research on 25 European cities found that if the WHO limits to $PM_{2.5}$ exposition would be respected population would live on average 22 months more for an ideal person of 30 years old or more, resulting in 19.000 premature deaths less each year (Pascal et al., 2013). Also an economic evaluation and esteem has been proposed in the research about the savings gained by the health disease reduction: 31€ billion annually, due to savings on health expenditures, absenteeism and intangible costs such as well-being, life expectancy and quality of life. These esteems are probably underestimated, due to variability in data available and statistical errors, but also to the selection of a population older than 30 y.o., that excludes the youngest and children.

3.6.2 Indirect effects

Beside the direct effects of pollution also indirect factors are able to influence people's health, acting on their behaviour, in particular on their physical activity. The active travel and mobility is considered nowadays by a huge part of the literature on health issues and preventive medicine in particular as one of the main tools to contrast important diseases in the population, such as obesity, cardio vascular issues, strokes, etc…
Unfortunately the characteristics of the living space are not always suitable to enhance healthy behaviours like, for example, adopting walking and cycling as daily transport choices. US are known for being particularly unfriendly towards active modes of transport, due to the planning policies adopted until today and for the transport policies that have been since long time keen to the enhancement of car usage: "With over 95% of all parking free of charge, and with gasoline taxes, roadway tolls, licensing fees, and vehicle taxes among the lowest in the developed world, the United States makes driving a car almost irresistible (Pucher & Dijkstra, 2003 p. 1511, from Transportation Research Board, 2001).
As a consequence people lifestyle is strongly determined by a dangerous sedentary way of living, usually, as already stated, linked to a wide range of health issues. Obesity is one of these. Obesity is clearly co-determined by a wide range of causes (alimentation habits as firsts), but strongly influenced also by non-active behavioural patterns. The main studies on the issue come again from the north American context, where the phenomenon is particularly widespread and relevant: there in fact in 2014 35% of men and 40.4% of women were obese (more than the double than in the European population in the same year), with a BMI (Body Mass Index) $\geq$25 (Flegal KM, Kruszon-Moran D, Carroll MD, Fryar CD, & Ogden CL, 2016), and this figure excludes the overweighted people, that would increase the values.
Sprawled settlements and monofunctional (because mainly just residential) spaces are exactly at the opposite of healthy designed environment from a weight-control

point of view: as various researches demonstrate *density* and *diversity* of the urban spaces, in particular land use mix, are associated with lower values of BMI, after controlling for the main socio-demographic characteristics (Rundle et al., 2007; Stafford et al., 2007). Accessibility to opportunities is in fact a relevant driver for a higher active behaviour and, as a consequence, a lower exposure to overweight problems (Tilt, Unfried, & Roca, 2007). Being obese is found to be significantly associated with perceived indicators of absence of close nonresidential destinations, but also absence of sidewalks, unpleasant community, lack of interesting sites, and observed indicators of poor sidewalk quality, physical disorder and presence of garbage (Boehmer, Hoehner, Deshpande, Ramirez, & Brownson, 2007).

Another interesting research run in Perth, Australia, confirmed as the urban design, not only from an objective point of view but also as perceived by people, could be associated with differences in overweight or obesity rates, after controlling for sociodemographic properties (Giles-Corti, Macintyre, Clarkson, Pikora, & Donovan, 2003): overweight was associated with living on a highway (odds ratio [OR], 4.24; 95% confidence interval [CI], 1.62–11.09) or streets with no sidewalks or sidewalks on one side only (OR, 1.35; 95% CI, 1.03–1.78) and perceiving no paths within walking distance (OR, 1.42; 95% CI, 1.08–1.86). Similarly obesity was associated with poor access to four or more recreational facilities (OR, 1.68; 95% CI, 1.11–2.55) and sidewalks (OR, 1.62; 95% CI, .98–2.68) and perceiving no shop within walking distance (OR, 1.84; 95% CI, 1.01–3.36).

3.6.3 Active living

Physical inactivity is an increasing issue all over the developed world: Across the WHO European Region for example, is estimated that one in five adults engage in little or no physical activity (WHO Report, 2002), and only about one third of the schoolchildren seems to meet recognized physical activity guidelines (Currie et al. 2004). This is particularly problematic for the implementation of active living policies, the strongest tool under promotion recently by governments and institutions in order to improve living conditions of population. As defined by WHO active living is: “a way of life that integrates physical activity into daily routines. The goal is to accumulate at least 30 minutes of activity each day. Individuals may do this in a variety of ways, such as walking or cycling for transport; exercise for pleasure and fitness; participating in sports (both organized and informal); playing in the park; working in the garden; taking the stairs; and using recreational facilities.” (Edwards & Tsouros, WHO, 2006, p.3)

A specific attention in this field is given to those categories of the population for which the level of activity is lower also due to their particular condition, like age, disability, social vulnerability. A focus recently developed by the literature on the issue is that for example of active aging[25], comprising the promotion of healthy aging processes, particularly relevant in a society (at least in developed

[25] With *Active Aging* is considered an ageing process that includes social participation, healthy living and safety of the elders (WHO, *Active Ageing: a policy framework*, 2002).

countries) where general population aging is a consolidated datum and, even if a great success for society, a factor increasing health system expenditure and investments. For these reasons the delineation of specific policies towards preventive action on health conditions is always more a key point for governments.
In 2002, more than 60% of Europeans older than 65 years engaged in no moderate physical activity in the past seven days (Eurobarometer, *Physical activity: special Eurobarometer*, 183-6, Wave 558, 2003). Key barriers for older people include accessibility (for example, compromised mobility may limit the ability to use stairs in undergrounds); safety issues related to weather (such as icy sidewalks) and road traffic (such as unsafe street crossings); ageism (a belief that physical activity and sports are only for the young) and isolation (such as lack of support from others, including health professionals and recreation specialists).
Creating better conditions for adopting active modes of transport and lifestyles is, in particular for populations for which proper sport activities are less feasible, a fundamental goal for health enhancement.

3.6.4 Safe spaces

Also dependent from the built environment structure and deserving a special mention, is the safety level of spaces, operationally defined as risk and rate of accidents that affect urban spaces: due to the already highlighted relation between BE and transport models, spaces in which car and motorised vehicles are predominant, because spaces themselves are shaped according to their needs, have also a higher level of danger for other kinds of users like pedestrians or cyclists. In the US for example a recent research showed how the fatal accident rate (normalized for trip walked or km travelled) for pedestrians and cyclists was higher than in two European countries (where urban design is traditionally different form the anglosaxon one) like Germany (3 times more for pedestrians, 2 times for cyclists) and Netherlands (6 times more and 3 times more) even if, for example, the two European contexts had a greater amount of cyclists (Pucher & Dijkstra, 2003). This is due also to the existence of specific policies aimed to the protection of these “weak” street users like: better facilities for walking and cycling, traffic calming of residential neighborhoods, urban design sensitive to the needs of non- motorists, restrictions on motor vehicle use in cities, rigorous traffic education of both motorists and non motorists, and strict enforcement of traffic regulations protecting pedestrians and bicyclists.
Together with New Urbanism principles and Smart Growth rhetoric, active living is one side of the debate on the need to reshape the living spaces in order to improve the living conditions of the urban populations and the challenges produced by current development patterns and tendencies.
The actions on the policy issues here reviewed differ in efficacy according to the specific contexts considered, due also to the level of awareness of the relevance of the issues, but all together can be judged as relevant components of the general effort in building sustainable societies, generally recognized as one of the main challenges for the next future.

3.7 Social impact of walkability: empowering social relations?

Beside the environmental and health impacts of the BE also the social dimension and its relation with the space have been analyzed in the literature on sprawl and urban space design. The idea that space is a fundamental contributor in influencing and shaping social behaviour affirmed itself in the last decades of the XX century in the sociological tradition. If the first reflections on the topic can be found also before in time, in the contributions of Simmel at the beginning of the century and the reflections of Goffman in the ‘60s, it is only in the ‘70s, with the works of Lefebvre and Foucault that the space is acknowledged as both a crucial product and generator of social actions.

Space can endorse (specific) social contacts or obstacle them, according to its characteristics and to the social relations considered, this is at the base of the urban design and planning domains. In such a framework walkability has been questioned as an element able to increase the social encounters and so social relations among settlements’ inhabitants due to easiness of social exchange made possible by the structural characteristics of the walkable residential spaces: proximity to opportunities and amenities, greenness of the walking spaces, safety and pedestrian-centered urban design, land use mix (variety of uses and of opportunities), etc. The debate on the issue is still ongoing and strongly discussed, due to the many difficulties in the definition of concepts and operational implementation of analysis.

The main issues are linked to 1) the definition of the dependent variable to be considered in order to address the topic: How is the level or richness of social relations conceived? 2) which scale has to be adopted for the analysis? The neighbourhood is usually the preferred geographic level at which the studies focus, due to its overlap with the residential area or community boundaries inside which the main or most significant relations take place. Even when adopted as level of analysis another question arises: what are the boundaries of the neighbourhood?

The measure of social relations’ magnitude

The level of social relations’ richness is usually conceived in the literature in two different ways: 1) as the level of Social Capital present in the study context (neighbourhood or residential settlement) (Putnam, 2000; Brueckner and Largey, 2008; Nguyen, 2010; Glaeser E, Gottlieb J, 2006; Wood, 2008) or 2) the presence and strength of sense of community (McMillan and Chavis, 1986; Bothwell, Gindroz, and Lang, 1998).

Social capital is a key concept in social sciences, developed in the late ‘80s and beginning of ‘90s and defined generally as a collective dimension of society, external to the individual, “It is not a single entity […] consist[s] in some aspects of social structure and […] facilitate[s] certain actions of actors […] within the social structure. […] Unlike other forms of capital, social capital inheres in the structure of relations between actors and among actors.” (Coleman, 1988, p.98)

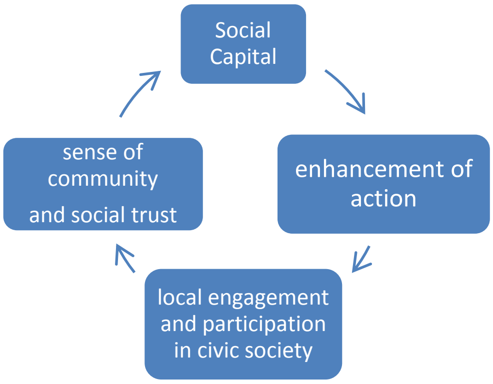
It is considered as a basic element in the explanation of society functioning.

Putnam is recognized as the main author who worked on the measure and analysis of social capital trend in contemporary society, especially in the USA, where he highlighted the existence of an ongoing process of decrease of its level. The operativisation of S.C. is usually done considering people's level of social and civic engagement (community organizational life, engagement in public affairs, community volunteerism, informal sociability, and social trust, as summarized in Jackson, 2003), assumed to be a product, and so an indicator, of the existence of that structure of social relations and dynamics, able to push people to engage in those kind of activities.
The decreasing trend in US society is due in Putnam's opinion to a complex set of phenomena, among which a relevant role is played by the rise of suburban planning tradition in the second half of XX century, producer of an increasing deterritorialization of people and loose of rootedness in the residential neighbourhoods. It is not the traditional high residential mobility (decreased in the last decades), usually associated with less rooted relations, nor the low home ownership (that increased), that is generally considered a positively correlated factor with sense of belonging, to affect SC.
The sprawl phenomenon is the cause, for the author, of a growing need to commute to reach work and study places, subtracting in this way time and energies to the social interactions in the residential spaces, and breaking the neighbourhood boundaries, increasing the distances and extent of people's daily geographies[26]. Less and poorer social relations in the residential neighbourhood are translated in lower participation and involvement in local organizations, working as the main drivers of such a phenomenon. Moreover sprawl is associated with more social segregation, and social homogeneity seems to be correlated with less civic engagement, being a negative factor for bridging social capital construction.

Social trust is as well considered one of the main elements composing social capital levels, and is the substratum or environment in which civic engagement can flourish and be implemented (Coleman, 1988), nurturing so to speak the social *viscosity* of neighbourhoods.
This viscosity is strictly linked to the existence of a sense of community (McMillan and Chavis, 1986), an element, as well as social capital, both product and producer of civic engagement (cfr. Graph 2 for a schematic representation of production and reproduction of civic engagement in our view).

[26] A negative relation between car use as a single occupant for commuting purposes and richness of social ties is found by Freeman (2001).

Graph 2 – Proposal of civic engagement circle scheme.



Sense of community variation is also questioned in the literature in order to investigate its relations with BE. It has been defined as a combination of 4 different sub-dimensions (McMillan and Chavis, 1986), in detail:

- ***membership***, is the feeling of belonging or of sharing a sense of personal relatedness.
- ***influence***, a sense of mattering, of making a difference to a group and of the group mattering to its members
- ***integration and fulfillment of needs***. This is the feeling that members' needs will be met by the resources received through their membership in the group.
- ***shared emotional connection***, the commitment and belief that members have shared and will share history, common places, time together, and similar experiences.

Authors in Social Sciences debated the elements able to influence such a property, highlighting the role of space and of the relations with it as a relevant one. Environmental psychology is the discipline in which the tradition of this kind of studies was born, in particular in the cluster of researches on the sense of belonging and place attachment to the territory (Woldoff, 2002; Stokols & Shumaker, 1981). The study of the role of the environment in enhancing and facilitating the emergence of a particular attachment to the local context has been underlined by many studies (Perkins & Long, 2002; Pretty,Chipuer, & Bramston, 2003), where elements like density, proximity and presence of amenities and social arenas are showed to be influent for the sense of belonging emergence (Fried, 2000).

Results are contradictory, since, according to the specific studies, the relation between spatial characteristics of the residence and local social ties strength and number are not always demonstrated to be directly correlated, and sometimes they are found to be negatively correlated.

Brueckner and Largey (2008) for example demonstrate how density is correlated with negative values of social capital, after controlling for the main socio-demo characteristics. Leyden (2003) reported that respondents who were living in walkable neighborhoods were more likely to know their neighbors, participate politically, trust others, and be socially engaged, compared to those who were living in car-oriented suburbs. In this case however the controlling variables included only age, length of residence and few other variables, detecting the enrollment to organizations like parties or associations.

Some other studies found both positive and negative relations between built environment characteristics and social capital levels, depending on the specific declination and operational definition of the dependent variable. Nguyen (2010) shows that compact living, characterized by high population density and street accessibility at the county level, is found to be unfavorable to social interaction, faith-based social capital (religious participation or involvement), and giving and volunteering. However, the analysis shows that it is positively related to political participation such as voting, involvement in political groups and local reforms, and interest in national affairs. Social interaction, in this case, may not always take place in more compact areas as some authors have contended, but those can amplify the positive effects of other factors (for example income, as showed in the study cited) on social interaction. Compact living can compensate for or widen the social-capital gap intrinsic to race and income for example.

Always controlling for socio-demographic characteristics of the population surveyed Wood (2008) finds, in a study investigating three neighbourhoods with different structural and street patterns, that the built environment have a significant but small effect on social capital and feelings of safety, particularly in relation to the number and perceived adequacy of destinations.

Glaeser E, Gottlieb J, 2006 on the contrary find negative relation between density of the settlements and social capital. They reproduced the analysis run by Putnam, operationally defining social capital as: attending church, working on a community projects, writing a letter to a magazine or newspaper, contacting a public official and being a registered voter.

Many critiques could be addressed to these studies, stressing the variables and indicators chosen for detecting the different properties (like in the last case, where attending to church could be considered as a measure of secularisation instead of fewer sense of community, or contacting a public official not a proper form of social capital expression). Also the geographical level of analysis brought to different results: we listed researches based on the metropolitan, county (Nguyen, 2010), city (Leyden, 2003) and neighbourhood levels (Brueckner and Largey, 2008; Wood, 2008).

Our aim here is not to draw a complete and exhaustive literature review of studies on the topic, but just to show how the debate on BE characteristics and social relations and social capital is open and that relations between the two dimensions are present. As highlighted by many studies, if a direct relation is contested and the role of residential self selection and attitudes is strong and confounding the relationship between BE and social engagement, it is true that a walkable BE can improve and enhance the opportunities to have casual encounters and create new relations (Cabrera 2013; Lund, 2003). This element can work as an indirect factor improving the social capital of the residential settlements, creating the best conditions for its reinforcement and production, even if social capital and sense of community are much more complex concepts, and casual encounters are not enough for influence them on their own (Talen, 1999). Spatial design is not clearly a sufficient condition to develop these kind of reactions but it is anyway a facilitating factor.

3.8 Economic value of walkability

As already discussed above, the enhancement of walking behaviours, and more broadly of active modes of transport, is highlighted to be a leverage for the reduction of environmental, social and economic costs due to the negative effects of car dependent society and sedentary life styles, today widespread among the western and developed countries. These are some, even if probably the most important, economic positive spillover effects of active mobility.

Walking anyway has an intrinsic value on its own: it is comprised in many other mobility practices, since using transit modes or private ones includes always a portion (even if small) of necessary walking trip, that through a multimodal chain perspective can be detected and evaluated. Some empirical results highlight as walking could be considered 6 times more relevant, if measured in such a way, than usually done (Rietveld, 2000). For this reason walking, since constitutes the easiest and most common way of moving, is fundamental for any kind of mobility and its loss could damage strongly the freedom of people (while it is not the case for other modes of transport like driving). Despite of these observations, traditionally low attention has been dedicated in concrete to this mode of transport, as can be derived by its few relevance in policy making and economic funding. This is probably due to the 1) difficulty in measuring its magnitude and consequently its 2) economic impact as stated above, considered to be limited and not relevant (if compared to the economies linked to the car-usage), or even interpreted as an indicator of lack of mobility opportunities (Litman, 2003).

Recently an important discussion has been raised about the economic impact of walkability levels on housing market in particular, due to the increase in attractiveness of urban places particularly devoted to pedestrian transit. Since walkable is usually linked to pleasant and enjoyable space, it is considered as a generator of value for the space itself, translated into rent and land value. The assessment of such a linkage is valuable of course for RE professionals, but also for public actors, both in a taxation policy perspective and in a gentrification process control.

Adopting WalkScore (see next paragraphs) as a walkability measure, Pivo and Fisher found that an increase of 10 points in the level of walkability was followed by an increase between 1 to 9% of properties' value, according to the different kind of property (Pivo & Fisher, 2011).

An analogous research highlighted as accessibility (proximity) and land use mix, elements considered in the literature among the most influential on the level of walkability, can be considered important influencing elements on the economic value of houses. Matthews & Turnbull, (2007), working on the King County in Washington, found that (1) there are areas where proximity to retail sites has a significant positive effect on residential values but also areas where the effect of proximity is insignificant. This is due, on the base of their results, to the contrasting negative effect of the negative externalities of land use mix: proximity of residence to activity areas can carry more noise pollution or congestion in the

immediate surrounding area, but (2) this contrast exists for a limited distance from the opportunities (712 feet[27] or 952 feet[28] on average depending on the context considered in the study), after which the positive effect of proximity overcomes the negative one. (3) In those areas where no retail proximity effect is recorded, its absence appears to be due to the highly segregated land uses and the resultant greater straight-line and travel distances needed to reach the opportunities.
What is found also to be relevant in assessing the variations in property values is the dominant shape of the neighbourhoods, affecting in a radical way all the other elements analysed. They showed how the specific characteristics of the overall neighbour block are strictly linked to the preferences of their inhabitants, highlighting the relevance of the self selection phenomenon in this kind of studies: distance is in fact conceived differently in the two different sections of the county analyzed, one more grid-shaped (more traditional) and the second characterized by the typical cul-de-sac structure (traditional suburban settlement shape). It has significant negative effect in the first case, and no effect in the second one. The same can be said for accessibility. It is due to the different markets they represent, and the different demands they satisfy.
The importance of individual preferences is highlighted also by other studies, like the one carried by Diao & Ferreira (2010) on the Boston Metropolitan area. They found that accessibility to transit and jobs, connectivity, and walkability (here conceived as percentage of roads with sidewalks, curbs or wide space for pedestrians) impact positively on housing price but this relation is lower in traditional suburban settlements or neighbourhoods.
A clear and ultimate answer on the relation between walkability and housing prices is hard to be found, due to the extreme complexity of the theme, but what emerges from the research is that it is valuable in those contexts in which it can impact the most: in the more grid-shaped neighbourhoods.

[27] 216m c.a
[28] 290m c.a

3.9 Walkability assessment services

An indicator of the increased interest in the walkability issue and its spillorver effects on the urban attractiveness is the flourishing in the last years of a set of web instruments and market services aiming to measure and detect the walkability of spaces, as an useful marketing and business input for investment or residential mobility decisions.

Among the main examples of this kind of services can be listed: *WalkScore*, *Walkshed* and *LevelOf Service platform*, all independent experiences, oriented towards the same objective, the provision of a reliable and consistent extimation of walkability of places.

WalkScore, developed in 2007 by Front Seat Management, is one of the main experiences of walkability measure provision to the market, working at the international level, providing data on walkability on the United States, Canadian and Australian territories. It consist of a final index ranging from 0 to 100, computed considering the distance and proximity to all the valuable amenities included by the tool: educational (schools), retail (groceries, books, clothes, hardware, drugs, music), food (coffee shops, restaurants, bars), recreational (parks, libraries, fitness centers) and entertainment (movie theaters) destinations (Pivo & Fisher, 2011). Amenities within a 5 minutes walk (.25 miles) are given maximum points, the value then decreases according to a decay function for which no points are given after a 30 minutes walk (WalkScore.com).

A classification of the contexts is made on the base of the level of WS detected:

90–100	**Walker's Paradise** Daily errands do not require a car
70–89	**Very Walkable** Most errands can be accomplished on foot
50–69	**Somewhat Walkable** Some errands can be accomplished on foot
25–49	**Car-Dependent** Most errands require a car
0–24	**Car-Dependent** Almost all errands require a car

On the base of this experience the company developed also similar specific measures like the *Transit Score* (to detect the level of service provided by transit system) and *Bike Score*, dedicated to the measuring of environment friendliness towards bicyclists. A more recent field in which the company is working is the crime ranking of neighbourhoods, another element important in affecting the value of land and the quality of life.

The tool, is considered a useful instrument, at least for its continue updating and its wide coverage, even if it has been also criticized for many reasons in different studies that validated its effectiveness (Carr, Dunsiger, & Marcus, 2011; Duncan, Aldstadt, Whalen, & Melly, 2013; Duncan, Aldstadt, Whalen, Melly, & Gortmaker, 2011; Leinberger & Alfonso, 2012; Manaugh and El-Geneidy, 2011). The main observation is linked at the amenities choice and their weight in people preferences (Duncan, Aldstadt, Whalen, Melly, & Gortmaker, 2011), since the WalkScore doesn't distinguish among them. Also the size of amenities (relevance or dimension) is not considered, even if it could affect walking behaviours. Moreover, some dimensions are lacking, like the land use mix, traffic, greenness and similar elements impacting on the walkability levels.

Walkshed.org is a similar tool developed by Aaron Ogle, a Philadephia ICT company developer, only for the cities of New York and Philadelphia, working through a decision tree system on the same principles of *WalkScore*, but developed in order to overwhelm its main limits: the now resolved crow-fly approach to proximity measure (*WalkScore* has recently adopted a network based approach for distance calculation: "Street Smart" WS) and the amenities weighting procedure. In *Walkshed* it is possible in fact to build walkability maps fitting the users'needs, attributing a weight or point ranging from 1 (low weight) to 3 (high weight) to the different amenities available, or not including them (0 points). The platform composes then through a decision tree procedure the different geographic layers including the various amenities and their weights, restituting a continuous index, ranging from 0 to 100.

Another interesting experience in web data generation and collection on walkability is represented by *levelofservice.com* platform, developed by a consultant company on New Zealand, and aiming to become a central store for data on walkability in the country. It works integrating Community Street Audits, based on the experience of *Living Streets UK* in 2002, collecting data on the quality of public spaces – streets, housing estates, parks and squares – from the viewpoint of the people who use them, involving people and users in the data acquisition, with a numerical rating system (based on objective measure of physical elements addressing the Level of Service of the area of interest). The platform provides a free LoS assessment, offering then as a service the support for the construction of a complete Community Street Review.

Conclusions

As it has been shown, walkability, interpreted both as a field of study and policy concept, appears to be a product of a long cultural and scientific debate on the planning patterns adopted until now and of their impact on current status of the society at worldwide level.

We have seen how the nowadays society, at least in the developed countries, is clearly car-dependent, and that this is the result of a specific development strategy, risen in the years after the second world war. It has far cultural roots in the anglosaxon domain, but it has been exported also in the Old Continent.

Having a car dependent society carries to a specific planning policy, able to transform the built environment according to the needs of such a policy. Even if BE is not the unique and most important elements impacting on the people mobility behaviours, it has an important role in shaping it, and in affecting as a consequence many other aspects of people’s life, today greatly influenced by mobility strategies (Urry, 2000).

Environmental issues, Health issues and somehow also social issues that affect today our cities could be faced efficiently taking into consideration also BE planning strategies oriented towards the creation of more inclusive public spaces, not only open to different kind of users practicing different kind of mobilities, but expressively favoring them.

The institutional domain has since some decades started a path towards a better integration of policies for the sustain of pedestrian needs into overall sustainable development strategies. The results are various, but the course is on.

Private actors as well understood the potentials of a greater attention to walkability and pedestrian accessibility environments, providing services and visions that contributed as well to the debate on the issue.

The debate is still open, and in particular on the scientific side there is the need to improve the analysis of the theme, in order to better understand the potential and relevance of practices directed towards the enhancement of walkability in urban contexts.

Chapter 4

Metropolitan development and the criteria for defining Metropolitan areas: the cases of Milan and Lyon.

Introduction

As a first step in the analysis of the Milanese context we must distinguish between the different territorial levels of analysis that are possible, and so, specifically, between the main different territorial structures (both functional and institutional) existing in the study-area.

This is due to avoid the misunderstanding of the extent of our analysis and to describe as better as possible the territorial complexity of the study area.

In order to help in doing so the following chapter will give an overall description of the diverse international and national approaches and main studies that proposed innovative methods for the description and delimitation of the metropolitan areas in the western word. This review is based on a previous work carried out in 2013, of which the present one would like to be considered a continuation and deeper evolution. A focus on the Metropolitan City of Milan will finally be carried out and its characteristics presented briefly in comparison with the other Italian Metropolitan Cities instituted by the recent legislative reforms. In order to highlight the relevance of the issue, we will focus also on a different context, similarly engaged in a long standing struggle for the definition of the more fitting extent useful to manage the current urban processes faced by metropolitan level cities: the city of Lyon, in France, comparable in terms of urban relevance in the national context, of economic development and, at least partially, territorial extension.

4.1 The phenomenological path of the metropolisation process

Italian literature on the metropolitan development has a quite recent tradition, if compared to the anglosaxon one. The first attempts to work and define the growing complexity of the urban environments' diffusion in the country, increased during the economic boom of the 50s and 60s, are those carried by Cafiero and Busca (1970), followed then by Ercole e Zonta (1991), that are based on the foreign examples dating to the 40s and 50s and coming from the American context. A tradition that was the result of an intense debate on the nature of cities, and of their development trends, in a country in which the environmental conditions for the birth of a specific urbanization pattern were particularly favourable: availability of wide and empty spaces, lack of pre-existing territorial structures and infrastructures,..., that brought the American, but also, even if for different reasons and in a partially different context, English cities to face a new phase of urban development and a specific morphological expression of it: the metropolitan city.

4.1.1 The Metropolis

The metropolis or metropolitan city can be conceived as a product of, on the one hand, the diffusion in the territory of urbanized land but also, on the other hand, the consequential distribution of the economic, political and social functions (mainly of high level, those who Christaller [1993] defined as *central functions*) that have their principal headquarters in the main cities and that spread in their surroundings. The metropolis follows this tendency of breaking the traditional administrative boundaries, and expands, physically and functionally, due to the impossibility of keeping inside the city's limits all the activities once located there. The former boundaries are not anymore able to attribute strong meaning to the functional relations emerging in the territory, due to the expansion of city's influence.

Such a process of the urban (economic, physical and social) structure's transformation has been effectively described in the Italian literature by Martinotti (1993), who distinguished between three different kinds of metropolitan cities, according to the emergence and increasing relevance of different distinguishable populations living them. The author identifies in fact a *first generation metropolis* that, in contrast with the former traditional city (compact, autonomous and functionally independent), is characterised by the complexification of its structure and in particular of its population, divided between inhabitants and workers, constituting populations always less and less coinciding. The first ones in fact live for the all day into the urban contexts, being for them both places of residence and work; while the workers, on the contrary, have a more limited experience of the city, generally confined to the working hours, producing a only partial overlap between their daily sphere of life and the overall city's domains.

Such a result is made possible by the increase of the mobility opportunities, both in terms of public infrastructures and private motor-vehicle affordability, giving birth to one of the main phenomena linked to the urbanization process: the commuting, able to connect a territory more and more dispersed, characterised by a stronger distinction between residential settlements and poli-functional main centers.

On this base the author develops also a second model of metropolises, characterised by the rising of different populations starting acting in the metropolitan context and shaping it through their presence and behaviours: the *second generation metropolis* sees the emergence of the so-called *city-users*, individuals commuting to (and into) the metropolis in order to consume or live for specific and limited reasons the city. A more complex structure emerges too, always under the same interpretative framework where practices are shaped and shape the environmental contexts, due to the diffusion of new opportunities of purchase and consumption into the metropolitan areas, also in the so-called *hinterland* fringes. As highlighted by Nuvolati (2007), if in the first generation metropolis the movements were concentrated *towards* the main center of the MA and limited to the working or studying purposes, nowadays the daily pathways changed, growing in complexity, multiplying the destinations and aims. Leisure mobility acquires more and more relevance, being distributed not homogeneously but less concentrated than in the past into the territory constitutive of the metropolitan areas.

With the globalisation and increase in scale of functional relations between metropolitan centers (Sassen, 1991) (more and more tied in a global network of high ranked cities) the *third generation metropolis* then appears, whose main actors, belonging to a peculiar elitist population, are the *businessmen* of global level, commuting on high distances, living for working reasons a partially nomadic condition on a worldwide perspective. As we already stated before, in the description of the first signs of urban diffusion, the central functions extend their influence in the territory around the main urban centers, but a parallel phenomenon is ongoing at the same time: cities are bridges (or nodes) through which supranational relations are intertwined, carried out by the members of the *hyperbourgeoisie* (Duclos, 1999), an emerging elites of supralocal level, acquiring more and more a specific role, positioning itself at the high vertices of the world social hierarchies, expression of a specific cluster of interests that are impacting more and more strongly on the nowadays cities built-up structure and society (Smith, 2002).

But all these transformations took time to get realized, and the phenomenon showed different paces according to the different contexts considered.

4.2 The proposals for the description of contemporary urbanization processes

After the first half of the XX century in particular a more and more relevant decrease in the urbanization of the western countries' population emerged from the data. Such a trend astonished the analysts, since the decreasing trend in urbanization was counteracted by a parallel increment in the population living in areas located outside of the metropolitan agglomerations, a process called by some authors *counter-urbanization* (Berry, 1976). The explanation given by the authors of those observations introduced a scenario in which the population's tendency to leave urban centers and settle in more rural contexts was strongly switching backwards, overturning the urbanization process of the last decades. Berry's data showed that between 1970 and 1973 the former trend in the population growth, characterised by a continuous increase of the metropolitan city's inhabitants and a four times lower one in the non metropolitan territories, changed suddenly, reversing the ratio. As Martinotti stressed however (1993), the reality was exactly showing the opposite phenomenon of what was presented and the reversing trend disappeared if the definition of metropolitan area was changed, enlarging its boarders: the apparent population growth in the non-metropolitan territory had to be attributed to the extension of the urbanized context, that turned former countryside locations into city-a-like spaces. In order to correctly represent the real phenomena ongoing and the extreme dynamic juncture the scope of the analysis had to be enlarged and widened, to show that the reality was exactly the opposite: an increasing urbanization process.

4.2.1.1 Italian context: Cafiero and Busca and Svimez experience

Such an event showed the relevance and critical role of the metropolitan areas territorial identification and delimitation, generating a flourishing of attempts aiming at the representation of the current urbanization phenomena. The first Italian attempts in the definition of the metropolitan areas were based on their conceptualization as homogeneous geographical regions characterized by the spatial contiguity of their urbanized territory (Cafiero e Busca, 1970), and on the physical component of the metropolitanization process. On the base of this approach the metropolitan area is conceived as "huge and extended city" (Cristaldi, 1994), a wide continuous surface, whose components are defined thanks to the homogeneity they show in terms of specific properties, considered as expression of *urbanity* such as density of built up space and of resident population. In her analysis on the study tradition about metropolitan areas Cristaldi labels this approach as the "*territorial homogeneity*" focused one, merging those dimensions that Martinotti, in a former work (1993), defined as two different elements: the homogeneity and the morphology, the former related to the socio-demographic characteristics able to gather similar contexts, the latter focused on the physical properties of the territory.

Such an approach had a wide success, especially at the beginning of its diffusion, due also to the economical methodology on which it is based, founded on the administrative data analysis, but it presents some limits:

1) It does not consider the relations between the components of the territory, hypothesizing them on the base of their functional homogeneity. This is the case of the analysis of the job market structure and vocation, that allow to suppose the existence of functional linkages between areas sharing for example a similar proportion of employees in the third sector.
2) It considers a territory homogeneous even if, spatially speaking, it appears at a more narrowed sight fragmented

Limiting the urbanization factors at the mere physical component means in fact to detect just a part of them, excluding the functions that act through and overpass, even if rely on, the physical boarders and structures. The aforementioned limits are the two sides of the same coin, since the supposition of the connection between areas not physically contiguous is made possible by the functional relations existing between them, allowing the localization of the characteristics of *urbanity* also in areas labeled as rural, relations of which the commuting flows are one of the main expressions, as correctly highlighted by Cafiero and Busca (1970).

4.2.1.2 The K.Davis's Institue of International Studies proposal

However data on the functional relations have never been available in all cases and times, and also nowadays in many contexts they lack, forcing the decision of not considering this component. This is the reason at the base for example of the methodological choices taken in one of the main studies on the metropolitan areas in the past, produced by the *Institute of International Studies*, Berkeley. Promoted by Kingsley Davis, the study was carried out in 1959 and focused on all the world's urban areas, giving a definition of metropolitan area based on two dimensions: 1) the contiguity of municipalities to a city of at least 50.000 inhabitants, conceived as metropolitan center; and 2) the presence in those municipalities of at least the 65% of employees dedicated to the non-agricultural activities. As a last condition, the agglomeration must exceed at least 100.000 inhabitants. The dimensions considered are related to the morphological aspects of the territory and its homogeneity, and the functional hierarchy present between the different settlements, overlooking the level of the interrelations linking its different parts: population size, contiguity (physical continuity of the urban land) and economic structure, based on non-agricultural activities, are the criteria driving the metropolitan area delimitation according Davis's research team. A method so designed fall in a second category, the *hierarchical-functional* models, listed by Cristaldi (1994), in which not only homogeneity but also the functional structure of the metropolitan contexts is taken into consideration. Anyway only center-periphery relations are conceived here, excluding potential linkages between lower level centers.

4.2.1.3 The American Metropolitan Statistical Areas

Such a broad research, regarding so many and so different territorial contexts, forced the authors to consider only a limited set of indicators, due to lack of harmonised data. Relation and flux data in particular are usually available only where the statistical tradition is more consolidated and shows a higher level of development. It is not by chance that the United States represent the country in which the study on metropolitan areas adopted also data about functional relations, in particular on commuting flows. We referred to the work of the *Bureau of the Census*, that, already at the beginning of the XX century, defined the first delimitation of the metropolitan districts (1910) for Census purposes, then updated in 1950 to Standard Metropolitan Areas[29] (Cafiero e Busca, 1970), territorial statistical units on which were then based the studies on the metropolitan development.

Beside the dimensions of homogeneity (socio-economic and morphological) in that case is included also a relational dimension: the information on commuting. Metropolitan areas in the American definition are consequently: a conglomeration of counties 1) contiguous, 2) located around a main center of at least 50.000 inhabitants, 3) hosting a number of non-agricultural workers at least above the 75% (as defined in 1960 with the shift to the new Standard Metropolitan Statistical Areas), or, as an alternative 3bis) a density of population above 150 inhabitants/mi^2, and where at least the 15% of the employed population moves to the main county for working[30].

The Bureau of the Census's contribution is one of the main examples of the analytical dimensions' extension from the physical/morphological and functional/hierarchical, to the relational one.

The next examples of attempts to define the metropolitan areas basically are inscribed in such a tradition produced by the first studies, even if its interpretation varies from case to case, operationalizing into different properties the dimensions of homogeneity, contiguity, etc…

Trying to summarise the main dimensions we could distinguish:

1) The presence of a conglomeration (gathering of contiguous territories) of settlements

2) The presence of a high rate of employees in the secondary and tertiary sectors, highlighting the non-agricultural vocation of the territories.

3) The high density of residents or employees (not below a given threshold). These indicators are replaced for the smaller settlements by the absolute size of the population.

4) Functional relations identified by mobility fluxes (commuting flows) towards the central locality, highlighting the territorial functional dependence from that.

Another relevant case in this sense can be found in the study developed by Hall e Hay, University of Reading, published in the volume *Growth centers in the European Urban System* (1980), focused on the analysis of the main European urban areas' evolution. As well as Davis they collected data on the economic and job structure of groups of contiguous settlements, facing relevant difficulties in the scarcity of data on commuting. Their contribute was fundamental for the introduction of a successful concept: the *Daily Urban Systems*, consisting in functional clusters of territories, strongly interrelated due to the fact of sharing relevant economic relationships, mainly represented by the commuting flows for working reasons.

[29] Nowadays *Metropolitan Statistical Areas*.

[30] Or otherwise at least the 25% of the local workplaces are residents of the main center/county.

On a similar perspective is built the study of Cafiero and Busca (1970), one of the first and best attempts of metropolitan areas' definition in the Italian context, entitled "*Lo sviluppo metropolitano in Italia*" (the metropolitan development in Italy). Also in their research, beside the individuation of a central settlement around which are located smaller centers composing the fringes, are considered the size and density of the employees in the secondary and tertiary sectors, but not the commuting flows (since those data will have been collected only form the 1981 Census).

Of the shown approaches the most complete remains probably the American one, but what seems to be outdated today is the focus on only center-periphery relations, while absent are the interconnections among the suburban or fringe settlements. It is still strong in such an approach a christallerian hierarchical-functional framework. In this sense the metropolitan area is perceived as a commuting basin, or an organism diffused centrifugally in the territory, binding to its center areas more and more distant, but that remain in a dependent relation with it. The reality has been characterized historically by this structure, especially at the beginning of the metropolisation process, but nowadays a view of the metropolitan areas as network of centers, not only functionally oriented towards the main center but more and more interconnected among themselves, is rising (Cristaldi, 1994; Camagni 1991). In fact, as highlighted by Scaramellini, with the residencies, step by step also specific functions of middle-low level (not the high range functions defined by Gottmann quaternary sector [1961], still located in the centers or *cores*) spread into the territory, structuring a network of which they constitute the nodes, minor points of attraction, but allowing the rise of new ways of territorial fruition. As recognized by Ravalli e Corbellini (2004):

> Una vita totalmente suburbana è oggi non solo concepibile, ma effettivamente praticata da un largo e crescente numero di presone che abita, lavora e consuma e si diverte nei circuiti della grande distribuzione globalizzata: shopping mall, parchi a tema, multiplex, discoteche, ecc. un modello che, certo, si presenta fortemente limitato, costruito attorno ad una offerta massificata, segnata da rapporti di scambio commerciale piuttosto che da interazioni culturali, al quale si aggiungono tutte le note considerazioni sulla sua marcata dispendiosità in termini energetici, di tempo, di sottrazione del territorio…[31]

What looks interesting to stress is the complexity of the current landscape that emerges from the process of urban diffusion, for which a more detailed methodology should be adopted in order to highlight the peculiarities of the nowadays metropolitan development.

4.2.2 Recent remarkable metropolitan areas definitions

4.2.2.1 OECD Functional Urban Areas

Among the last attempts and definitions of metropolitan areas an important place is taken by the OECD method, developed in 2012, that tried to find a common approach

[31] "A totally suburban life is nowadays not only conceivable but actually lived by a wide increasing number of people, that reside, works, purchases and enjoys itself in the circuits of the globalised large distribution: shopping malls, parks, multiplex, discos, etc..., a model that seems to be strongly limited, built around a conformed offert, marked by commercial exchange based relations rather than cultural interactions, to which are added all the well known considerations about its high cost nature in energetic, time and land consumption terms..." (our translation).

useful to draw an harmonized tool for the metropolitan development monitoring and analysis.
The OECD has traditionally used thresholds based on population density (gross density, the ratio between population and the area of the administrative unit of reference) to classify regions as either urban or rural. Such a method comported an important degree of distortion due to the ecological fallacy, given by the different extension around the countries of the administrative units, and of the distribution inside them of the inhabited areas. For this reason a different approach has been recently taken into consideration.
The method is quite complex, but seems to share all the criteria listed in the above paragraphs: metropolitan areas (in the OECD proposal introduced as *Functional Urban Areas*) are defined considering the population density distribution adopting as a territorial unit a grid of 1km^2 cells, developed by the EEA[32].
Three steps are then followed: step 1 consists in the definition of urban cores, looking for high density cells clusters (1.500 in/km^2 in Europe, Japan, Korea and Mexico, 1.000 in/km^2 is applied to Canada and the United States due to their different urban development patterns). All the municipalities in which 50% population lives inside a cluster is included in the urban core. The urban agglomerations not reaching a specific minimum threshold (100.000 inhabitants for EU, Japan, Korea and Mexico, 50.000 inhabitants in all the other cases) are not included in the list of urban cores. The urban cores defined through this procedure are found to be good approximations of contiguous, highly built-up surfaces.
Step 2 is aimed to identify interrelations between cores, in order to highlight the presence of polycentric functional areas. Two cores are considered integrated in a common *metropolitan system* if at least the 15% of the residence population of any of the cores commutes to work in the other core.
Step 3 is focused on the delimitation of the hinterland of the metropolitan areas: this is defined as the cluster of municipalities which send to the core a percentage of their workers above the 15% of the residents employed.
The method seems to be quite close to the American MSA, since it takes into consideration many criteria as *homogeneity* and contiguity (clustering of densely urbanized parcels of land) but also the *relational* dimension, through the inclusion of data on commuting. Both OECD FUA and MSA are inscribed in the tradition of the *Functional Urban Regions* (FUR) *approach*, derived from the *Daily Urban System*'s one developed by Hall and Hay in the above cited work of the 1980.

4.2.2.2 The French Zonage en Aires Urbaines

The last example of metropolitan areas definition method, inscribed in this tradition, that we will here refer to, derives from the French context, where the attention to the territorial development and urbanization dynamics is deeply rooted in the scientific and administrative tradition of the country. In particular we refer to the

[32] Data on population density come from the European Environmental Agency (EEA) for the European Countries, and from *Landscan* project databases for other countries. *Landscan* is a data collection and distribution service producing data on world population, derived from census sources and analysis of high resolution satellite images. The population recorded is the ambient or average population (integrating diurnal movements and collective travel habits, not only resident population), whose presence is computed on a worldwide grid structure of 1km^2 cells.

tradition of the studies carried by the INSEE, the French national statistical institute, that since the '60s has been working to contribute to the building of an exhaustive description and classification of the whole country's territory (INSEE, 1962; 2010). The first product of the French effort is the so-called *Zonage de Peuplement Industriel ou Urbaine*, a zoning method quite similar to the one developed for the American MSA that distinguished between 4 kinds of territories:

- The central city
- The *banlieue* (peripheral or suburban areas)
- The *couronne periurbain* (periurban fringes)
- The rural contexts

Constituting the *Urban Areas*

The classification will be modified in the years, in 1997, 2002 and 2010, due to the changes in the urban structure of the country, that, like in the case highlighted by Martinotti for the critique of Berry's conclusions about the American metropolitan context of the '70s, brought the classification method to underestimate and misinterpret the reality of French urbanization processes (in 1990 in fact the 96% of the population resulted to be settled in rural contexts according to the 1962 ZPIU).
It seems interesting for our scope to describe briefly the method for the classification of the last version of the French zoning, the ZAUER (Zonage en Aires Urbaines et en aires de Employ de l'espace Rural). The ZAUER distinguishes between 5 kind of areas:

1. **Urban Poles** (*Poles urbaines*), agglomeration of urban units[33] with more than 1.500 employees.
2. **Periurban municipalities** (*Couronne periurbain*), municipalities where at least 40% of the population works in the urban pole, or in another municipality of the urban area (distinguished in two classes according to the size of the poles, whether big or small).

   Urban poles and periurban municipalities compose the *Urban Areas*, that are classified into **Big Urban Areas** (poles with more than 10.000 employees) or **Small Urban Areas** (poles with less than 10.000 employees)

3. **Multipolarized Municipalities** (*Communes multipolarisée*), isolated and rural municipalities where at least 40% of employees work in at least two Big Urban Areas.
4. **Residual Multipolarized Municipalities** (remaining *communes multipolarisée*), isolated and rural municipalities where at least 40% of employees work in at least two Small Urban Areas.
5. **Isolated municipalities,** municipalities not enclosed in the influence region of one or more urban areas.

As we can see, the method shows strong similarities with the American MSA approach, but (1) it does not distinguish between agricultural or non-agricultural employees, and (2) considers commuting flows not only towards the main center (urban pole) but also to the other parts of the urban areas (like the *couronne*

[33] A urban unit is a settlement of at least 2.000 inhabitants, distributed continuously in the space, with gaps of maximum 200m

periurbain). Such a characteristic allows to take into consideration also the relations between smaller centers of the urban areas' fringes, showing a conceptualization of urban structures closer to the last evolutions found in the literature.

Tab. 3 – Overview of the main researches aiming at defining *metropolitan areas*, by year of publication, scale, dimensions considered and hinterland definition criteria.

Research unit	**year**	**Scale**	**Dimensions**	**Agglomeration criteria for metropolitan area definition**
Davis	1959	International	Morphology, Homogeneity	Contiguous settlements with a proportion of non-agricultural employed above 65%
SMAs (SMSAs)	1950 (1960)	National	Morphology, Homogeneity and Relational	Contiguous settlements with a proportion of non-agricultural employees above 75% or of commuters above 15% towards the main center or above 25% from the main center
Cafiero e Busca	1970	National	Morphology, Homogeneity	High density and size of employed in non-agricultural sectors
Hall & Hay	1980	European	Homogeneity and Relational	Density of employees proportioned to the main center's one and classification of the municipality according to its commercial attractiveness (if lacking communting data)
INSEE	2010 (previously 1962-97-2002)	National	Morphology, Homogeneity and Relational	Contiguous municipalities with a proportion of at least 40% of employed working in the Urban Pole (in the Urban Area for Multipolarised Municipalities)
OECD	2012	International	Morphology, Homogeneity and Relational	Municipalities with a proportion of at least 15% of employed commuting to the agglomeration core

4.3 The Milan case study

4.3.1 The Milan Metropolitan area or city?

Located in the center of the Padana plain, the Metropolitan City of Milan should not be confounded with the Metropolitan Area of Milan. If we would in fact look at the overall territorial context in which the city is inscribed the figure appears much more complex and the latter exceeds without doubts the boundaries of the former.

The literature on the issue is huge in the Italian academic debate (see Del Fabbro 2017 for a deep analysis of the issue), and as a consequence a wide amount of proposals emerged from it.

The whole northern part of the country, inscribed in the Padana plain, has been described, in a partially provocative way, as a wide, strictly interconnected *Megalopolis* (Turri, 2000), embracing the territories from Turin (West) to Venice (East): “Se applichiamo il modello gottmanniano alla megalopoli padana vediamo che essa si configura come città lineare che s’interpone nella fascia pedemontana e dell’alta pianura tra gli spazi montani (Alpi ed Appennini) e gli spazi della bassa pianura padana[34].” (Turri, 2000, p.29)

Fig 8 – Land use typologies in Padana Plain (left) and satellite night-time image of the same area (right).

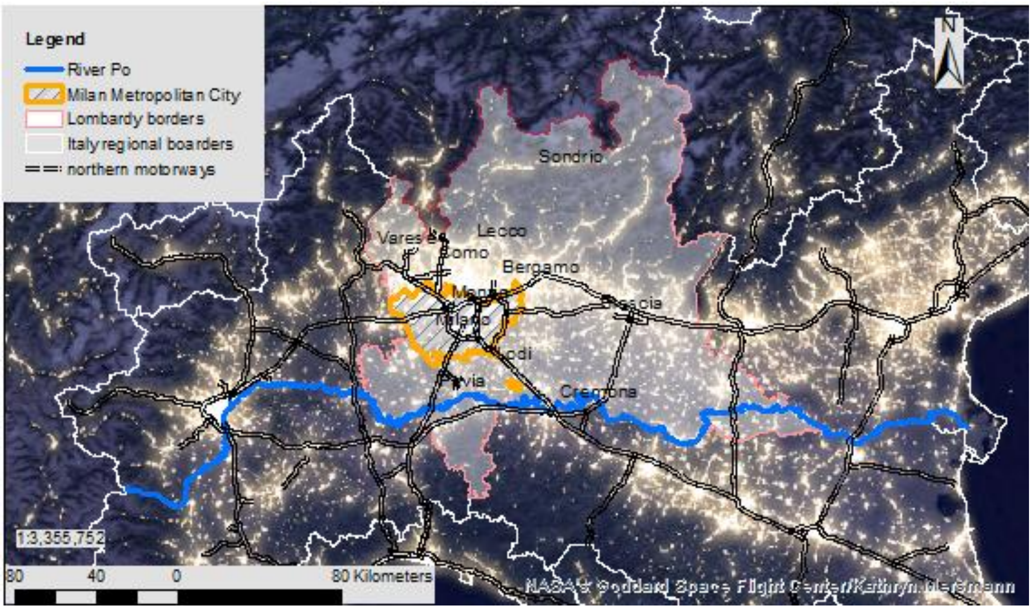
Source: Turri, 2000, pp 18-19 (left); NASA images 2016 (right). Legend Turri: 1)Aree fortemente urbanizzate; 2) aree prevalentemente agricole 3) aree montuose 4) città metropolitane 5) città 100.000> 6) città > 50.000 7) città > 20.000 8) aereoporti 9) autostrade.

Even without agreeding on such an evocative image, we could anyway highlight the existence of a continuous built up territory streching at least from the border between Piedmont and Lombardy regions, to the city of Venice, drawing an urbanized developed line under the Alps, of which the Milan Metropolitan City is just a portion, even if a central one.

As shown in Fig. 9, the Milan Metropolitan City embraces just a small sector of such an extended surface, especially diffused on the northern part of the MC (Varese, Como, Lecco, Monza and Bergamo). An apparent gap is highlighted by the break of the continuity between Lombardy and Piedmont regions, and it is visible thanks to the lack of overlap between lights and motorway network.

[34] “If we apply the gottmannian model to the padanian megalopolis we see that it appears as a linear city inscribed in the mountains’ fringe and of the higher plain between the mountainous spaces (Alps and Appennini) and the spaces of the low Padana plain” [our translation]

Fig. 9 - The skeleton of the *Megalopoli Padana* and the relative position of the Milan Metropolitan City.



Source: Our elaboration on Istat, OSM, NASA data (2016).

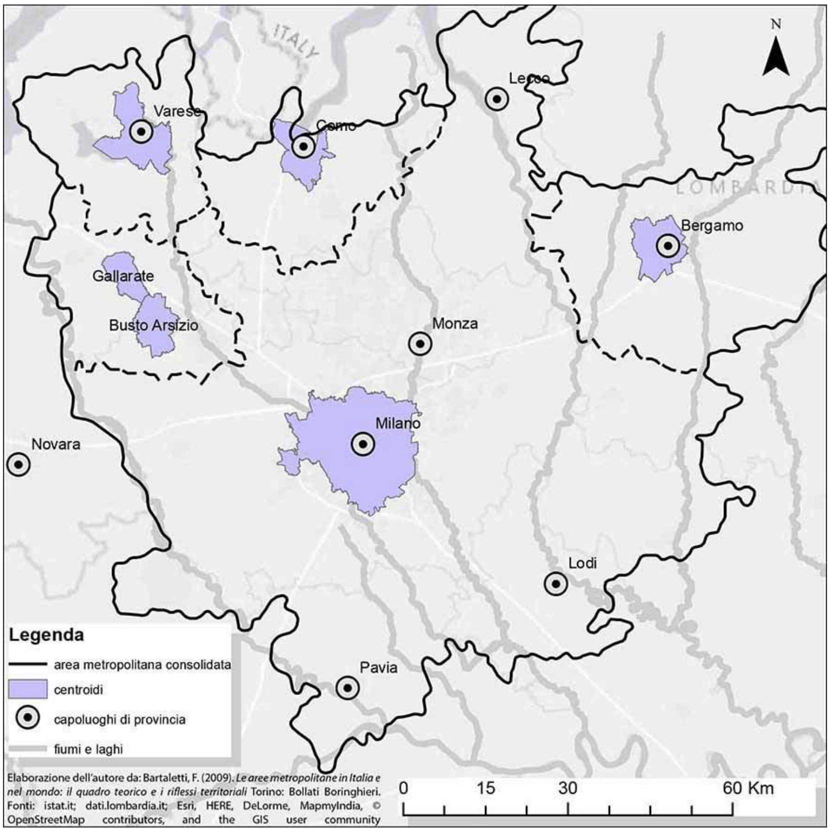
On the Eastern side, on the contrary, we can see a strong correspondence between the line of urban lights and the structure of motorway network, that can be considered as its underlying skeleton. We can appreciate then a more scattered urban context in the central area of the plain (the agricultural band), separated from the emilian cities (the light strip constituted by Parma, Modena, Reggio Emilia, Bologna) by the river Po, the most important waterway in the northern part of the country, that runs from west to east, crossing the whole plain and contributing in shaping the *megalopolis'* natural frame.

4.3.2 Many Metropolitan areas

The fuzzyness of the megalopolitan phenomenon in the northern part of the country produced a parallel flowering of interpretations of the metropolitan dynamics present in that area. For our purposes we will focus on the milanese area, but an immediate issue emerges: what are the boundaries of what we call the *milanese area*? As highlighted by Del Fabbro (2015) the literature on the description of the Milan metropolitan phenomenon has manifold examples of definitional proposals. Among them he distinguished between two main traditions: one inscribed in the legacy of **functional approaches** (like many of the ones described before), shaped on the model of the Functional Urban Areas. The second one is called **"spazialista" (spatialist)** and is more focused on the political and cultural elements able to gather and connect specific areas, distinguishing the different territorial contexts. The author analyses 5 different conceptualisations of the milan urban context, each one introducing a different view of the study object itself.

1st view: Milano as "metropolitan Area", is based on the already cited work of Cafiero and Busca (1970), who, applying a similar method as the one developed by the U.S. Bureau of the Census, described the Milan Metropolitan Area as coinciding practically with the lombardy region, showing a regional scale conceptualisation of the city. Similarly Bartaletti (2009) made a proposal through which a smaller area was drawn, encompassing the provinces of Milan, Monza, and parts of Como, Lecco, Lodi, Varese and Bergamo (Fig. 10).

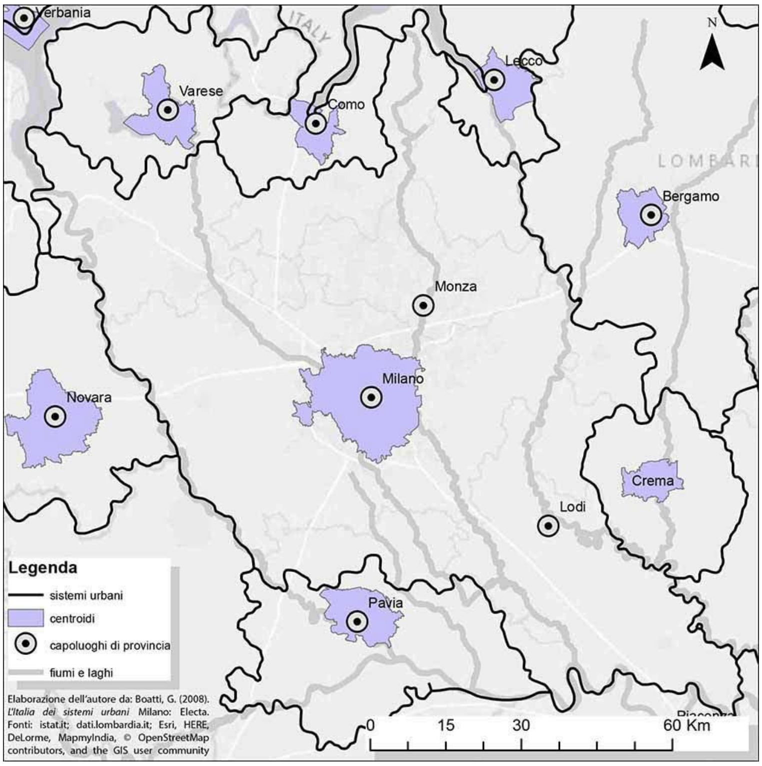
Fig. 10 – The consolidated Metropolitan Area of Milan-Bergamo-Varese.



Source: Bartaletti (2009), quoted in Del Fabbro (2015)

2nd view: Milano as "Urban System", highlights the interdependences between homogeneous areas defined by Istat according to the level of commuting for working reasons (the Work Local Systems), developing an approach close to the english Daily Urban Systems (Hall, Hay, 1980). Boatti (2008) draws on these data, adding also the mobility flows due to study reasons, a partially different picture, showing the existence of wider systems than the ones developed by Istat (Fig. 11).

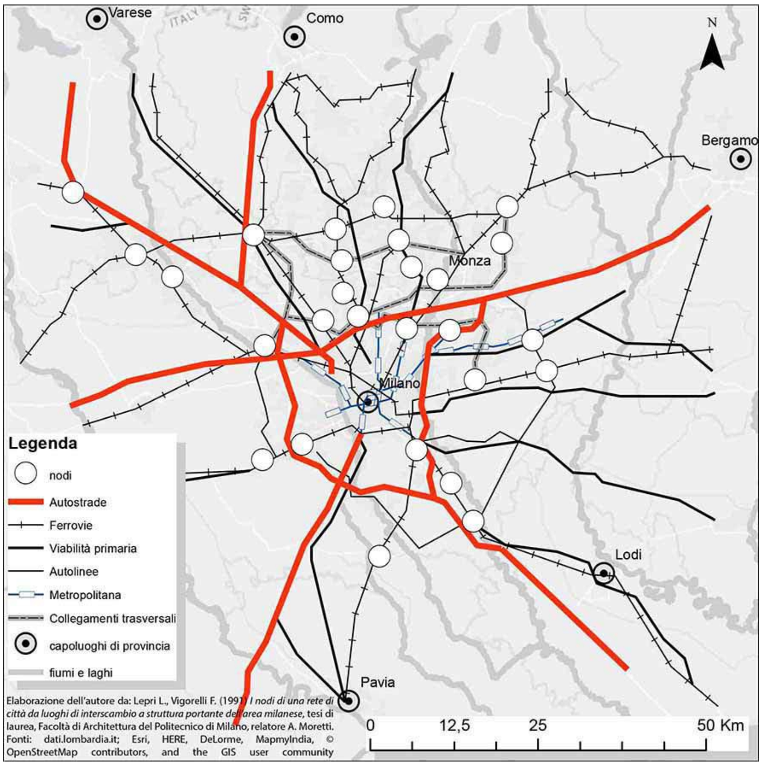
Fig. 11 – The Milan Urban System.



Source: Boatti (2008), quoted in Del Fabbro (2017)

3rd view: Milano as a "Network of cities", is derived from a transportist approach developed by Moretti (1999), who described the milanese area as a networked system structured on the road net, with 27 main nodes, acting as specific elements, components of a wider functional system, the *system of cities* (Fig. 12).

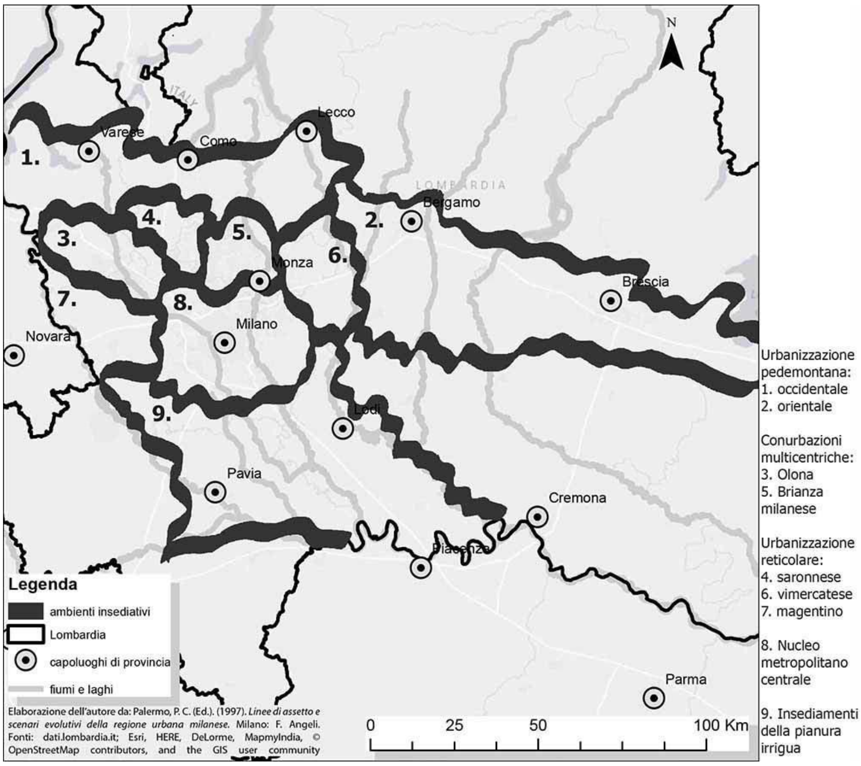
Fig. 12 – Milan as a "Network of cities".



Source: Moretti (1991), quoted in Del Fabbro (2017)

4th view: Milan as an "Urban Region", the approach belongs to the spatialist tradition, and is based on the individuation and identification of different **settling environments** (*ambienti insediativi*), defined according to morphological and socio-economic criteria (Lanzani, 2005; Boeri et al, 1993). On this legacy Palermo (1997) drew the boundaries of the Urban Region, analysing the morphology, the communting flows and socio-demographic characteristics of the territory, and identifying 9 different living contexts (Fig. 13) clustered into 3 macro-areas: *territorio pedemontano* (the area rising just below the line of the Alps, the most continuously urbanized, areas 1 and 2), *fascia periurbana* (characterised by a scattered urbanization around the regional core of Milan, from 3 to 7) and *Sud Milano* (a variegated area mainly rural in the southern territory below Milan city, area 9).

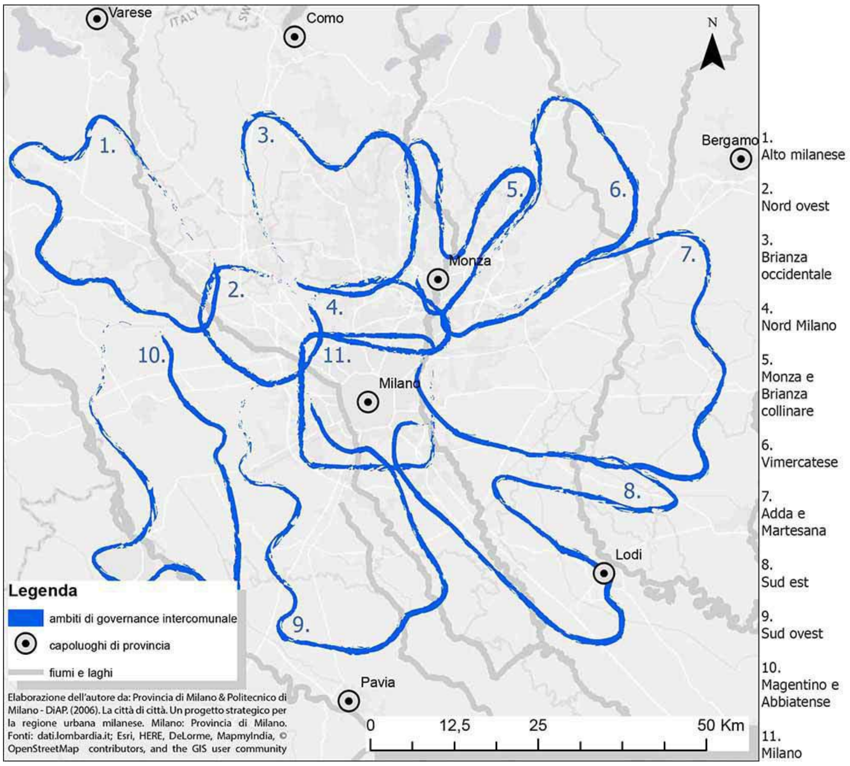
Fig. 13 – The Milan Urban Region and its *ambienti insediativi*.



Source: Palermo (1997) quoted in Del Fabbro (2017)

5th view: Milan as "city of cities" is the result of an analogous approach (spatialist) carried out by Balducci and a research team from Politecnico di Milano (2006), on which then the current Milan Metropolitan Cities' *Zone Omogenee* (homogenous zones) have been defined. The study highlighted the existence of 10 urban systems, defined on the base of the morphologies of the *settling environments*, but also on the analysis of the government cooperations and relations among the municipalities. The authors found that what they called the *Milan Urban Region* extended on 10 different provincies (Milano, Monza, Lodi, Piacenza, Pavia, Novara,Varese, Lecco, Como and Bergamo), covering a wide territory and a huge portion of the region (Fig. 14).

Fig. 14 – Milan as “City of cities”.



Source: Provincia di Milano e Politecnico di Milano-DIAP (2006), quoted in Del Fabbro (2015).

4.3.3 The Italian metropolitan areas/cities

In such a complex scenario, it is not difficult to believe that a solid and shared definition of Italian metropolitan areas still lacks, but the political and legislative debate on the issue came recently to a first conclusive (?) step in that can be considered a long path, dating, at least from a legislative point of view, from the 1990s. In those years also in the Italian scientific and political arenas rose the awareness about the last changes of the city nature, and the need to define new tools to better administrate the growing territories’ complexity. A proper and universal identification (neither statistically speaking) of the territorial extent of the metropolitan areas has not yet emerged: in its place an institutional definition of the **metropolitan cities** has been introduced.

In 1990 in the framework of a huge reform of local administrative institutions (*legge* 142), the Metropolitan Cities were officially defined as components of the administrative hierarchical structure of the country (Calafati, 2014). In the following years many changes have been done to integrate the legislation (among the many the *legge* 42/2009) until the most recent reform of the 2014 (*legge* 56/2014), that gave the last formalization to the boundaries and administrative limits to this discussed entity. According to the law the metropolitan areas in Italy have substituted the former provinces whose territory they cover, in order to manage their own political-administrative tasks (Del Fabbro, 2015). In particular their objectives are: the care of the strategic development of the metropolitan territory, promotion and co-management of the services, structures and communication networks of interest for the Metropolitan

City; care of the institutional relationships belonging to their level, included the European ones in which the other European metropolitan cities are engaged (L. 56/2014, art. 1, comma 2).
Among the 10 metropolitan cities defined by the new legislation (Torino, Milano, Venezia, Genova, Bologna, Firenze, Bari, Napoli, Reggio Calabria and Roma) is included also the metropolitan city of Milan. In the last years also other 4 metropolitan cities have been instituted but through regional laws and not thanks to the former reform of 2014: Palermo, Catania, Messina (in Sicily), Cagliari (in Sardinia). In Tab. 4 some indicators useful for an overall comparison between the different Metropolitan Cities instituted show how the Milan one is the most dynamic in economic terms, with the highest household/income level (double than the one of Sicilian MC and Naples, the lowest, and 12% more than Bologna, the second highest), employing the highest number of people (more than the MC of Rome, inhabited by a wider population) and hosting the highest percentage of foreigners. It is interesting to note the datum about the share of region's employees included into its limits: it is high (47%) but not so much as in other cases (Rome, Naples, Turin, Genoa), showing as it represents just one of the productive nuclei of the whole region, covering less than the half of the total. Actually it is due also to the restricted extension of the metropolitan city's boundaries, that, if in other cases enclose the most part of the functional domain of the metropolitan areas, in the Milanese case they are not able to embrace its complete surface.

Tab. 4- Data on Metropolitan Cities in Italy.

Metropolitan City	population 2016	% foreigners 2016	2012 Households' income capita* in €	surface in kmq	population density 2016	number of municipalities	Employees				2011	
							2001 a.v.	% of the region	2011 a.v.	% of the region	employed (% on total population)	unemployed (% on total population)
Roma	4 353 738	12.5	21 330.6	5 352	813.48	121	1 443 732	84.5	1 619 238	84.9	47.4	5.5
Milano	3 218 201	13.9	26 733.3	1 575	2043.30	134	1 849 456	47.1	1 824 784	46.8	51.4	3.9
Napoli	3 107 006	4.0	12 314.5	1 171	2653.29	92	467 394	54.1	526 552	54.7	32.7	11.6
Torino	2 277 857	9.6	20 454.8	6 827	333.65	316	832 258	56.7	773 534	56.3	47.4	4.6
Cagliari[a]	1 653 135	1.0	15 893.8	1 248	1324.63	17	110 175	38.1	121 230	40.1	42.2	9.8
Palermo[a]	1 268 217	2.9	13 687.3	5 009	253.19	82	160 092	24.8	180 239	24.4	33.7	10.9
Bari	1 260 142	3.3	13 397.7	3 825	329.45	41	255 765	38.7	274 192	38.2	39.7	7.5
Catania[a]	1 113 303	3.1	11 874.8	3 573	311.59	58	141 107	21.8	173 998	23.6	35.2	11.1
Firenze	1 014 423	12.8	21 730.7	3 514	288.68	42	351 108	31.0	349 170	30.8	49.8	3.6
Bologna	1 009 210	11.7	23 711.2	3 703	272.54	55	387 946	25.1	399 136	25.4	52.1	3.5
Venezia	854 275	9.7	19 157.6	2 462	346.98	44	263 408	15.9	263 703	15.6	48.8	3.7
Genova	850 071	8.4	20 529.4	1 839	462.25	67	235 752	59.0	276 964	62.3	44.8	3.7
Messina[a]	636 653	4.4	12 938.9	3 266	194.93	108	88 384	13.7	98 917	13.4	37.2	9.4
Reggio di Calabria	553 861	5.7	12 386.2	3 183	174.01	97	57 986	24.3	71 531	25.4	36.1	9.2
Italia	60 532 325	nd	nd	301 340	200.88	nd	16 440 770	nd	16 969 252	nd	nd	nd

Source: our elaborations on Istat data (2001, 2011, 2017). [a] Metropolitan cities established with regional laws after 2014 reform. * data source *UrBes 2015* Istat

4.3.4 The Milan Metropolitan City

With a territory of 1.575 km² and a population density of 2.016 in/km^2 the Milan Metropolitan City is the residence of 3.196.826 inhabitants (2014), and is the richest metropolitan city in Italy with an average household/capita income of 26.733€ (in 2017) and the second for demographic dimensions.
In order to allow for a better management of the metropolitan cities the national law 2014 envisaged the possibility to constitute sub-areas, called *zone omogenee* (homogeneous zones), characterised by a shared set of properties, grouping into different territorial clusters the metropolitan context (Fig. 15). The dimensions considered for the constitution of such areas are: the geographical characteristics, socio-demographic profile, historical, economic and institutional commonalities. In the Milanese case 7 different zones have been defined:

1) Alto Milanese
2) Magentino e Abbiatense
3) Sud Ovest,
4) Sud Est,
5) Adda Martesana,
6) Nord-Ovest,
7) Nord Milano

As already affirmed before, the 7 areas delimitation is based on the institutionalization of the results coming from a former scientific project developed by the former Province, called "*Città di città*". In that contribution the research committee highlighted the existence of 7 potential different cities (plus Milan and three areas constituting the nowadays province of Monza e Brianza) in the territory belonging to the province of Milan, according to the criteria already cited.

Fig. 15 – The Metropolitan City of Milan and its 7 homogeneous zones as instituted by the Metropolitan Assembly (Deliberazione n. 51/2015).

Source: Milan Metropolitan City official website (http://www.cittametropolitana.mi.it)

The Metropolitan City's territory is one of the most dynamic of all the country, not only of the Lombardy region: the rate of birth of enterprises is 6,7%, higher than the national and regional ones, producing more than the 9% of the total exported goods of the country (Città Metropolitana di Milano, 2016). It employs almost half of the region's employees, mainly in the secondary, but also in the tertiary sector. It represents also a relevant national scientific hub, hosting 8 universities (among the highest ranked in Italy) and more than 180.000 students.

From the natural point of view the territory of the metropolitan city is a variegated context, more densely inhabited in the northern part and less developed in the western and southern areas, covered by two of the main regional parks (*Parco del Ticino* and *Parco Agricolo Sud Milano*), for an amount of 840 kmq of protected areas (the 53% of the whole territory). In the time interval between 2000 and 2012, DUSAF data[35] showed an increase of the built up soil of the 2% circa, mainly due to the increase of productive establishments or infrastructures (2/3 of the increase), the 60% of which is concentrated on already developed land.

Looking at the mobility infrastructural aspects, the metropolitan City is characterized by a radio-centric pattern of mobility, being Milan the most relevant and attractive center of the area. This causes phenomena of congestion around the city, that the recent development of public transportation system (in particular through the empowerment of the suburban railway network) had not succeed in reducing enough. Intermodal transport and extension of the local transportation system beyond the municipal boundaries of Milan are among the key instruments through which the current situation has been planned to be faced.

If the definition of the metropolitan city as a new administrative unit has been the difficult result of a long standing process, it does not represent a definitive one, also due to its lack in detecting and consequentially, managing the socio-economic functions acting on the territory (see previous paragraph for an example).

As we could highlight thanks to the argumentation developed by Del Fabbro, many different functional extents of the Milanese metropolis could be drawn, and all of them consistently overpass the boundaries defined by what until today looks like a weak attempt to give an answer to a complex issue. Many critiques have been raised by the public opinion, in the press, but also by experts (see the various contributes appeared in *ArcipelagoMilano* web community). Roberto Camagni adfirms in fact that:

> La città metropolitana delineata nella legge Delrio è inadeguata. I nuovi enti assomigliano molto alle province, ulteriormente indebolite. La questione del sindaco metropolitano e gli obiettivi e le competenze da rafforzare[…] la distanza fra obiettivi e soluzioni appare tale da far presagire un'ennesima occasione mancata per il paese.
>
> *LaVoce.info*, 18/02/2014[36]

[35] DUSAF stands for "Destinazione d'Uso dei Suoli Agricoli e Forestali" and is the database elaborated by the region in order to monitor the land use changes, combining orthophotos and other administrative data sources.

[36] "The metropolitan City designed by the *Delrio law* is not adequate. The new bodies are very similar to the provinces, further weakened. The issue of the metropolitan Mayor and of the tasks and competences are to be reinforced […] the distance between objectives and solutions seems to prepare the further country's wasted opportunity." (our translation)

So a first critique could be addressed to the territorial structure of the final new institutions "very similar to the provinces" but that should act on a much broader extent.
In the Milan metropolitan city definition for example some areas strictly linked functionally to the Milanese urban context are kept out: Monza, that is probably the most evident case, and all the municipalities that are located in the north-east part of that area, where the built up land show an uninterrupted pattern from the Milan city and functional relations are very intense.
A second critical point is linked to the financial and resources provision for the new institutions, that has been compromised by the popular rejection of the Constitutional Reform proposed by the government in December 2016. The reform project was narrowed, among the other objectives, to the abolishment of the Provinces, that had to be substituted by lighter bodies, not directly elected or by the new-born metropolitan cities. Its aim was to strongly resettle the institutional assets of the Republic, and it should have followed the legislative institution of the Metropolitan Cities themselves, completing their constitutive process. As highlighted by the *Conferenza delle Regioni e delle Province Autonome*[37] (Region and Autonomous Provinces Conference) without the approval of the Constitutional Reform the MC introduction has been not perfected, producing a stuck in the institutional structure, and a systematic lack of financial resources for the already existing provinces and the new-born Metropolitan Cities:

> Si sottolinea quindi l'impossibilità da parte di Province e Città metropolitane di far fronte pienamente all'esercizio di funzioni. A mero titolo di esempio, spicca l'assistenza e il sostegno agli studenti disabili, per le quali lo Stato ha stanziato - per il 2016 e con la legge di Bilancio 2017-2019, per il 2017 -70 milioni di euro, importo che copre a malapena la metà del fabbisogno riscontrato a livello nazionale.[38]
>
> (Documento 17/1/CR05/C2 presentato alla *commissione parlamentare per l'attuazione del federalismo fiscale*, 19/01/2017)

We will not address deeper here the problematic of the current metropolitan cities roles and the reasons that brought to such a situation, we wanted just to stress that the institution of the new bodies did not solve the issue of finding a new tool or strategy to manage the functional metropolitan complexities that are investing and transforming the Italian urban contexts since at least 30 years[39]. The scope is too narrowed, and the basis on which the reform has been developed misleading. Martinotti was clear in one of his last contributions on the issue, stating that "*il termine di città-metropolitana è l'ennesimo fuorviante ossimoro prodotto dal burocratese. La forma metropolitana è un*

[37] The Conference is a political coordination organism, composed by the presidents of the 20 regions and 2 autonomous provinces, born in 1981 to help the new-born (1978) Regions and autonomous Provinces (like Trento e Bolzano, whose territorial and cultural peculiarities brought to the recognition of a broader autonomy by the State), in order to better act in the relations with the Central State and promote *best practices*.
[38] "We highlight the lack of possibilities for the Provinces and the metropolitan cities to accomplish their own functions. Just as an example, is relevant the case of the assistance and support services for the disabled students, which the State has funded, in 2016 and with the Budget Law 2017-2019 in 2017, with 70 million euros, covering rather the half of the national amount required."
[39] As a consequence, also from an analytical point of view, it is not possible to properly compare the different Italian Metropolitan Cities, due to the strong differences between them and the lack of correspondence to their functional extension.

tipo d'insediamento nuovo e diverso da quello urbano o cittadino."[40](ArcipelagoMilano 24/07/2013)

The result is not satisfactory, but the condition of Milan is not so different from other European cities' one: the same phenomena are of course common to other countries' urbanization processes, where the complexification of the metropolitan realms is pressing for new solutions to be found. In the next paragraph we will show another case study, facing similar challenges, we will use to compare to the Italian case of Milan.

[40] "Metropolitan-City is the last misleading term produced by the bureaucratic language. The metropolitan figure is a new kind of settlement, different from the urban or city one". (our translation)

4.4 The Lyon case study

4.4.1 The Grand Lyon case: a high rank city, a similar condition.

Our analysis will consider another case study, comparable to Milan in terms of economic relevance in its national context (and only partially in the European one) and in economic structure. If compared to the Milan city case the city of Lyon experienced clearly a different history in the territorial development in terms of administrative evolution (different, even if not strongly, is the national administrative structure and balance of powers among the different local authorities), but significant similarities can be found at a deeper sight.

Both countries are divided in fact into 4 main administrative levels: Central State, Region, Province (Department in France), municipality[41] even if competencies and relevance in the administrative hierarchy are not strictly corresponding: regions for example have much more institutional weight in Italy than in France and local representatives of the Central State (the Prefects) have much less power towards local authorities decisions in the Italian context. As already shown, recently a new administrative body has been introduced both in Italy and in France, at the same hierarchical level than the Province or the Department: the Metropolitan City, that substituted the former provinces/departments of which they share the relative territory[42].

4.4.2 The city of Lyon

Lyon is the 2nd main French city for population dimension and economic position, and one of the main centers of the European continent. The relevance of the city in the national context is confirmed by DATAR[43] that in 2003 ranked Lyon higher than Marseille and Lille, while according to ESPON and OPALE[44] data, its connectivity is, referred to an European average of 100, 126 in 2004 against 120 of Lille and 107 of Marseille (quoted in ESPON 2010). Its median income for unit of consumption was also among the highest in 2014, with an amount of 21.493, while Marseille (19.745) and Lille (19.203) lag behind (see Tab. 5).

---

[41] France → Central State – Regions (13 in Metropolitan France) – Departments (96 in MF) – Municipalities (36.446 in MF)
Italy → Central State – Regions (20 + 2 autonomous provinces) – Provinces (87 + 14 metropolitan cities substituting former overlapping provinces) – Municipalities (7.978)

[42] In France actually the Metropolitan Cities exert the same powers of the Department on the territory under their jurisdiction.

[43] *Délégation interministérielle à l'Aménagement du Territoire et à l'Attractivité Régionale*, French consultancy institute for the Minister of Territorial Development, recently merged with the *Secrétariat général du comité interministériel des villes* (SGCIV) and the *Agence nationale pour la cohésion sociale et l'égalité des chances* (Acsé) to constitute the CGET (*Commissariat général à l'égalité des territories*).

[44] *Observatoire Partenarial Lyonnais en Economie* (Partnership for the observation of the Lyon economy), created in
2000 by the major local authorities, chambers of commerce, development agencies and business organizations of the
metropolitan area (from ESPON 2010).

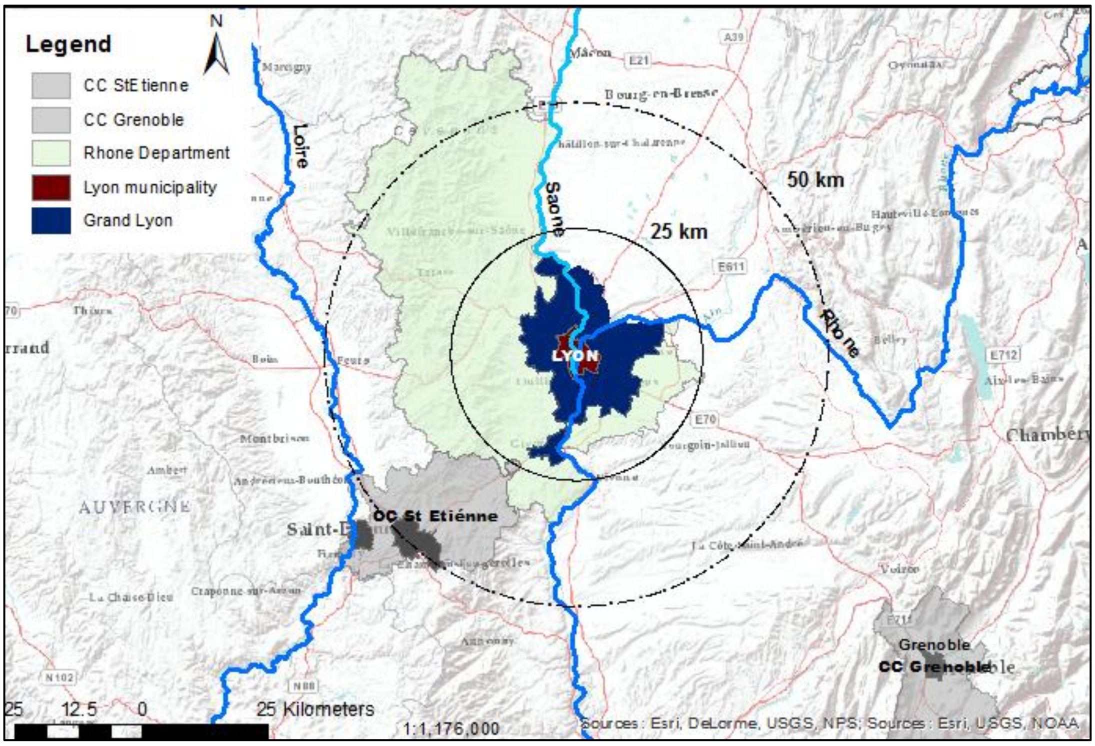
Tab. 5 – Population, employment statistics and income in the 4 main French Urban Units* (2009 and 2014).

	population		pop. growth rate	employed	unemployed	median gdp
	2014	2009	% 2009-2014	%	%	euros
Paris	10.659.489	10.413.386	2,4	66,3	9,8	22.325
Lyon	1.620.331	1.536.974	5,4	63,7	9,8	21.493
Marseille	1.578.484	1.557.950	1,3	57,9	11,1	19.745
Lille	1.037.939	1.015.744	2,2	57,8	12,2	19.203

Source: our elaborations on INSEE data 2017. * for Urban Units is considered the INSEE definition of it.[45] According to 2010 classification the Urban Unit of Paris includes 412 municipalities, Lyon 130, Marseille 49, Lille 59.

Located in the south-east of the country, it is settled on the confluence of two rivers, the Rhone (4th French waterway for length) and the Saône (11th), in an area enclosed between the Alps (east) and the *Massif Central* (west). It has been historically a crossroad for the commercial and cultural traffics: between Swiss, Italy and France (connecting Geneva, Turin and Lyon on the east/south-east axis), but also from and to Marseille and the cities of the southern coast (north-south axis), thanks to the Rhone waterway. The Saône connects the area to the Seine and Rhine basins in the north, opening the path to the North Sea (Fig. 16).

Fig. 16 – Location of Lyon and of the main close agglomerations of St. Etiénne and Grenoble.



Source: Our elaboration on INSEE, OSM and ESRI data.

The city has always been a strategic node, dating back to its foundation by the Romans (it was Capital of the Gaul Province), facing a decadence period during the middle age, and regaining relevance in the Renaissance (Carpenter and Verhage, 2014).

[45] It is defined as Urban Unit a municipality or a group of municipalities constituted by a continuous built up zone (separated by a distance of maximum 200m) including at least 2.000 inhabitants.

Similarly to Milan, it developed an upstanding position in the industrial system of the country, thanks to its strong industrialization process that brought the area to be leader since the 17th century in the textile sector, then in the chemical one, and more recently in the new sectors of pharmacy and health science (it hosts companies like Sanofi and Merieux). If in fact the industrial sector is still relevant (even if in the years a decrease has been recorded in the employed stock, amounting for example to -7,6% from 2009 to 2014 in the urban unit), the tertiarization has invested recently the whole urban area of Lyon, increasing the number of its employees of 6.4% between 2009 and 2014 (INSEE).

In 2015 Lyon shows to be the most economically dynamic among the main French cities (excluding Paris), with a higher percentage of workplaces in industry and a slightly higher than Marseille, but lower than Lille in services:

Tab. 6 - Workplaces in all economic sectors, Urban Areas of Lyon, Marseille and Lille.

	Lyon		**Marseille**		**Lille**	
	n.	**%**	**n.**	**%**	**n.**	**%**
Total	*913.597*	*100,0*	*647.63*	*100,0*	*500.724*	*100,0*
Agriculture and fishing	2.819	0,3	1.874	0,3	1.922	0,4
Industry	138.545	15,2	67.261	10,4	42.137	8,4
Construction	54.993	6,0	35.445	5,5	25.045	5,0
Retail, transports, services	461.795	50,5	319.117	49,3	260.091	51,9
among which in automobile sector	125.843	13,8	83.861	12,9	77.879	15,6
Public Services	255.445	28,0	223.933	34,6	171.529	34,3

Source: our elaboration on INSEE data 2015.

This is also the result of a relevant investment plan in Research and Development, that brought the area to be the third one in the country for European patent production in 2003-2005 (after Paris and Grenoble) (OMPREL, 2010)

Its Urban Area[46] has grown constantly in the last years (see Fig. 17), and more than Lille and Marseille ones, cities of a similar level. Its population grew of 28% from 1999 to 2010, absorbing the AU Bourgoin-Jallieu, and Villefranche-sur-Saône, shifting its barycenter towards est, direction in which the development has traditionally gone since the 1970s, due to the effect of the St.Exupéry airport attractiveness, touching the limits of the close AU of Grenoble (Agence d'Urbanisme Lyon, 2011).

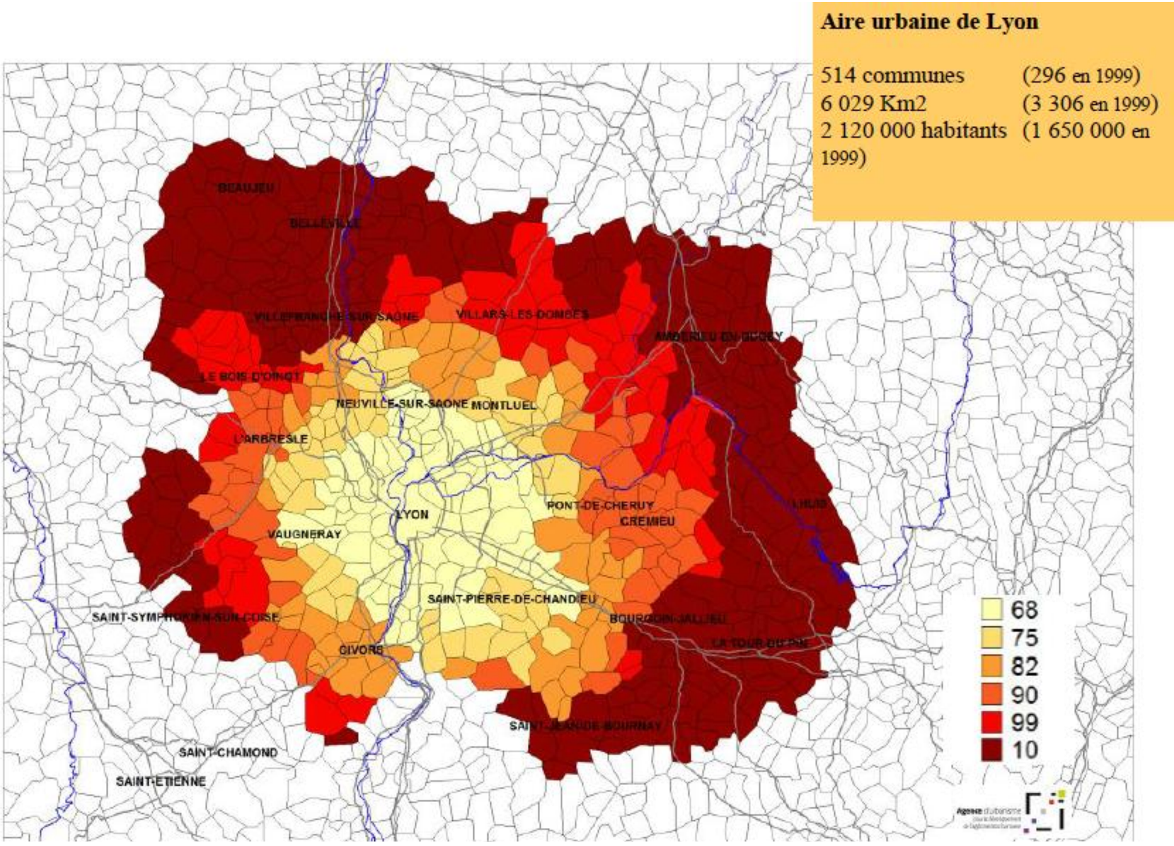
However, the strong development experienced in the last years has not been homogenous in all the territory covered by the Lyon influence, also looking at a smaller scale: the Metropolitan City (former *Grand Lyon*). For example transportation system has improved for the municipalities included inside the GL boundaries, while the same cannot be said for the outer area, facing the consequences of traffic increase due to the urbanized area extension (ESPON 2012).

The many challenges produced by the evolution of the urbanization process in the area have been faced by the authorities with a consistent effort into cooperation and territorial agreements, whose first attempts date back at the beginning of the XX

[46] As defined by the INSEE (cfr. paragraph 4.2.2.2).

century, with variegated results, both positive and negative. As a consequence the area can be interpreted, in terms of extension and territorial domain, in various ways, changing according to the relative composition of municipalities cooperating for different purposes and for this reason gathered into different territorial collective bodies. In the next section we will show the main territorial bodies currently existing in the area, representing different interpretations of the Lyon metropolitan context.

Fig. 17 – Lyon's Urban Area evolution from 1968 to 2010 (in different colors the various time frames from lighter, older, to darker, newer)



Source: Agence d'Urbanisme Lyon, Observatoire Parternarial Demographie, October 2011, n.2, p.5, original data source INSEE 2010.

4.4.3 *Many ways to define Lyon: functional and administrative perspectives*

An important role in the Lyon area has been traditionally played by the local Joint authorities, a territorial management institution supported by the central state in order to face the strong fragmentation that characterizes the French territory, divided into more than 36.000 municipalities, whose relations have been increased in complexity due to the metropolisation phenomenon[47]. As highlighted by Nicholls (2005) such a need for a new approach to territorial governance emerged in the 70's, when the urbanization and growth of the peripheral centers brought them to face new needs, asking for more resources adequate to their increasing relevance. The former tradition of favoring the central cities role was consequently questioned, pushing to a renewal in the territorial govern, open the shift from the tradition of *government*-driven to that of *governance*-

[47] From 2013 (réforme territoriale du 16 décembre 2010) each French municipality must belong to an EPCI body (see next paragraph for further details on EPCI entities).

driven development[48]. Often such a decentralization and reshape of territorial authorities opened a new front of discussion and analysis, due to the overlap of competencies and the consequential conflicts emerging among the authorities and between them and the administrative bodies (following the *Deferre* Laws of 1982).

Local authorities got the role of "policy communities […] formal agencies with decision-making bodies, internal divisions of labour, administrative apparatuses and technical services responsible for implementing tasks" (Nicholls, 2005, p.792). They can assume different forms like inter-municipal organizations (*Etablissements Publics de Co-ope´ration Intercommunale*, EPCI), public–private organizations charged with specific development responsibilities (*Sociétés d'Economie Mixte Locales*, SEML), and contract-bound committees (*politique de la ville*). Such a change in the territorial management introduced a new policy implementation approach, characterized by a strong emphasis on the *contractualisation* of the governance (Gaudin, J. P., 1995), made by agreements and contracts between administrative bodies. Among the most relevant recent bodies of this kind the EPCI have a particular role, (they somehow act as parallel administrative bodies, equipped with an own fiscal autonomy and budget, see box 2).

4.4.4 Lyon area inter-municipal cooperation tradition and territorial composition

4.4.4.1 The Lyon's Spirit

Lyon is characterized by a quite consolidated legacy of territorial cooperation, due to its specific experience of network governance arrangements that have brought to the last innovations in the field and to its current metropolitan structure (Carpenter, Verhage, 2014). Such an expertise and tradition has been attributed to the *Esprit Lyonnaise* (Lyon's Spirit), an administrative and political attitude oriented towards an horizontal cooperation, where, even if the Mayor of the main center, Lyon, was recognized as the leader of the territorial management authorities, the core of the action has always been firmly respectful of the local autonomies and oriented towards a fruitful collaboration with private actors.

The constitution of the nowadays Grand Lyon is just the final step of a long path of cooperation and succession of different aggregation of municipalities sharing common services as a base of networking. In the 30's and 40's the first *Syndicats Intercommunaux* were born, in order to manage three different and relevant services for the municipalities around the main city: the water supply, the public transports and the waste collection and disposal (Scherrer, 1995).

[48] As highlighted by the New Urban Politics and its following interpretations, the current territorial management has shift from a *government*-driven development and management regime to a more complex and fragmented *governance*-driven approach, more suitable to face the issues raised by the impact of nowadays global economic processes on the local territories. (Cox, 1993; Le Gales, 1995).

Two periods can be distinguished: a first one regarding Lyon and its first ring of municipalities (the *banlieue*) in the '30s, and a second one regarding the further municipalities (once rural) in the 60s and on. In 1929 the *Syndicat des Eaux de la banlieue* gathered 28 municipalities of the Lyon's fringe, but it has never been fully operative until 1949. In the same period other attempts of generating inter-municipal bodies for collective services management can be found in the transportation field (with the creation of the first nucleus of SYTRAL, managed by the city and the Rhone Department) and in the planning schemes (bringing to the initial definition of the metropolis' functional space in 1939). The main issue in the functioning of the various inter-municipal authorities has always been the presence and role of the Lyon city, able to act as a catalyst in the cooperative relations between territorial entities, and the conflicts or agreements among municipal groupings.

Box 2

Scheme of administrative bodies' structure in France (updated 2017)

In addition to Municipalities, Departments and Regions, in the French territorial system act specific forms of inter-cooperation between administrative bodies: the *EPCI* (*établissements publics de coopération intercommunale)*. According to the *Réforme Territoriale de 2010* and of the law 27 January 2014 *de modernisation de l'action publique territoriale et d'affirmation des métropoles*, are defined as EPCI, in order of territorial relevance:

- *syndicats de communes* (introduced in 1890) ;
- *communautés de communes* (introduced in 1992) ;
- *communautés d'agglomération* (introduced in 1999) ;
- *communautés urbaines* (introduced in 1966) ;
- *les métropoles* (introduced in 2010).

All the categories of EPCI (excluded the *syndicats de communes*) are EPCI *à fiscalité proper* (they manage a specific budget that can be funded directly, *à fiscalité professionelle unique*, or through a part of municipalities' fiscal revenue, *à fiscalité additionelle*).
They differ in terms of (1) flexibility in the constitution process, in (2) minimum size for their constitution and relevance/number of (3) functions delegated by the administrative bodies composing them:

The C*ommunautés de Communes*, the simplest ones, can be created without minimum size limits and can be dissolved.

Communautés d'Agglomération and *Communautés Urbaines* can be created only for urban agglomerations of at least 50.000 inhabitants and 250.000 inhabitants respectively and cannot be dissolved by the municipalities'assembly (only by higher hierarchical institutions).

The *Métropoles* (*de droit commune*) are defined as EPCI with at least 400.000 inhabitants and located in an Urban Area (INSEE definition) of at least 650.000 inhabitants or in which a Regional Capital is hosted. It is possible (but not compulsory) to convert into *Métropole* an EPCI in which is located a Labour Zone (*Zone d'Employ*).

4.4.4.2 The Great Lyon

But the real process of empowerment of the local cooperation reached a successful result later, at the end of the '70s, with the constitution of the *Communauté Urbaine* of the *Grand Lyon* (Great Lyon). The *Grand Lyon* authority was created in 1969, collecting 58 municipalities among which Lyon acted as barycenter: and it represents today 440.000 inhabitants on 1.3 million of the entire agglomeration. The gathering worked as a joint authority, whose creation has been strongly sustained by the central state (more precisely "imposed" by it, Scherrer,1995), in order to produce a management administrative framework able to better rule a complex and expanding urban context[49]. It has gained progressively more and more competences in the domain of urban services (roads, water supply, cleaning, waste disposal), in urban development, in economic and big infrastructures management. It progressively evolved from an inter-municipal body in charge of networks and services management only, to a proper administrative body working on strategic planning, designing the decisions able to shape the future territory (SEPAL, 2017). As a final (?) step in this evolution process, in 2015 the Grand Lyon has been converted into a new administrative body, the Lyon Metropolis (*Métropole de Lyon*), to which all the competencies of the former Rhone Department have been transferred (social policies implementation, sport and cultural infrastructures management, departmental roads maintenance, …), substituting it on the territory of its jurisdiction.

4.4.4.3 The Lyon's SCOT

On a parallel path at the beginning of the 1990s a new territorial management proposal was carried out by the Lyon city's Mayor (Michel Noir): the *Scheme de Cohérence Territoriale* (SCOT). The SCOT is a legal document ruling the planning scheme of the area covered by the inter-municipal body by which it was founded, which has a *de jure* power over local plans (*Plan Local d'Urbanisme* – PLU) which must be consistent with it. However, the SCOT was produced in such a way that local plans have a *de facto* autonomy. The organism in charge of the definition of the SCOT is the Sepal (*Syndicat mixte d'Études et de Programmation de l'Agglomération Lyonnaise*), created in 1985, whose main objective was to innovate the planning tradition shifting it from a *normative* to a *strategic* approach.

A Territorial Coherence Scheme is in fact both a political project and a planning tool at high scale, elaborated on a time interval of 20 years, long enough to produce a development perspective able to enhance territory's structuring. It is designed in order to coordinate the various sub-tools that has been introduced in the 1990s legislation (e.g. *Plan des déplacements urbains*, *Programmes locaux de l'habitat*, *Schéma directeur d'urbanisme commercial*, etc…), and solve the challenges and issues produced by such

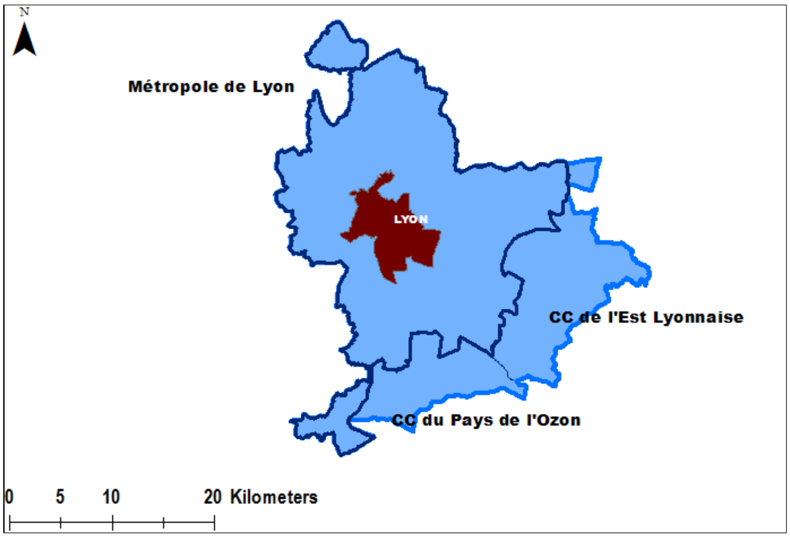
[49] It is not here intended to discuss exhaustively the issue of legitimacy and the conflicts generated by the French legislative approach towards the integration of municipalities, but it is important to highlight how the process of creation of inter-municipalities is strongly controlled and managed by the Central State through the role of the local Prefect (*Préfet*), regional or departmental, who can force and dismantle municipal cooperation structures on its own (Unione dei Comuni della Bassa Romagna, 2017). It is anyway possible for the inter-municipalities' assemblies to vote against a prefectural decision in order to stop it (but with a *qualified* and not *simple* majority). Such a situation caused numerous objections raised by the local administrative actors and municipalities (Gardere, 2013).

a fragmentation and specialisation of the planning instruments (SEPAL, 2017) and of the actors engaged in nowadays urban territorial management, and by the need to guarantee a sustainable development in the management of metropolitan phenomena occurring in the last decades.

The SEPAL gathers 74 municipalities of the Lyon area, grouping three *Communautés de Communes*, from here on CC, (Inter-municipal body): the Lyon Metropolis (Grand Lyon), la CC de l'Est Lyonnais (Intermunicipality of the Est-Lyon) et la CC du Pays de l'Ozon (inter-municipality of Pays de l'Ozon) (Fig. 18).

As *Syndicat* it has not financial autonomy, but a dedicated budget attributed by the various EPCI composing it[50], in order to fulfill its aims that consist in following the phases of definition of the SCOT and checking for its application. Beside the CC other institutions take part to the SEPAL, both public (administrative bodies) and private (associations and economic unions): the Region Auvergne Rhone-Alpes, the Rhone Department, the SYTRAL, the Lyon metropolitan Chamber of Commerce, …, etc.

Fig. 18 – Lyon's SCOT territorial extension and composition.



Source: our elaboration on DREAL – Auvergne Rhone-Alpes data 2017

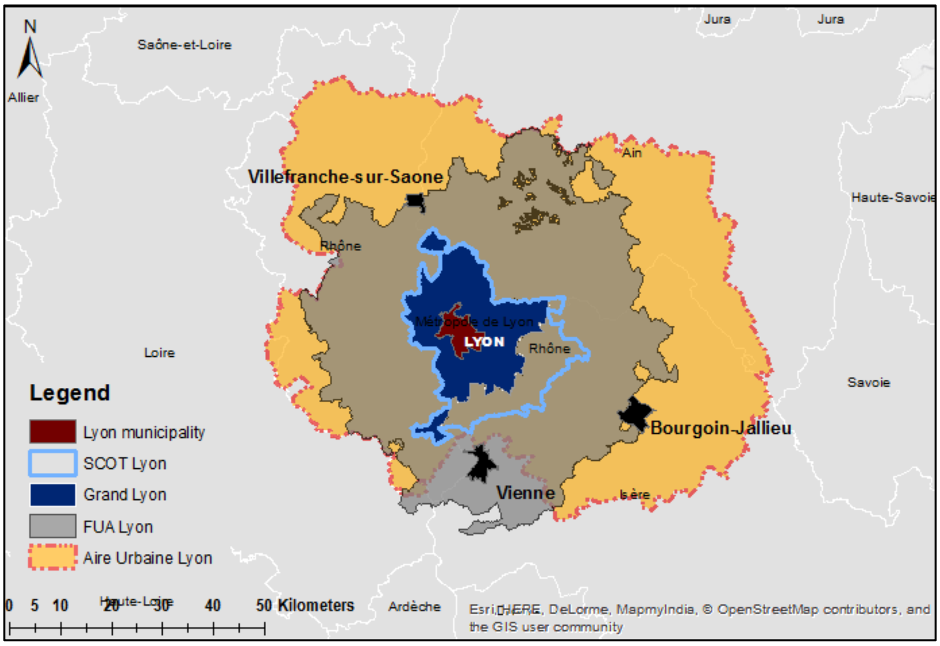
4.4.4.4 The INSEE Urban Areas and OECD FUA

However, from the very beginning it was acknowledged that the territory covered by the SEPAL, the joint authority in charge of the SCOT, was too small to address the planning challenges of the metropolitan area (ESPON, 2012). In fact the extension of the metropolitan functions in the Lyon area embraces a much broader territory, as highlighted by the application of the definitions of *Urban Area* produced by INSEE (2010) and of the similar *Functional Urban Areas* by OECD (2012). Instead of the application of political administrative criteria for territory classification, like in the cases of the SCOT or DTA or *Communautés de Communes*, the definitions of Urban Areas and Metropolitan Areas, focused on statistical purposes, and address the spatial relations

[50] The *Communautés de communes* (and the communautés d'agglomération, related to bigger size groupings) are public institutions of inter-municipal cooperation (*établissements publics de coopération intercommunale*, EPCI) with specific budget, meaning financial autonomy, while the Syndicats don't have such an entitlement. See box 2 for further details.

existing between different settlements and territories, in order to detect the unfolding of metropolitan functions on their territorial extension (cfr. paragraph 4.2.2 for a deeper analysis). Here we can find a similar distinction between two different methods of territorial representation already cited for the Milanese case, highlighted in Del Fabbro (2015): a *spatialist* one, more keen on political relationships and schemes, and a second one more *functionalist* (linked to the DUS and FUR legacy).
A visual comparison between the various proposals make it possible to appreciate these differences:

Fig. 19 – Territorial extent of 4 different metropolitan scope bodies: Lyon Metropolis, SCOT Lyon, OECD FUAs and INSEE Aire Urbaine (2010).



Source: our elaboration on DREAL – Auvergne Rhone-Alpes data 2017, based on INSEE 2008, OECD 2000 and ESRI data.

The Lyon Urban Area (orange) covers a much wider space and territory, including the municipalities of Villefranche (North-West) and Bourgoin-Jallieu (South-East), two of the main industrial and economic centers of the area, locations of secondary and tertiary economic activities of high level (Buisson et al, 2001). It represents a functional urban system hosting about 2 million inhabitants, covering 5.988 km^2 of land and 500 municipalities.
A smaller but analogous representation of the Lyon metropolitan extent is given by the application of the OECD methodology for the detection of the Functional Urban Areas (cfr. paragraph 4.2.2 above), from which emerges that a smaller portion of territory is included (in dark grey in Fig. 19). Has to be stressed although that the basic data for the drawing of the FUAs are referred to year 2000, making it not well comparable with the Urban Areas extension (updated to 2010 data). However the comparison can be done with the other administrative bodies' territories, whose definition does not depend on statistical criteria. The Functional Area covered, in 2000, 3.620 km^2 and hosted 1.856.200 people, according to 2015 data, and 324 municipalities. Differently from INSEE's proposal it includes the CC of Vienne (in the South) but it does not embrace the CC of Porte de l'Isere, both included into the *Pole Metropolitain* (see next

paragraphs). Of course changes could have occurred in the last years, even if we cannot estimate their relevance, whatever it would be, high or low.

4.4.5 Further territorial representations of Lyon's Metropolitan Area

It does not surprise to find out that other broader territorial entities have been developed in the years, more similar in extension to the functional representations of INSEE Urban Areas and OECD Functional Urban Areas just shown, in order to better align policies to their scope. Among these wider governance and cooperation tools/institutes can be enlisted:

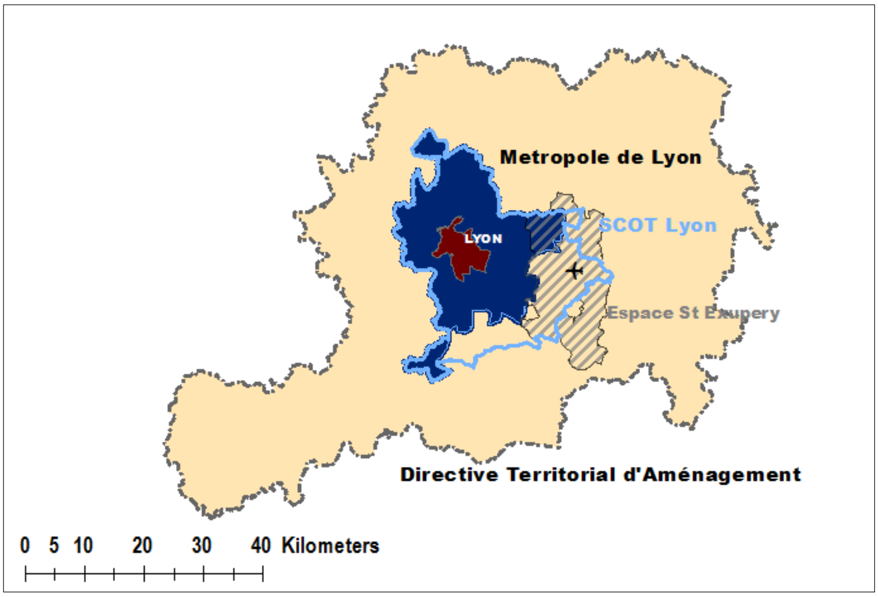
- **The Territorial Planning Guidance** document (*Directive Territorial d'Aménagement* – DTA), which details the State's priorities in the medium and long term for planning in the national interest.
- **The Inter-SCOT** plan, coordination tool derived from the SCOT, enlarged in order to be able to solve the issues due to its restricted domain.
- **The Metropolitan Pole** (*Pole Metropolitain*)**,** instituted on the base of the 2010 reform (loi n° 2010-1563, 16th december 2010)
- **The *syndicat mixte des transports de l'aire métropolitaine lyonnaise*** (SMT AML).
- **The Lyon Urban Region** (RUL, an association of local bodies, dismantled in 2014)

All these bodies can be grouped in our opinion into 3 different categories according to their specific nature and aims: strategic planning authorities; local services management bodies and territorial associations.
A first group is composed by DTA and Inter-SCOT, both strategic planning realities, but distinguishable according to the players in charge of their building and implementation. DTA is a central state led and designed ruling, while the Inter-SCOT is the product of an effort coming from the cooperation between local authorities, working together in order to harmonize the specific planning plans, relative to their own territories, and face those broader challenges that are not able to be address by singular actors. A second group is composed by the Metropolitan Pole and the Syndicats mixtes, whose aim is to manage the territories of the members, and in particular cooperate for and efficient management of specific services (water supply, waste disposal, …), without a strategic perspective for future general development.
A third group is constituted only by the Lyon Urban Region, a political light association of administrative authorities, founded by the former mayor Noir, and dismantled in 2015. It was thought as a discussion arena for the intercooperation of Lyon area's administrative and economic actors, never really worked as an institution.

4.4.5.1 The Directive Territorial d'Aménagement (DTA)

DTA, approved in 2007, covers the agglomerations of Lyon, Saint-Etienne and Nord-Isère, extending on 4 departments' territories (*Rhône, Ain, Isère* and *Loire*), and includes 382 municipalities. It represents the effort of the central State in orientating the long-term development of the Lyon area in terms of natural and agricultural space management, of economic development and transportation policies and strategies. The main focus of the DTA is in fact to manage on an higher scale the planning of Saint Exupéry airport area, in order to harmonise it with the local bodies' strategies (local SCOTs), orienting them to empower the intermodal transportation system of the area and reducing the soil exploitation and land use. For this reason Lyon's Scot has integrated in 2015 the directives given by the DTA about what has been called the *Espace Interdépartemental Saint Exupéry*, a group of 20 municipalities around the St Exupéry airport covering a strategic territorial context for the development of the area's infrastructural system (SAPEL, 2017).

Fig. 20 – Comparison between the territorial extents of Lyon Metropolis, Lyon's SCOT and DTA, with highlighted the *Espace Interdépartemental Saint Exupéry*, designed around StExupery airport.



Source: our elaboration DREAL – Auvergne Rhone-Alpes data 2017, INSEE, and ESRI data.

The DTA has a wide metropolitan scope (it is not by chance that the official documents introduce it has the "DTA of the Lyon *Metropolitan Area"*[51]) and represents one of the most interesting efforts made by the Central State to address the management of the metropolitan area of Lyon with a tool aiming at adjusting policies' domain to the real extension of functional metropolitan relations.

4.4.5.2 The Lyon's Inter-SCOT

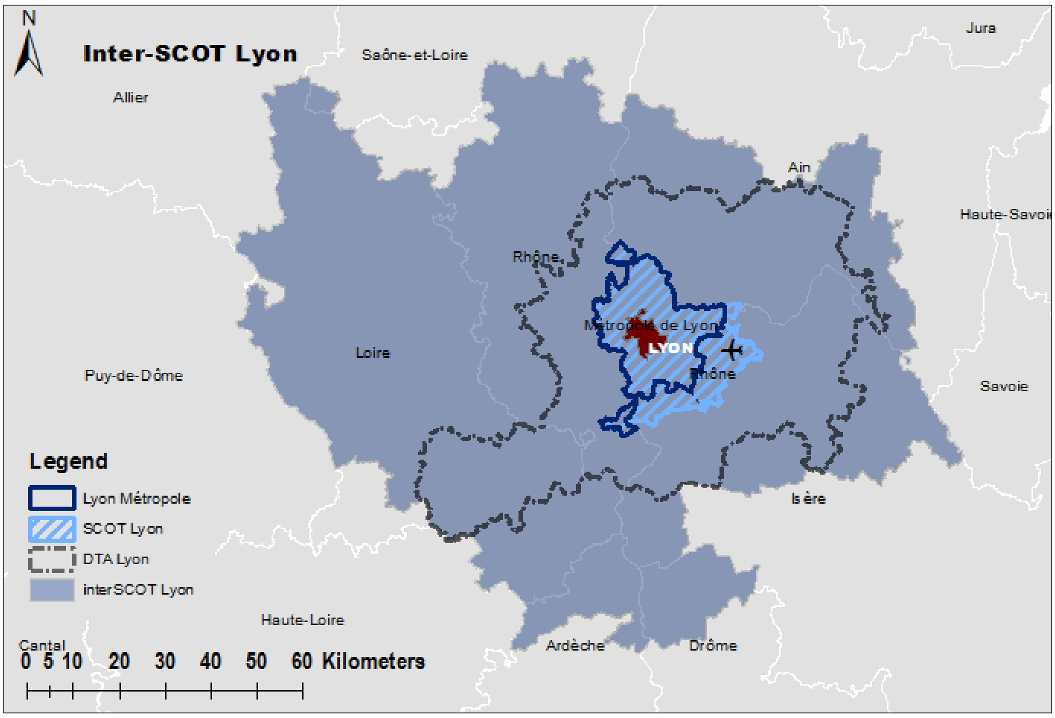
On the local level, for a similar purpose, the project of Inter-SCOT was developed. In order to compensate and adapt in fact the limitations of the strategic plans produced by first SCOT it was decided to start a process of cooperation regarding a much larger territory: the Inter-Scot process (ESPON, 2012). The Lyon Urban Agency worked in order to favor the networking of the many local *Syndicats Mixtes* (inter-municipal

[51] Rapport de la Commission d'Enquete 2014 relative à la modification de la Directive territoriale d'Amenagement de l'Aire Métropolitaine Lyonnaise sur les 20 communes de l'espace Saint-Exupéry.

coordination bodies[52]) in charge of their own SCOTs, belonging to the Lyon and St. Etienne Metropolitan Areas, and to enhance the coordination of the specific objectives and analysis of the issues faced, for the individuation of common interests.

The Inter-Scot area finally covers 1.000 municipalities (among which are included as said Lyon and Saint-Etienne) organized in 10 different *Syndicats*, and 3.2 million people.

Fig. 21 – territorial extension of Lyon-St.Etiénne Inter-SCOT.



Source: our elaboration DREAL – Auvergne Rhone-Alpes data 2017, INSEE, OSM and ESRI data.

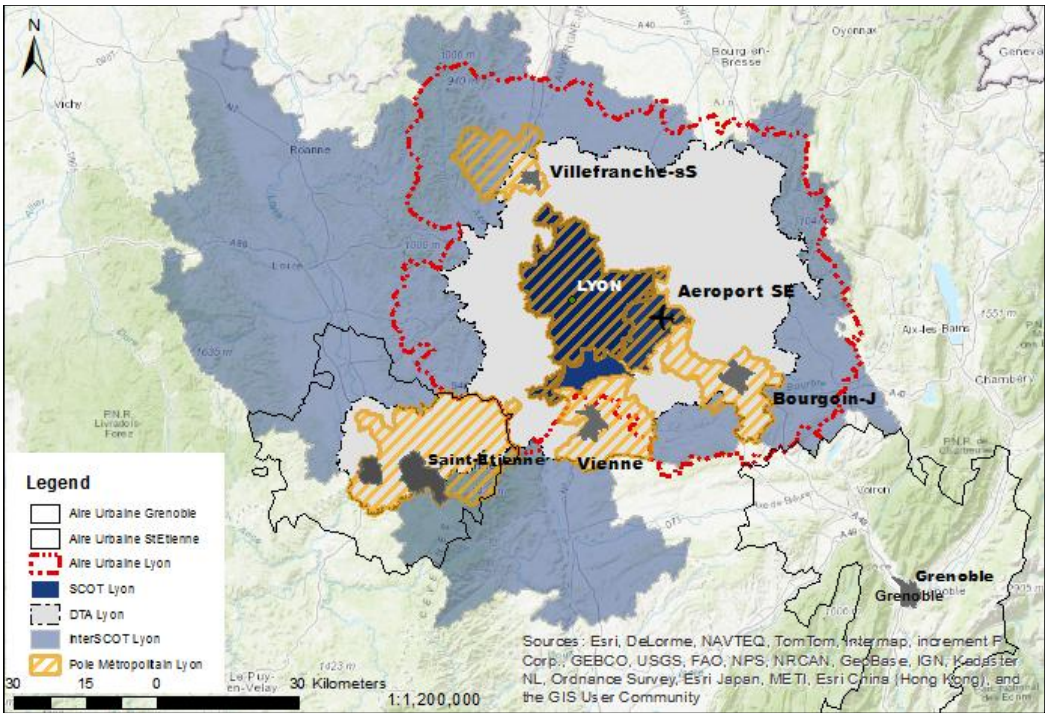
4.4.5.3 *Le Pole Métropolitain*

In 2012 a new base for the creation of a higher administrative level, more suitable for the coverage of the real extension of metropolitan functions in the area, was defined through the introduction of the *Pole Métropolitain*, a new institution whose aims range from transport administration, to the more general economic and environmental dynamics. The initiative, born as implementation of the administrative territories' reform of 2010 (loi n° 2010-1563, 16 December 2010), brought together the actors of the joint authorities existing in the region, gathering four major entities: the Greater Lyon, the St.Etienne Metropolitan area, the group of municipalities around Bourgoin-Jallieux and the town of Vienne in the south of the area, producing a final agglomeration of 140 municipalities, including about 2 million people (an amount close to the one defined by the INSEE classification seen just above) (

Fig. 22).

[52] The *Syndicats intercommunaux* are a simplified and less structured kind of inter-municipal cooperation body, belonging, as well as the Communautes de Communes, to the main category of EPCI.

Fig. 22 – Comparison between different territorial representations of Lyon Metropolitan context: Lyon's SCOT, DTA, Metrpolitan Area by INSEE, Inter-SCOT and Lyon Pole Métropolitain.



Source: our elaboration on DREAL – Auvergne Rhone-Alpes data 2017, INSEE, OSM and ESRI data.

The new institution showed already from the beginning some weaknesses and criticalities, for example the lack of territorial contiguity between CC composing it, and the exclusion of the St.Exupéry airport area from the *Pole Métropolitain*, that appeared, correctly, to be illogical, but deep rooted in local political and territorial relations. Local conflicts in fact arisen in the 60s and 70s during the important phase of reorganization of the departmental structure and of the strategic planning of the area (Carpenter, Verhage, 2014), that brought to the imposition from higher hierarchical administrative levels of specific decisions not shared by the municipalities located in the east of Grand Lyon authority, where the airport is settled. Such a friction enhanced the constitution of the Communauté de Communes de l'Est Lyonnais (that are part of the SEPAL as seen above), in order to give to that cluster of municipalities a stronger voice and autonomy in the governance relation with local and country level entities, voice that was expressed through the decision of not entering the new Metropolitan Pole authority. An agreement between the *Pole* and the CC de l'Est Lyonnaise was finally found in 2016, and frictions were fixed, since it decided to join the new territorial entity. Few time later also the CA de Villefranche joined the authority, including in this way the last main economic agglomeration of the area, increasing the overlap between the DTA and the UA domains.

Summarizing we can define 7 very different interpretations of the metropolitan area of Lyon (Tab. 7), some of which displaying a centripetal structure (Grand Lyon, SCOT, FUA and AU), other a more multipolar shape (Pole Métropolitain, inter-SCOT), due to the inclusion of other relevant centers of the area (the main of which is St.Etienne). Differences occur of course due to the reasons and principles on which they have been produced and to the aims they have to reach, but from their brief analysis what emerges is the need, for territorial management authorities, of finding tools for the interpretation of a dynamic and rapidly evolving context, for which the traditional administrative domains are not anymore sufficient instruments.

Conclusions

In this chapter we saw how the scientific debate on the urbanization phenomenon has been impacted by the emergence of a new form of city: the metropolis.

With the evolution of the traditional, compact city into the nowadays metropolitan areas a need for new interpretations of its territories rose in the last decades, carrying to a wide amount of proposals for their delineations. The main difficulties in pursuing such a task are due to the dynamic nature of the metropolitan phenomenon and to the data collection: the lack of harmonized datasets among countries was the main issue against a common definition and representation of the metropolitan areas extension on an international level. Many national proposals in fact have been developed in the years, but usually with scarce possibility to be exported elsewhere without modifications in the methodology.

A further issue is due to the lack of correspondence between institutional extension of the metropolitan realms (as defined through legislation and administrative regulation) and the actual functional domain of metropolitan areas. Due to the fuzzyness of the MA definition, the political structures lag behind the territorial functions impacting on the territory, covering usually just a part of them. The Milanese case is an example of such a situation, where the institutional Metropolitan City[53] did not included many spaces that other representations of the MA considered part of it.

A similar condition is anyway common to other contexts, like the one we took as a comparison case, Lyon. Lyon's situation is although different from the Milanese one due to the longer experience both in statistical and institutional management of the metropolitan phenomenon. A tradition of efforts directed towards the implementation of innovative forms of territorial management has generated a better, at least apparently, correspondence between functional (in its interpretation elaborated by INSEE) and institutional definitions of the metropolitan phenomenon.

The need to overpass the traditional city concept in order to better analyse the nowadays urbanization phenomenon is highlighted by these examples. An urbanization process that, if extending more and more the city boundaries on the territory, cannot be considered homogeneous and whose differences worth to be stressed, in order to better manage the variety of territories generated by it.

For this reason in the next chapters we will present our proposal for a better description of the metropolitan contexts, where the difference between degrees of urbanity and of metropolitanity is at the core of the discussion.

[53] Called correctly "city" and not "area".

Tab. 7 – Overview of 7 different interpretations of Lyon Metropolitan context.

Authority or territorial agreement	**year of establishment**	**Competencies/objectives**	**administrative status**	**Main player**	**surface** (km^2)	**population (2014)**	**Density** (pop/km^2)	**Municipalities** (number)
Lyon Metropolis (former *Grand Lyon*)	1969 as GL, in 2015 converted into *Lyon Metropolis*	Planning, public transport, water treatment, waste management, economic development and culture	yes	Lyon	538	1.354.000	2.516,72	59
SCOT Lyon	2000	Define the general principles of territorial organization and convert them into juridical binding norms	no	Lyon and other CC	756	1.419.000	1.943,83	74
DTA	2007	Details the State's priorities in the medium and long term for planning in the national interest on a specific area.	no	Central State	4.460	2.497.374*	559,94*	382
Urban Area	2010	*Statistical purposes*	no	INSEE	5.988	1.736.961*	290,07*	500[a]
OECD FUA	2012	*Statistical purposes*	no	OECD	3.639	1.954.596*	537,12*	323
Inter-SCOT	2003	The connection of the local SCOTs of the Lyon-St.Etienne Metropolitan area	no	Lyon and other CC	12.300	3.200.000	260,16	1000
Metropolitan Pole	2012	Transportation management, economic development and the environmental protection.	no	Lyon and other CC	1.668	2.037.000	1.221,22	140

Source: our elaboration on DREAL – Auvergne Rhone-Alpes data 2017, INSEE, OSM and OECD data. *data 2013; [a]data 2016.

Chapter 5

Defining a tool to detect the urbanity of spaces in the metropolitan context

Introduction

The measure of the urban development and the evolution of its trend has been at the basis of the literature on Urban Studies of the last decades. As showed in the previous chapter, the analysis of the dimensions describing the evolution of the urban territories has been crucial for the measure of the morphological transformations of the settlements, of the structure of the urban systems and the monitoring of the environmental and social costs linked to the expansion of the metropolitan city (Martinotti, 1993, 1999;Turri, 2000; Camagni, 2002). The look for the drivers, or the functions, characterizing the urban space was the base for its spatial detection and the measure of its magnitude (Gottman, 1970; Cafiero, Busca, 1970; Ercole e Zonta, 1991; Casacchia et al. 2006, Parr, 2007; Bode, 2008).

This corpus of studies has somehow always focused in general on a broad concept of *city*, in which the sociological and cultural aspect of the urban nature received, when it happened, an indirect and gross consideration. Since the aim of these studies was to define the extension of a specific form of the urbanization process (the metropolitan areas, cities *de facto*, Functional Urban Areas, etc…) few attention has been given to the meso and micro-scale of the urbanization. This is due to the fact that in such an approach the overlap between *urban* (cultural dimension) and *city* (physical dimension) is not questioned: of course there is a strong awareness of the differences between different degrees of urbanization in terms of sociological and territorial characteristics, but it is not assessed deeper. The sociological nature of the urban environment is rarely analyzed, bringing to an underestimation of the differences in territories and degrees of urbanity.

We would like to take back the distinction between urbanization, city and urbanity, highlighting the fact that a common process, urbanization, can produce different urbanity-level environments, and not only different patterns and examples of city-a-like land use. The two elements are, as obvious and as already stated, interrelated, but not all that is *city* can be considered, in our view, also properly *urban*. In this chapter we will stress further this distinction focusing on the main keywords adopted in the literature to define urban spaces and distinguish them from non-urban ones.

5.1 Urban and urbanity measures in the literature

This distinction between different dimensions of the urban phenomenon is not usually considered in the literature when it comes to be defined the different level of urbanity of spaces (in particular for the distinction of urban from rural settlements). If it is nowadays well recognized that the urban-rural dichotomy is not considerable valid anymore (Pahl, 1966; Vlahov, Galea, 2002), and that a more real continuum between the idealtypical poles of urban and rural spaces must be considered, the methods and tools to measure this continuum are still based mainly on traditional ways of defining urban space and urbanity.

The need to distinguish between urban and non-urban spatial contexts is relevant in many fields studying human behaviour, since it is widely acknowledged that it brings with it relevant peculiarities and impact strongly on individual experiences, opportunities, expectations and identity. For this reason the literature working on the theme is quite wide, encompassing geographical studies, medicine, urban planning, and many others.

The methods can be classified according to (1) the dimensions considered, and so the indicators used (that could be summed up in five categories like *land use* and *built up soil*, *population density*, *size*, *territorial economic profile*, *accessibility*, *urban amenities' concentration*), (2) the geographical level of data collection and analysis. Since the focus of this section is on the operational aspects, we will review only methodological articles in order to analyse a sample of them, and to highlight their pros and cons. Here we will analyse some studies proposing different operative definitions of urbanity, in order to show the main approaches existing and their main characteristics. In the end a new proposal we made will be presented.

5.1.1 A matter of density and built-up soil

The concept of urbanization has always meant principally an increase of population inhabiting urban contexts, phenomenon accompanied usually by an increase in the built up territory, both due to residential and infrastructural land development. The expansion of urban functions is clearly linked to the increase in impervious surfaces, that these functions need in order to be located in the territory, and for this reason it has been considered as the traditional indicator of the *urbanity* of spaces. The studies on the sprawl phenomenon take usually the amount of built up soil as the key variable for the detection of urban expansion (Harvey and Clark 1965; Ewing 1997; Angel S, Sheppard SC, Civco DL, 2005; Angel 2007): the main concern of this kind of studies is to follow the evolution of urban development in order to monitor the potential negative externalities of the loss of natural terrain and of the increase of the impervious soil (T. Esch, 2010), and to determine the ecological footprint of this kind of process (Muñiz, Galindo, 2005).

Due to the specific aims of this kind of studies it is clear that some dimensions are lacking in the definition of the level of *urbanity* of a territory, since the goal is to

highlight the physical homogeneity and morphological structures proper of these specific environments.
The main critical element in such a method is the fact that it considers homogeneous (from a functional and sociological point of view) territories that just share a common amount of impervious soil, being in this way unable to distinguish between different contexts (since it is not the strict object of their analysis). Anyway this is the most common approach adopted to measure the level of urbanity of spaces, due to (1) the simplicity of the analysis and (2) the strong comparability of data between case studies.
In recent years the increasing availability of satellite data have pushed the possibilities of built environment measurement, making it easier, faster and cheap (in terms of both time and resources). *Landsat* programme first and *Sentinel* project more recently, have produced a huge amount of data, freely accessible, while at the same time the expansion of GIS software's use made it possible to process these data. As a result many studies had exploited satellite data in order to detect the changes in the composition of the soil and of the land use, in particular to measure the expansion of urbanized land.
Zha's work (2003) on Nanjing city (East of China) is a clear example of this cluster of studies adopting satellite data to measure the urban built up soil expansion. The use of satellite data have produced a parallel diffusion of indexes and composed indicators useful for the interpretation of the row information given by those sources. Indexes derived from satellite data vary according to the different objectives of the researchers: the measure of snow presence for the monitoring of glacial sites (NDSI) (Sidjak and Wheate 1999), of greenness coverage for forests or agricultural land status (NDVI) (Achard and Estreguil,1995; Fernandez et al. 1997), of water basins conditions (McFeeters 1996) and so on. All of them anyway share a common logic: the composition (mathematical) of different spectral bands layers, in order to obtain a final measure, detecting particular kinds of soil. This is possible since to every spectral band corresponds a specific radio-reflection behaviour (wave length) of the different components of the soil itself, that, after a classification of the wave lengths to be attributed to the respective specific kind of soil, can distinguish between diverse land coverage patterns.
Zha, following the same approach, proposes in particular a Normalized Difference Built-up Index, in order to allow the automatic elaboration of the data, and the distinction of the areas covered by urbanized soil from other kinds of land-use, with a high level of accuracy and correspondence to the real characteristics of the territory (92,6% as measured in the research).

5.1.2 Density of functions: population

Beside satellite data analysis, other approaches are possible to measure the gradient of *urbanity* of space. Always in the literature on the sprawl phenomenon other studies carried out different methods based not only on the morphological

and physical characteristics of the territory and the settlements, but on the **urban functions** present in the space (Ewing 1997; Galster et al. 2001).
The first and most common function considered in the assessing of urban imprint expansion is the **residential** one: operationally defined as the density of population inhabiting an area (gross or net according to the denominator adopted, if the total area or the built up portion of it) this method measures the different degrees of urbanity of spaces considering the amount of people living in it as a *proxy* of the urban nature property. Of course the higher the presence, in terms of density, of the population, the higher the urban level of the territory (Lang, 2003; Anthony 2004; Davis and Schaub, 2005; Tsai, 2005; Cutsinger et al. 2005).
Also literature belonging to other field than urban sprawl studies worked in this direction. Studies on the metropolitan development, even if strongly linked to the ones on urban sprawl, have a specific connotation. Urban growth patterns are always at the core of the research, and they are assessed using, generally, density of population and amount of built up soil. In this case we can see a combination of the methods aiming to objectives similar to those of urban sprawl literature: the detection of urban and metropolitan morphology and its structure, useful for planning the best location of additional infrastructures or facilities.
The study run by Heris (2017) is an example of the application of a population density and satellite data based method for the distinction of different types of metropolitan settlements in the US metropolitan contexts, according to their degree of *urbanness* or *urbanity*. He computes a net population density index, based on the number of housing units per residential-developed soil. In order to better assess such a measure he defined the proportion of soil covered by built up land potentially used for residential purposes[54], using USGS satellite data on a 30mX30m cell grid, and attributing, for each census block in which cells are included, the proportional number of housing units to every "developed" cell of the grid. Then the pattern of distribution of population density in the space is used as a tool to distinguish between different kinds of territories, considering the decay function of the index. Starting from each census block a varying neighbourhood threshold is considered in order to detect the average housing density variation in the territory around each block. According to the decay trend of the density (the farer the drop of density, the higher the level of *urbanness*) a 5 class typology of metropolitan settlements is produced, distinguishing between:

1) High density urban areas
2) Medium density urban areas
3) Low density urban areas
4) Suburbs
5) Fringes

[54] He did not consider as residential impervious areas of less than 54 m^2, excluded from calculation infrastructural areas (roads and similar), reduced the potential noise in the cell values assignation.

The approach is derived from a similar proposal by Bibby and Shepherd (2004, 2013), who elaborated a method for the differentiation of rural-urban settlements in England and Wales according to the population density, computed thanks to the availability of data on households location at the postal address level (10m grid resolution).
Although these examples show a very interesting level of detail (the main focus of their methodological design) no other functions are taken into consideration, maintaining still the usual urban-built up soil conceptual approach.

A common characteristic of all the urbanity measure methods (common to both the examples here reviewed) is anyway the aim to build a measure applicable at the smallest scale possible, in order to avoid the distortions due to the administrative limits and boundaries in the computation, and so representation, of *urbanity*. Computing density indexes of any kind of property can give different results according to the territorial level of analysis considered, in particular strong distortions are possible when considering population density. Administrative boundaries vary in size and structure and usually include various kinds of land use areas, generating an underestimation of density values, since calculated on a too much wide surface. A smaller territorial unit of analysis can avoid or at least reduce such an effect.

5.1.3 Land use and accessibility

In some cases also measures of mixed land use are taken into consideration, at different level of complexity, distinguishing for example residential from working areas (population density/jobs density ratio) (Galster et al. 2001; Song and Knaap 2004).
Sohn et al (2012) present an example of this approach introducing another dimension relevant in the urban sprawl research: the accessibility to different functions. In their study the authors adopt an accessibility measure technique in order to detect the level of availability of urban opportunities for the population inhabiting residential blocks in a portion of Busan city, South Korea. The idea of considering accessibility is linked to the recognized limits of a measure assessing only the population or built up area density and the relative improve a different approach can produce: a) it encompasses also people interaction with space and so a more sociological dimension of the urban environment and of the impact of urban development itself on the territory and population, b) it can assess in a more detailed way the different degrees of urbanization, giving a more powerful tool for policy design (Sohn et al, 2012). The functions, defined as urban-detecting dimensions, considered are: (1) commercial (or office), (2) industrial, (3) public services, (4) urban neighbourhood parks and (5) urban forests.
Accessibility is measured for each residential block[55] of the study area considering the:

[55] 75% of the r.b. are 3.000 km^2 c.a on average

1- Distance (network based) of the residents from the opportunities, hypothesizing a negative relation with the level of urbanity (Handy and Niemeier 1997; Rodrigue *et al*. 2006)
2- The amount (size in terms of land use proportion in each residential block) of functions accessible → positive relation (Handy and Niemeier 1997; Rodrigue *et al*. 2006)
3- The amount of people able to access the functions → negative relation[56]

The index adopted shows a better detail in the definition of the different areas' level of urbanity when compared to the traditional methods. Differently from traditional tools, in this case it is possible to detect also local changes in the distribution of *urbanity* in the space.

5.1.4 Socio-demographic dimensions

Beside functions distribution, usually economic-related or employment-related functions (density of employed people in different economic sectors), other dimensions detecting the socio-demographic aspects of urban spaces are considered for its definition and measure. Some studies highlight the need to embrace other indicators as infrastructures (Plessis, 2001; Albrecht, 2006), since in rural areas their density and level is comparably lower than in the urban ones, or indicators of human capital level (Cecchi, 1999), assuming a lower degree of it among rural population.
The inclusion of other elements in the territorial classification is probably due to the specific objectives and also sensitivity of researchers belonging to fields other than urban planning or remote sensing. An example of this different corpus of studies is the medical research on the impact of urban environments on individual health status (Vlahov, Galea, 2002; Hall, Kaufman, & Ricketts, 2006). In particular for developing countries, scientific research has highlighted the different pattern of distribution of diseases (and of their nature) in urban vs rural contexts, due to the better infrastructures and living conditions existing in cities, but also on the hazards existing in the cities linked to the unhealthy living conditions of specific parts of the urban population (Harpham T. 1991; McMichael AJ, Beaglehole R, 2000; Knudsen AB, Slooff R., 1992).
Due to the relevance of many socio-demographic properties in the definition of urban environments, many studies criticized the limiting distinction between urban and rural as dichotomous categories (Redfield,1947; Champion, Hugo, 2004; Schaeffer et al.,2012; Serra,Vera, Tulla, & Salvati, 2014). Dahly and Adair in particular proposed a new classification based on a more complete definition (2007): their aim is to detect not just the presence of a specific land use territory but a more complex property they referred to as *urbanicity* (as they call *urbanness* or *urbanism*), adopting a more sociological concept of urban.

[56] The evaluation of population density contribution is negative since it is considered a measure of potential competition for the access to resources, a source of congestion.

For their purpose the authors developed a scale measuring the level of *urbanicity* of territories, working at the *barangay* level (2km^2 administrative areas) for the collection and representation of data. The attention at the territorial detail of analysis is so in line with the main approaches of the urban sprawl literature already presented.
The scale have been based on the collection of several urbanity indicators (Montgomery et al., 2003) here listed:

Population Size
Population Density
Communications: The presence of phone service, mail, newspapers, the internet, cable, TV, and cellular phones
Transportation: The density of paved roads, and the availability of public transportation
Educational Facilities: The presence of educational institutions, including primary and secondary schools, colleges, and vocational schools
Health Services: The presence of health services, including hospitals, medical clinics, maternal health clinics, family planning clinics, and community health centers
Markets: The number of Sari-Sari stores (small, retail shops), and the presence of drug stores, grocery stores, and gas stations

The specific selection of indicators is affected by the particular context in which the study is carried (a developing country) but the dimensions considered cover a good range of socio-economic functions.
A comparison between the statistical office definition of urban and rural settlements and the *urbanicity* scale here developed shows a correspondence of the two measures for the extreme values of the *urbanicity* scale, but a strong confusion in the intermediate values: this is due to the specific nature of the two tools: one detecting a continuous property (*urbanicity*), the other a dychotomic one (urban-rural). The *urbanicity* scale allows for a more detailed description of space.
What is lacking, as highlighted by the authors themselves, in the method is the consideration of distance from opportunities, for which a more complex methodological design would be needed.

5.2 New methodological approaches to urbanity

In order to sum up the results of this review we collected all the main examples presented in a table:

Tab. 8 - Overview of the pre-existing recent examples of studies on urbanity indexes computation.

	Authors	year	Context of the research (case study location and aim)	dimensions	Indicators used	Territorial level of analysis	Pros (+) and cons (-)
1	Y. Zha et al.	2003	City of Nanjing, eastern China OBJECTIVE : develop a method based on Normalized Difference Built-up Index (NDBI) to automate the process of mapping built-up areas.	- Land Use	Normalized Difference Built-up Index on LandSat 5 TM data	30X30m cells raster grid	+ overcome administrative boundaries + fine and detail data disaggregation + easy and replicable method on different contexts - Focus only on population size and Land Use (built up land) No socio-demo properties included
2	Heris M.P.	2017	US metropolitan areas OBJECTIVE: 1) develop a method to identify settlement types in American Metropolitan Areas, distinguishing among high, medium and low density urban centers, suburbs, and urban fringes; 2) to depict and compare general metropolitan structures across the nation; 3) to evaluate the location of recently developed dwellings in relation to settlement types and structures and estimate growth trends.	- Population density - Land Use	- (net) Household density in census blocks, corrected for the real built up surface in each block. - density decay functions around each cell (following Bibby and Shepherd example)	30X30m cell raster grid (in which data from census tracts have been transformed)	+ overcome administrative boundaries + fine and detail disaggregation - Focus only on population size and Land Use (built up land)
3	Peter Bibby &John Shepherd	2004	England and Wales OBJECTIVE: develop a method to identify settlement types in english rural contexts (settlements below 10.000 inhabitants). A preliminary distinction between urban and rural has been done according to the population size of settlements.	- Population density - economic characterization in farm, tourist, other busisnnesses	- household density (two scales: local and broader; different thresholds) - prevalent kind of activities located (Land Use mix)	100X100m cell raster grid (data coming from the postal code 10m grid dataset and)	+ overcame administrative boundaries + fine and detail disaggregation - focus on rural territory

							- Focus only on population size and Land Use (built up land)
4	Sohn et al	2012	Busan, Korea OBJECTIVE: Although measuring sprawl based on morphology is conceptually simple and easy to implement, it is of limited use for deriving implications for urban planning. The study aims to develop accessibility-based sprawl indicators. For this purpose, it employs two accessibility based sprawl indicator categories and develops their measures: accessibilities to urban functions and open space.	- Population size and density - Street network accessibility to urban-specific amenities	residents accessibility to services and amenities on a street network (1)commercial (or office) functions, (2) industrial functions, (3) public services, (4) urban neighbourhood parks and (5) urban forests.	Residential blocks (75% of residential blocks have an area size of 3365 m^2 or smaller)	+ overcome administrative boundaries + fine and detail disaggregation + consideration of socio-demo dimensions + inclusion of accessibility to opportunities - approximation of households and services localization at residential blocks - a walking threshold is not defined but approximated to a friction coefficient in the distance to opportunities computation.
5	Dahly and Adair	2007	Philippines OBJECTIVE : most researchers still use a poor measurement of urbanicity, the urban-rural dichotomy. The article goal is to construct a scale of urbanicity in order to investigate the effects of urbanicity on child health in a three-country comparative study of China, Russia, and the Philippines.	- Population size and density - Availability and concentration of urban-specific amenities	Population size and density	Barangay (2km^2 administrative areas)	+ consideration of socio-demo dimensions - lack of distance (accessibility) dimension

If compared distinguishing for the dimensions or indicators considered, a better analysis of the different approaches can be done. We can see that all the studies have as a common aim the usage of a method based on the smallest territorial scale possible: 3 on 5 adopt a raster grid analysis and representation method, while two the residential block parcels (smaller than administrative areas surfaces).

Tab. 9 – Comparison between the dimensions considered in the main examples presented.

	Authors	year	Overcome of administrative limits	Dimensions/properties considered				Output territorial level of detail
				Built-up land	Population density	Socio-demo dimensions	Accessibility to opportunities	
1	Y. Zha et al.	2003	Yes (raster)	X				Raster grid (30mX30m)
2	Heris M.P.	2017	Yes (raster)	X	X			Raster grid (30mX30m)
3	Peter Bibby &John Shepherd	2004	Yes (raster)	Population density as a proxy	X			Raster grid (100mX100m)
4	Sohn et al	2012	Yes (residential block)	X	Blocks dimension as a proxy	X	X	residential block
5	Dahly and Adair	2007	Yes (residential block)		X	X		Residential block

Regarding the dimensions/indicators the built up land is indeed the most common tool used for the detection of the urbanity, being present in 4 on 5 methods, and exclusive in Zha's work. Population density as well is common to 4 on 5 studies, while socio-demo indicators (urban functions) are considered in only 2 studies. Only the Sohn et al work then take into consideration also the accessibility (distance) to the opportunities, but in the operationalization of the analytical tools, due to the lack of detailed data on population density, information on residents is approximated to the size of the blocks. Distance friction is also not precisely addressed, attributing an arbitrary friction factor. In adopting a walking accessibility measure the definition of a walkable threshold is important in order to define the plausible amount and kind of opportunities reachable by walk.

As we can see the complexity of the urban phenomenon is broadly acknowledged, the need to consider it as a continuous property in the space is usually accepted, but the methods adopted to operationally define the level or urbanity of places are still very variegated.

We would like to stress the need for a more complete method of *urbanity* definition, able to take into consideration all the dimensions considered in the literature, but enhancing the role of people's space fruition, believing that what distinguishes urban spaces must be detected *looking at the interaction between people and physical space and not just on its morphology or land composition*. Economic factors can't be enough for such a goal. Urbanity is strictly linked to the degree of existence of urban opportunities and of the accessibility to them of the people living those spaces (cfr. Chapters 1 to 3).

Another relevant issue is to produce a representation and analysis of the phenomenon the closest possible to its actual spatial behaviour. In this sense is central the need to work on the level of territorial detail of the data, both in the source selection and output.

Among all the examples here presented the proposal by Sohn is one of the best and most complete, including the main themes and dimensions taken into account by the recent literature. He also highlights an interesting perspective, the adoption of Accessibility as a conceptual and methodological tool to study urban development and its phenomenology. This opens a micro-scale analytical approach to the urban studies, useful to measure more precisely the evolutions of urban phenomena. But it is also useful to underline a methodological issue, often hard to be faced. In this case unfortunately the output representation and territorial description seem to be lacking somehow: the decision to keep the residential blocks as a territorial unit for the representation of the results (even if the analysis is run on a raster grid of 1miles squared cells) limits the power of the method: it is still limited to the administrative boundaries. This can be a not relevant issue in dense inhabited areas, as highlighted by the author, since the differences between blocks would be lower in terms of density of functions, but the relevance of the argument increases when other kind of territories are investigated. In fact due to the lack of detailed information on the number of residents in each block, the population density was for necessity approximated to the size of the block itself, but blocks, normally, when designed for statistical purposes, are bigger in rural or peri-urban areas, enclosing a bigger portion of undeveloped land.

We will try to avoid this fallacy, working as much as possible on the spatial representation of the data in order to overcome the distortions due to administrative boundaries effect (the so-called ecological fallacy or modifiable area unit problem, Sohn, 2012).

5.2.1 Pedestrian accessibility to services as a tool to detect urbanity of spaces

The study on which our proposal is based, was formulated originally to define, measure and describe the composition of peri-urban areas in the Milan Metropolitan Area. The study started from a definition of periurban environments, conceived as spaces located in between (conceptually speaking) the two ideal-types of urban and rural. Basing such a reasoning on the concept of urban-rural continuum (as developed by Pahl, 1966) if the *urbanity* of spaces can be conceived as a continuous property in space, we considered periurban settlement as places characterized by an intermediate level of *urbanity*. The main aim was, as a consequence, to find an operative definition of this property.

Our proposal for a different definition of *urbanity* origins from the concept of accessibility and the different mobility choices available in different urban contexts: from the literature on peri-urban phenomenon (Le Jeannic, 1997c; Eymard I., Seguin S., 2000) is acknowledged that the main characteristic of this kind of settlements consists in having a peculiar mobility-style population. Since the morphological and structural nature of peri-urban areas, scattered in the territories around the main centers, morphologically isolated from the built up continuum expanding from the main cities around which they are located, and characterised by a small population (even if, in general, fast growing), the opportunities located there are less and farer than in more urban areas. According to the principle of agglomeration economies the lack of a consistent amount of demand cannot sustain a level and degree of amenities and opportunities as high as in urban centers. The functional dependence (in terms of jobs and services) from bigger and higher level centers (in the hierarchy of the metropolitan territories) is another indicator of this condition. The consequence of such a situation is that the main way to have access to opportunities for the population inhabiting these contexts is to use a private mean of transport, most commonly a car. Literature shows that the amount of cars and kilometers driven is higher in suburban and peri-urban areas, due to this strong interdependence from the other main centers to which their inhabitants are pushed to commute daily (Le Jeannic, 1997c; Dupuy, 1999; Motte-Baumvol, 2007).

From these evidences we derived that, since distances are so big to force people to use the car to access the opportunities they need, the level of pedestrian accessibility to services will be low, at least lower than the one that can be found in urban centers. At the same time, always adopting the urban-rural continuum theoretical framework, the availability of services, at least for the low level and daily ones, would be higher than the one of properly rural settlements. The main difference between rural and peri-urban settlements is due to the different relation with the main urban areas: if for the rural contexts is possible to talk about peripheral territories (in the metropolitan frame), the same cannot be said for the peri-urban settlements, strictly linked to the main centers, functionally speaking. If both kind of territories are characterised by a general morphological isolation, the same cannot be asserted from a functional point of view.

If we would like to summarize the observation produced until now the following table could be created:

Urban-Rural continuum conceptualisation

Tab. 10 – Scheme representing the different properties of areas inside the Urban-Rural continuum.

Urban centers caracteristics	Peri-urban	Rural settlements
Big dimension and size	**Middle-low size** (threshold definition hard to be defined due to the grat variability in the periurban structure)	**Low size of the settlements**
Compactness of built up areas	**Diffused and scattered settlements**	**Scattered settlements**
Variety and richness of service provision	**Basic level of services**	**Basic level of services or lack of them**
Functional centrality and attractivity of the center for the territory around	**Dependence from main or other centers in the territory**	**Peripheral location** (and functionings)
-	**Morphological isolation from other centers** (tendentially)	**Morphological isolation**

5.3 The metropolitan nature of a differentiation

In our description of the urban characteristics we introduced a relevant dimension: the metropolitan frame of the nowadays urbanization process. The complexity of the current development patterns of urban territories has been highlighted by the new recent literature on the urbanization process, describing a **splintering** urbanism mode (Graham, Marvin, 2001) or a **regionalization** of the city edges and scope (Storper, 1997; Soja, 2010), or even an **endless** continuous city (Burdett and Sudjic, 2007) until the already discussed **planetary** scope (cfr. Chapter 1). What is clear is that the always stronger interrelations between environments and spaces has enlarged the scope at which the understanding of the urban processes is possible. It seems that it can be put always a bit further and new elements, relations and phenomena come into the visual frame and add some information to the understanding of the broad and complex picture.

For this reason, if it is fundamental to look at the micro scale in order to better distinguish what is urban (in our interpretation) from what is city, we cannot avoid to look also at a broader scale in order to better understand how does this urbanity can change and acquire different shades. It is from the intersection between these two levels (micro/meso and macro) that a better understanding of the urbanization process can be assessed.

In our approach we will consider as the most suitable level for the analysis of this interactions the metropolitan scale, derived from the anglosaxon tradition of Functional Urban Areas, conceived as functionally integrated territories, encompassing different degrees of urbanity and different interpretation of this property. Working on the metropolitan area frame is useful to avoid the risk of limiting the analysis to an administratively determined territory, like the city limits, but it can just replace the same issue just at a different level, a higher scale. The definition of the metropolitan boundaries is a hard and debated issue, at least in Italy, where our research is born, since universal and definitive functional definition of it is lacking and many attempts have been made to address this argument.

We will adopt a recent proposal for its definition (Boffi, Palvarini, 2011), that has been discussed in an our recent work (Colleoni, Caiello, 2013), and that produced an interesting representation of the Italian territory’s metropolitan structures, in particular from a methodological point of view. It highlighted in particular, for the case of Milan, the existence of a conglomeration and network of centers, prelude (or proof?) of a potential city-region: the metropolitan area of Milan, a territorial context strictly interrelated and covering an area of about 8.000 km^2, extended on more than one third of the Lombardy region’s territory.

5.4 Research questions

This work has three main declinations: a diachronic one, a comparative one and a methodological one.
In the next section we will present our proposal of metropolitan zoning of the Lombardy region's territory, in order to answer to the following research questions:

Diachronic

1) How did the Metropolitan Area of Milan and its sub-areas (as defined through our methodological proposal) change in terms of territorial and socio-demographic characteristics in the inter-census interval 2001-2011? Did it expand? How?

Comparative

2) we will then see how does it relate with the already seen interpretations of the Metropolitan Area of Milan.
3) In a comparative way we will adopt the same Metropolitan Area definition method in the French context in order to introduce a different representation of the metropolitan areas of the country and to confront our proposal with the INSEE one.
4) We will then focus on the specific case of Lyon city (Lyon Metropolis) in order to confront our proposal of MA with the other nowadays existing representations of it (and presented in Chapter 4).
5) The same criteria for the distinction of different degrees of urbanity, through the pedestrian accessibility measure, will be adopted in the French case in order to draw a zoning as well as done for the Italian case, and to study its socio-demographic composition and variation (with the data available).

Methodological

6) Finally a method for the walkability detection of the Milan and Lyon Metropolitan Cities will be applied in order to analyse more precisely, than through the crow-fly-based pedestrian accessibility measure applied for the zoning, the accessibility variation in the two contexts. Pros and cons of these two methods then will be discussed.

Chapter 6

Milan Metropolitan Area's zoning: a comparison between 2001 and 2011.

As already stated, the urban phenomenon cannot be limited to the city scale, at least in its traditional interpretation (cfr.Chapter 5), since the ways in which the urban territories evolve invest bigger and wider contexts than in the past. The scope at which observe and study these urbanization processes must be wider and bigger as well.
Our attempt will start from a study already run in a previous work (Colleoni, Caiello, 2013). In that case the scope of the analysis of the urbanization process was the metropolitan scale, a definition of which was needed in order to analyze its spatial and sociodemographic characteristics.
Metropolitan studies (cfr. Chapter 4), produced different definitions in time of the Metropolitan boundaries. Our aim is, in this section, to re-propose a method of classification of the Milan Metropolitan Area, in order to produce a zoning of the Lombardy region territory according to the different degrees of metropolitan functions concentration (that we will call *metropolitanity*) and *urbanity* that can be detected there.

6.1 A metropolitan index for the Lombardy region

Metropolitan definitions are variegated as seen, but one of the main approaches shown, the DUS model, is the most followed and adopted in the literature, both from single researchers' studies and National Statistical Institutes. At the core of the DUS model, then evolved into the FUA model, lies the concept of **metropolitan functions**, a specific set of domains of activities, whose concentration differs in the territory, agglomerating in the main centers, especially for the central functions (Christaller, 1933), the high level activities (cultural, health, political direction,...).

At the core of the FUR concept lies the agglomeration principle, as constitutive element and origin of centers' generation and, as a consequence, of the functional interconnections between them. As we have seen in Chapter 4, the agglomeration process has been the engine of the constitution of the urban settlements, exploiting the so called localization economies (and more specifically urbanization economies). This produced since the 19th century a flowering of urban centers, and the increase of their dimension (in terms of size and economic relevance). This process faced a new phase during the shift from the 1st generation metropolis to the 2nd generation metropolis (Martinotti, 1993). The main change in this phase was brought by the increase expansion of urban functions into the territory around the main cities, due to the complexification and expansion of mobility infrastructures. Without going too deep inside this argument what emerged was a new model of urbanization that invested a territory much bigger than in the past, causing the loss of precision in the delineation of the different contexts inside it.

6.1.1 The metropolitan zoning in 2001

The study on which our analytical method is based, was formulated originally to define, measure and describe the composition of periurban areas in the Milan Metropolitan Area. The study originated from a definition of peri-urban environments, conceived as spaces located in between (conceptually speaking) the two ideal-types of urban and rural. Basing such a reasoning on the concept of urban-rural continuum (as developed by Pahl, 1966) we could conceive *urbanity* as a continuous property in space, and, as consequence, periurban settlement as places characterized by an intermediate level of *urbanity* (crf. Chapter 5.2.1).

So recapitulating we could consider peri-urban territories areas characterised by an intermediate level of pedestrian accessibility to daily services, and so also by an intermediate level of *urbanity*, and located in the metropolitan fringes of metropolitan areas. From the detection of what is peri-urban we will then produce a general classification of the other metropolitan territories, highlighting their different levels of *urbanity* and *metropolitanity*, the latter measuring the degree of metropolitan function concentration.

In the following section we will explain the method applied to operationally access this.

6.1.1.1. Building the urbanity index from pedestrian accessibility

As shown in Chapter 2, accessibility can be detected and measured in various and different ways. It appears to be very useful for our aims due to its capacity to detect not only the physical characteristics of the environment usually adopted as the main key to interpret and measure the extension of urban spaces (cfr. Chapter 5), but also the relation between the environment and the population living it.
The literature shows many and different ways to measure accessibility: as shown in Castrignanò et al. (2012) the most common is the **geographical** or **proximity approach,** based on gravitational models, for which accessibility is conceived as the distance to be covered in order to access to opportunities (Hansen 1959; Ingram, 1971).
Many other approaches are possible, each focused on a peculiar aspect or analystical dimension relevant for the accessibility detection. Following the classification developed in Castrignanò et al. (2012) we can enlist also the economic or functionalist one, based on the measure of the costs connected to the reaching of opportunities; the utilitarian, where the combination between parallel decisions and choices among different travel possibilities is evaluated ( ); the temporalist one, based on the consideration of time as an element of cost and friction (Ben-Akiva, Lerman, 1979). The informational is, at last, based on Castells’ works and the consideration of the structure and variety of social networks in which individuals are inscribed as elements enhancing or reducing people’s access to opportunities (Castells, 1989).

Our approach will follow the first methodology, working on the intersection of the demand and of the supply of opportunities in order to measure the different levels and shades of their interaction. The level of accessibility will be measured comparing the density of the services and their magnitude (defined as the number of employees associated to each service considered) and the density of the population resident in the areas covered by the attraction basins of the services themselves.

6.1.1.2. Operationally defining accessibility

To obtain the goal described above we will operationally define the two elements the interaction between which performs the measure of the accessibility. Accessibility, according to the first approach described, is conceived as the degree (possibility) for a person or a group of people to access to a specific opportunity or set of opportunities. Our scale is local, since the kind of accessibility considered is a pedestrian one.

In the literature the average distance in order to consider accessible by walk a service or place is usually defined in 10-15 minutes walk or c.a. 400m radius[57] from its location (Boffi, in Castrignanò et al., 2012; Icma, 2011). For this reason we developed two analytical tools:
- the **Accessibility Basins**, conceived as the distance area from an opportunity in which the opportunity itself is reacheble by walk easily.
- the **Neighbourhood Areas,** conceived as the area reachable by walk from the location of the residence, a way to define the neighbourhood limits.
Both the elements were then constructed following the same method. The data adopted come from the National Census (2001 and 2011), providing data on population characteristics and of employment and economic activities at a very detailed territorial level: the census tract, the smallest territorial unit in which the country is divided for statistical purposes. The whole national territory is covered by a mosaic of 382.534 parcels[58], of various size (on average in the urban centers a census tract is comparable to a square of 200x200m side), including a maximum of 2.000 resident people.
The census tracts have been then imported in a GIS environment and converted into their centroids (their geometrical centers). In this way we could get as close as possible to the real localization of both residences and services, since, especially in urban areas, the census tract correspond to a block of buildings, in some cases also to single big buildings. This is not the case in countryside areas, where the surface include also natural spaces, but the level of approximation can be considered suitable for our analytical purpose.
In Fig. 23 we present an example of such procedure as applied to the center of Milan: in particular the area of the Castello Sforzesco is zoomed, in order to show a concrete application to our case study.

For each census tract (and so each centroid) few indicators are considered:

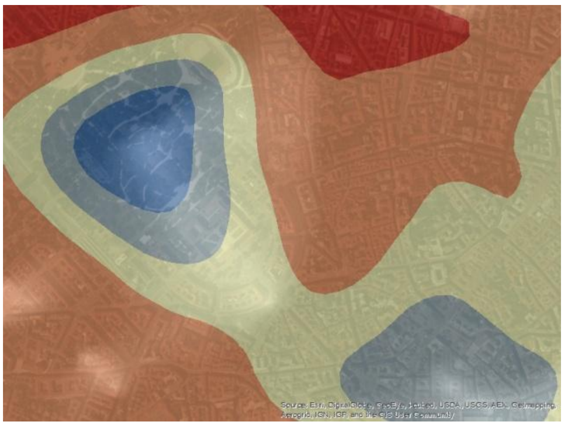
- **For the Neighbourhood Areas'** definition, the *resident population*
- **For the Accessibility Basins** the *number of employees* in three different kind of services: *bars* (cafès); *primary and elementary schools* and *local stores*[59].

The choice of the services to be included was based on the need to consider a set of local level and daily use businesses. Since the aim of the tool is to detect the pedestrian accessibility, the kind and level of opportunities to be considered must be the easiest to be found in all the contexts, avoiding specialised services and

[57] The radius distance can be considered as an euclidean distance thresholds,corresponding to a 10 minutes walk parcour on a street network. This is a minimum threshold, since it can vary according to the specific amenities considered. Other similar proposals can be found in Forsyth, 2000; Lindsey et al., 2001; Nicholls, 2001; The Trust for Public Land, 2004; Wolch et al., 2005.
[58] In 2001. For the year 2011 their number increased to 402.678
[59] With local stores we consider all those commercial activities of neighbourhood level (shopping malls and big supermarkets are excluded). A detailed list of the activities included can be found in the appendices.

preferring quotidian ones. Since all the services considered are of the same basic relevance and no criteria for their differentiation could be defined without arbitrary decisions we opted not to weight the various opportunities included in the accessibility basins. Only the size, in terms of amount of employees belonging to the establishments present, has been considered.
The issue of the amenities’ weighting is relevant in accessibility studies: the weight (and so the relevance in the indexes computation) can be attributed according to their importance for the specific population under study. Age, gender, social status, are examples of individual properties able to impact on relevance perception of the amenities present in the space, beign conntected to different needs and life-styles, and as a consequence a different set of preferencies. These properties can also impact on the specific perception of the neighbouring space, and in this sense, as already highlighted in chapter 3, impact due to the beliefs belonging to different persons, the travel behaviour (3.3.3). Usually those information are collected through surveys and interviews on the study population (Kestens, Y., Chaix, B., Gerber, P., Desprès, M., Gauvin, L., Klein, O., ... & Patte, M., 2016) , or focus groups (Witten, 2003), or otherwise just hypothesized on an arbitrary, but reasonable, basis.
In order to build the buffers around the centroids (approximated location of services and residences) a ***kernel density** model* (cfr. Box 3) is applied on the data, producing population and services’ employees densities surfaces. As explained in box 3 the Kernel Model builds on the data source (in this case the location of residences or services) a 3D surface, whose height is the value of the property analysed (population or services density) and whose band width is defined in 400m radius (as stated in the previous section, the accessibility threshold commonly adopted). The value of the property decreases according to the distance from the source point, reaching 0 at 400m from it. The intersection of the curves creates a common surface for both the properties.
The Fig. 23 and Fig. 24 exemplify this phase showing the same area of Castello Sforzesco in Milan.

Fig. 23 - Population density surface 2001. Castello Sforzesco area, Milan. (hot colours – high density; cold colours – low density)



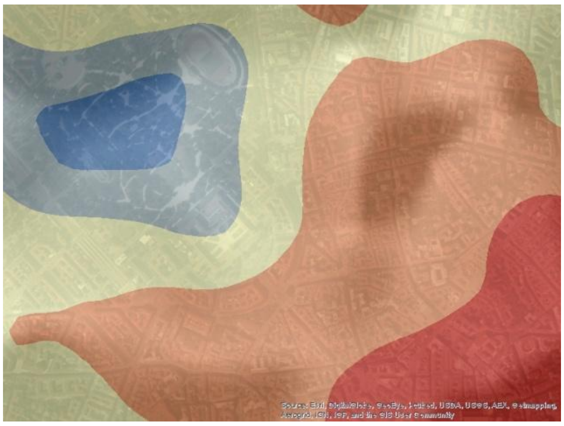
Source: our elaboration on Istat data 2001.

Box 3

Kernel Density Model

KDM is a common tool used to represent density of properties in the space. The tool draws a Normal Gaussian Curve on the data source location (points) whose height is proportional to the value of the property represented. This height represents the maximum of the curve (in correspondence of the data source location), degrading then as far as the distance from the center point grows, following a Normal (3D) pattern.
The intersections of density buffers of close points generate a continuous surface in the space.

Fig. 24 – Services employees' density surface 2001. Castello Sforzesco area, Milan. (hot colours – high density; cold colours – low density)



Source: our elaboration on Istat data 2001.

In this way we have transformed and translated the information collected and represented on a vector element (the census tract) into a raster surface: a raster is a regular grid of squares having the same dimension (in our case 50x50m), in which every cell acquires a specific value of the property represented. This allowed us to describe also in its spatial dimension the *accessibility* property, being freed from the limits due to the statistical areas' boundaries. It is clear that data will anyway be referred to the territorial level at which they have been collected, but their representation is in this way different, allowing to overpass the spatial delimitation of the former.

The different colours highlight different levels of the properties represented: the scale goes from low values and cold colours (dark blue, blue, etc.) to hot ones (red, dark red) and high values. In the pictures' examples we can see as the park behind the Castle (north-west part) is covered by a blue area, showing both low levels of population and services, while in the south-east part (corresponding to the Duomo area) a low level of population (Fig. 23) is counterposed to a high level of services (Fig. 24).

6.1.1.3. Setting the thresholds for the different levels of urbanity

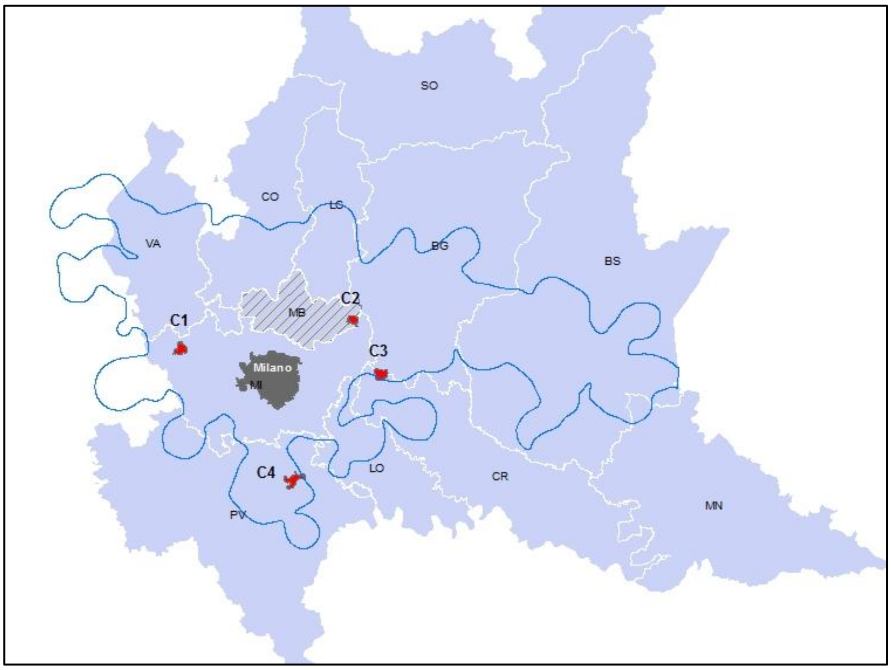
Now that the two properties composing the elements of the accessibility measure are computed the next step is to combine the two. Unfortunately a numeric index cannot be computed in this situation, since it would not be able to distinguish between both high or low levels of population density and services density. For this reason we opted for the computation of a morphological index of urbanity, confronting the different areas according to the different level of densities or (in our view) *urbanity* recorded.

For this purpose thresholds for the definition of high-medium-low levels of the two properties had to be defined. In order to set these values a selection of potential periurban settlements is considered as a sample. The criteria for their individuation are the following:

- these settlements must be located in the urban fringes of the metropolitan area of Milan (cfr. next section for its definition)
- low density of the built environment and low height of the residential buildings must be present (assessed visually through satellite images)
- high discontinuity in the built environment around the settlements, at least 200m of distance from the closest settlement[60].
- non contiguous areas of belonging, in order to diversify as much as possible the sample.
- low demographic size (considered following the INSEE classification between 2.000 and 10.000 inhabitants)
- a high increase in the resident population compared to the previous census (higher than the regional average increase rate between 2001 and 2011)

Four municipalities have been considered:Arconate (MI), Busnago (MI until 2004; now MB), Arzago d'Adda (BG), Cura Carpignano (PV), whose location can be seen in Fig. 25.

Fig. 25 – Location of the sample municipalities (in red) of the Lombardy region (divided into provinces). In blue line the border of the metropolitan area in 2001.



The municipalities-sample are:
C1_Arconate (MI)
C2_Busnago (MI until 2004; now MB)
C3_Arzago d'Adda (BG)
C4_Cura Carpignano (PV)

[60] Criterion adopted in the French context for the definition of an *urban unit* (INSEE).

For the thresholds definition we confronted the distribution of densities with satellite images of the municipalities-sample: we looked for a minimum value useful to cover the whole settlement isolating it from the rest of the territory. This process generated the following output:

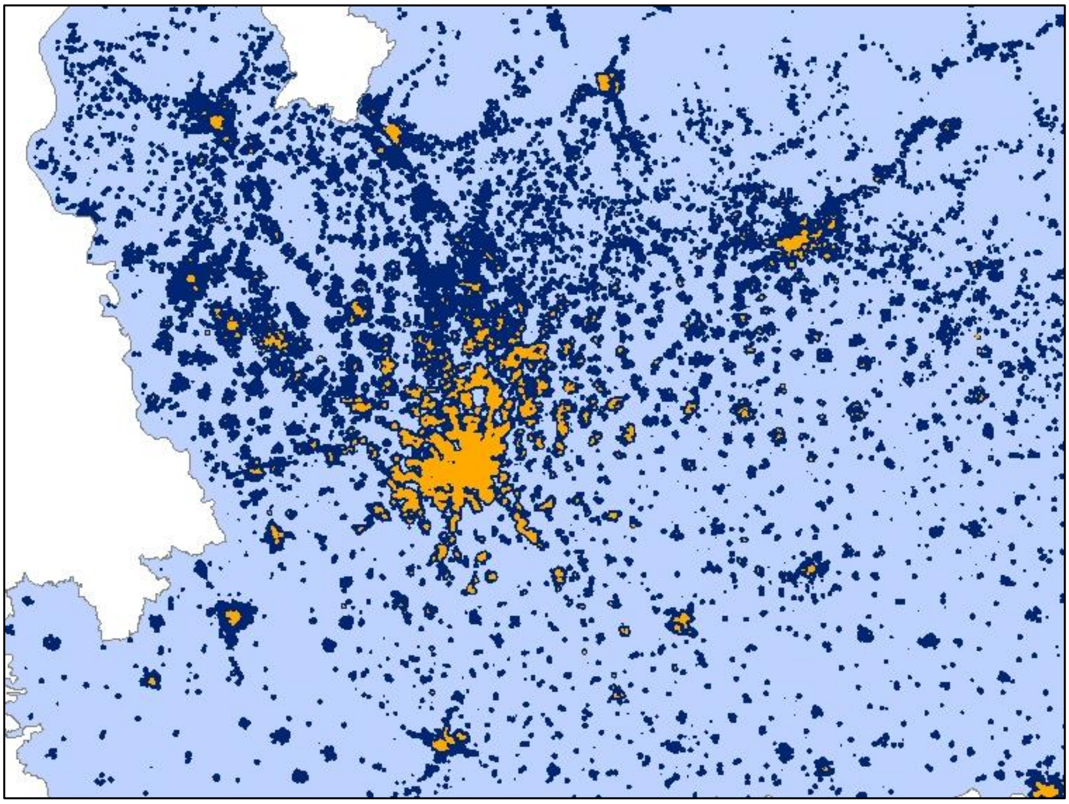
Fig. 26 – Exemplification of the thresholds definition: Arconate. (first image: the municipality; second image: the population density extension; third image: the services density extension).

Source: our elaboration on Istat and Esri data.

If for the population density surfaces the threshold definition has been easier, since the distribution of the population is more homogeneous and less concentrated in space, the same has not been for the density of services (in yellow in the picture above). Since the intersection between the two surfaces in this case (like in the others adopted as samples) would have not given an efficient final result (excluding areas strictly contiguous and continuous to the one enclosed into the overlapping surfaces) we decided to identify as peri-urban those areas in which the population density was at least medium (not lower than the one useful to cover the sample-settlement surface), and the level of services not higher than the one found in the sample settlements. This means that there is not perfect correspondence between medium level of population density and services, but that peri-urban areas must have a population density not below a certain level and a service equipment not bigger than the one defined as medium[61].
In picture 4 the result of the threshold definition is shown for the whole Lombardy region. Three different categories are represented: high urbanity (in yellow), medium urbanity (in blue) and low or no urbanity (in light blue). At a first sight it is clear how the high level of urbanity is concentrated in the main centers (Milan especially), but also distributed in the territory, representing the cores of the smaller urban or suburban centers.

[61] Attempts with a broader threshold of 600m and 800m of buffer's radius was made but the overlap was not satisfying as well. A threshold sensitivity analysis should have been run in order to define the best one to be adopted. Technical observations have been correctly risen during a presentation of the work in a seminar (LISER internal seminar, 22nd May 2017) highlighting the opportunity to consider different accessibility thresholds in different contexts and for different kind of services. Time constraints and technical limits forced us not to further address these issues.

Fig 27 – Classification of the Lombardy region territory into high (yellow), medium (dark blue), low (light blue) levels of urbanity. Scale 1: 1.000.000



Source: our elaboration on Istat data (Censimento della Popolazione e delle Abitazioni 2001)

6.1.1.4. A Metropolitan Index definition

As can be seen from the urbanity index's map observation, intermediate levels of urbanity can be found in all the contexts of the region, from areas in strict continuity and contiguous to the main cores (Milan included) to isolated zones in the Alpes (Northen part of the region) or in the rural areas in the south (not included in the frame above).

Although not all these areas can be considered as having the same functional nature: suburban centers contiguous to Milan are for sure physically and functionally diverse from settlements in the peri-urban plain between Milan and Bergamo. This is due to different location centers can have inside the interacting network of urban settlements. As shown in Chapter 4 the growth of densities and functions in the metropolitan areas created the conditions for the emergence of new urban structures, constituted by networks of centers, as highlighted in particular by Graham and Marvin among the others (2001). The strength of this forces is diverse inside the metropolitan contexts and so also the phenomenological manifestation of urban centers, while diverse too is, we hypothesize, the characteristics of the population inhabiting them.

In order to represent and take into account these diversities we worked on a recent definition of metropolitan areas developed by Boffi and Palvarini (2011), based on the analysis of the metropolitan functions and territorial interactions, elements at the core of the anglosaxon conceptual definition of Functional Urban Regions. As showed in Chapter 4 the main functions usually considered as fundamental elements for the definition of metropolitan areas domains are urban connections and interactions, operatively defined through the commuting flows between centers and the degree of presence of specific (both central and non-central or traditional) economic functions.

The metropolitan functions defined by Boffi and Palvarini are derived from a classification proposed by Ercole and Zonta in a past contribute (1991): a) residential, b) production, c) services, to which is added the mobility (as a measure of *territorial interrelation*), represented by the fluxes of people, for studying and working reasons, between centers. In Tab. 11 is summarized the operational translation of these functions:

Tab. 11 – List of metropolitan functions considered and indicators used for their operationalization (ATECO 2002)

Class	***Metropolitan Function***	***Indicator****
Residential	1. Residing	Resident population
Work	2. Manufacturing activities	Employees in sections C, D, E, F (no group 221)
	3. Financial and insurance activities	Employees in section J
	4. RE activities	Employees in group 701, 702, 703
	5. Information and communication	Employees in group 221, 642, 721-724, 726, 921-922, 924
	6. Professional, scientific and technical activities	Employees in group 731-732, 741-744
Commercial and leisure services	7. Commerce	Employees in group 521-524
	8. Accommodation and food service activities	Employees in group 551, 553-555
	9. Associationism	Employees in group 991-913
	10. Arts, cultural and sport activities	Employees in group 923, 925-927
Public services	11. Human health and social work activities	Employees in group 851
	12. Secondary Education	Employees in group 802
	13. Tertiary Education (Universities)	Employees in group 803
	14. Public Administration	Employees in group 751-753
	15. Social Assistance	Employees in group 853

Class	***Metropolitan Function***	***Indicator****
	16. Transports	Employees in section I activities (no group 642)
Fluxes	17. People Mobility	Study and Work-related commuting flows

Source: elaborated from Boffi, Palvarini, 2011.

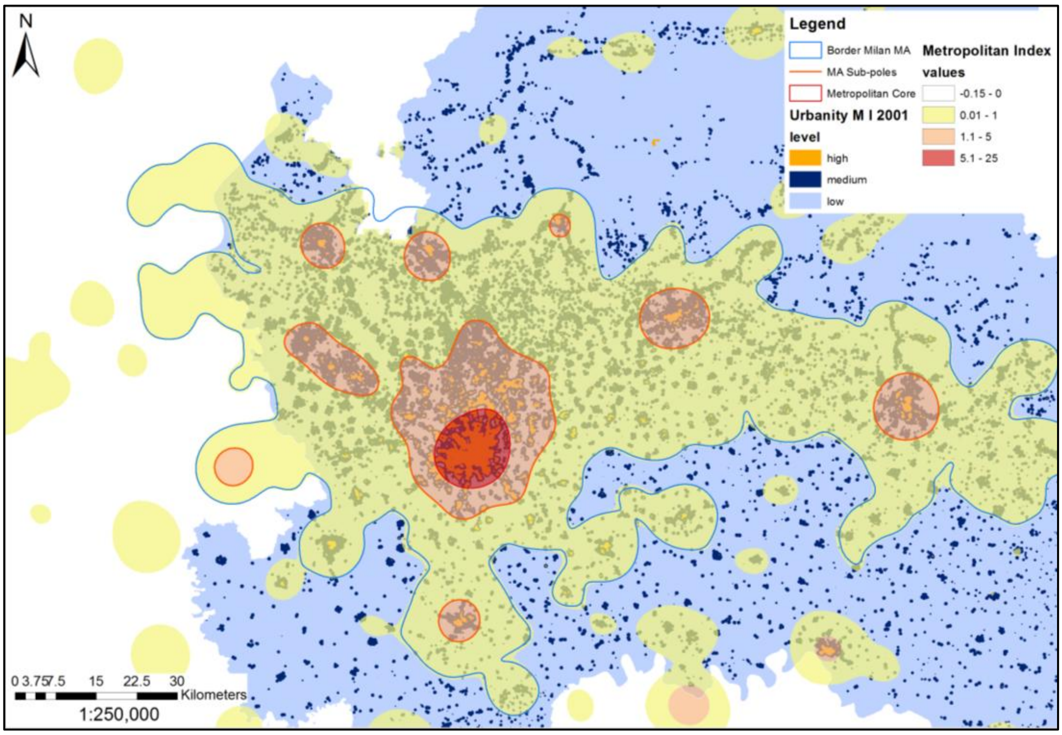
To each function one or more ATECO sector is associated, in order to measure the presence and degree of its relevance in the territory (operationally defined as the number of employees in the different activity groups composing the sectors).
17 indicators are in this way proposed, divided in 5 main dimensions (services function is divided into 2 different ones: public services and leisure services).

6.1.1.5. Technical procedures

The data adopted come also in this case from the National Census, at the census tract territorial level of detail for the population data and at the municipal level for all the other variables. For the analysis of the functions distribution a Kernel Density Model has been applied as well on the census tracts or municipalities' centroids. In order to build up a synthetic *index of metropolitanity* a Principal Component Analysis is run on the raster cells of the surfaces obtained after the application of the Kernel density model. The result showed a high level of correlation between the indicators and the existence of a common factor able to explain alone about the 55% of the variance. This factor has been considered and interpreted as the measure of the level of metropolitan nature of the spaces, the *metropolitanity*.
Once mapped the index, the authors adopted as threshold for the boundary definition and distinction between metropolitan and non-metropolitan, the average value of the index[62] (blue line in fig. 5). An internal sub-level is then defined, delimiting the territories with a specific concentration of the index, representing the metropolitan poles, the main centers of the metropolitan area, and their strictly surrounding areas (orange line in fig. 5). This sub-level is obtained computing the Getis-Ord Gi* statistic, adopting an inverse distance criterion for the definition of the computing threshold. Such a solution allow to highlight the most similar areas in terms of metropolitanity index values' concentration, corresponding to about a 1 standard deviation from the mean value (pink areas in Fig. 28)

[62] The threshold has been defined computing the Getis-Ord Gi* index (Getis, Ord, 1992)., a measure of the clustering propensity of a set of features in the space. The resultant z-scores and p-values tell where features with either high or low values cluster spatially. This tool works by looking at each feature within the context of neighbouring features. A feature with a high value is interesting but may not be a statistically significant hot spot. To be a statistically significant hot spot, a feature will have a high value and be surrounded by other features with high values as well. (for further details, see http://pro.arcgis.com/en/pro-app/tool-reference/spatial-statistics/h-how-hot-spot-analysis-getis-ord-gi-spatial-stati.htm)

Fig. 28 – Overlap between the metropolitan index and the urbanity morphological index applied to the Lombardy region territory (2001).



Source: our elaboration on Istat 2001 Census Data (Censimenti della Popolazione e delle Abitazioni e Industria e Servizi) and Boffi and Palvarini (2011).

A further sub area is in the end defined in order to underline the presence of a zone with the highest values of the distribution: the metropolitan core.
This zone covers the entire municipality of Milan and represent the nucleus of the MA. In this case the threshold is defined looking at the index distribution and adopting a power of 5 in the classification of values, the choice is highly arbitrary but it allows to highlight a peculiar break in the index distribution, even if not precise, corresponding to the location of the metropolitan core.

As can be seen the metropolitan area includes a portion of the urbanity index polygons, suggesting the existence of an important variety of urban settlements in its territory. The extent of the MA goes even beyond Lombardy regional borders on the west side, enclosing also the city of Novara (in Piedmont region), historically strongly connected with Milan. In order to distinguish the different settlements we will cross up the two indexes (Tab 12).
The resulting classification is composed by 12 categories, product of the intersection of 4 metropolitan classes (3 included in the metropolitan area and 1 non-metropolitan) and 3 urbanity classes. An additional class also exists, representing isolated levels of *metropolitanity* higher than its mean, but located outside the main metropolitan area boundary, and for this reason not included in the metropolitan realm. These areas correspond mainly to settlements rich of tourist activities or services infrastructures increasing the level of metropolitanity in those spaces. An example of this kind of territories is the Val Camonica (Camonica Valley), located above the Iseo lake, a touristic cluster, surrounded by

two national parks (Alto Sebino and Adamello parks). This first kind of exclaves is typical of the northern part of the region, where, due to the natural amenities of the territory, the settlements are usually important touristic attractors. Other metropolitan exclaves can be found also in the southern part of the region (this is the case for example of Mortara), where the infrastructural relevance of the settlements is prevalent, due to the presence of regional relevant transportation nodes or of provincial capital cities (the case of Cremona).

Tab 12 – Product of the crossing of the *Urbanity* and *Metropolitanity* indexes. Percentage values in parentheses are computed on the whole region as a total (surface: 23.844 km^2; population 2001: 9.033.602).

Urbanity

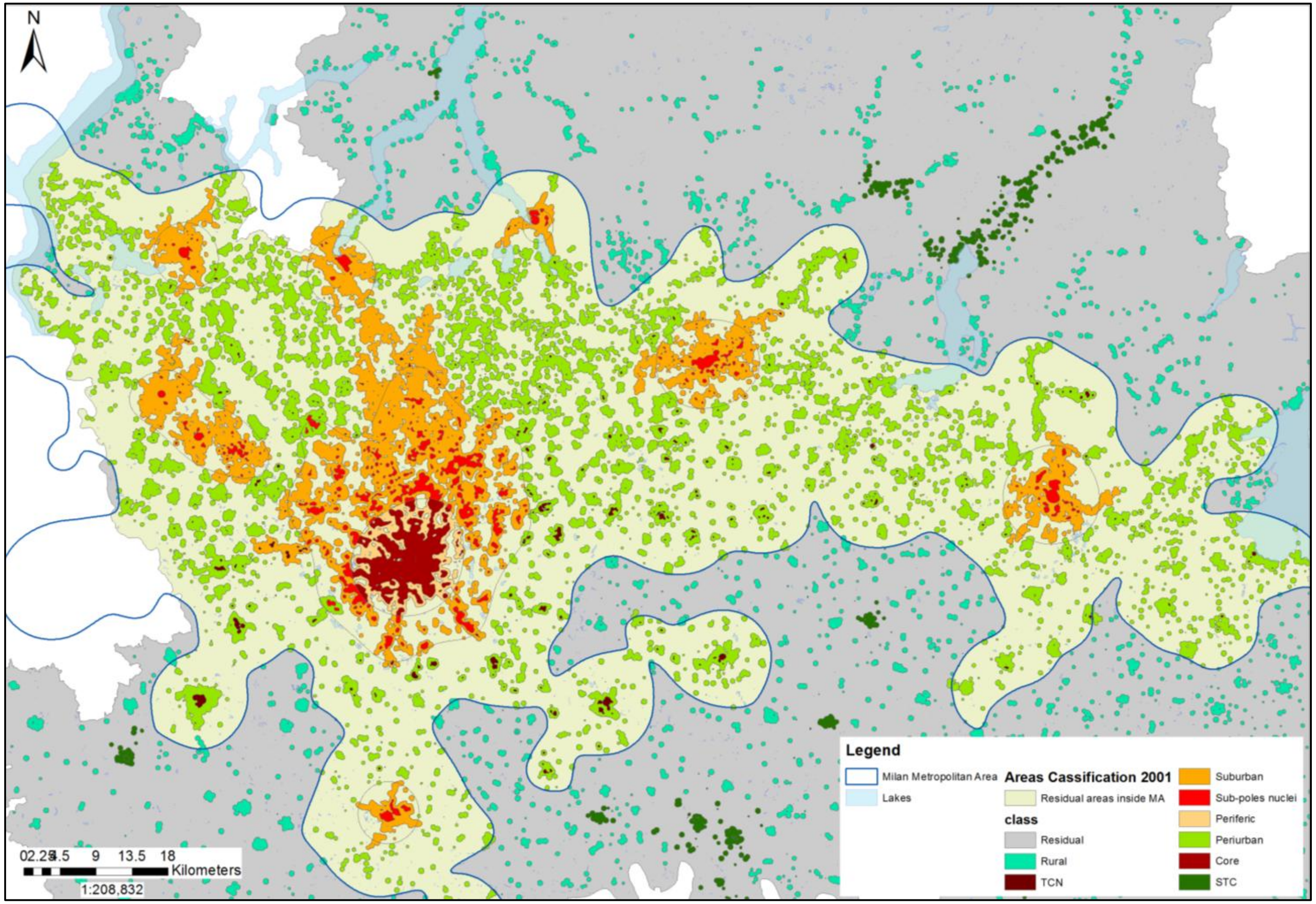
Metropolitan index

	high	medium	low	*total*	
Core	**Core Nucleus** Surface (0.34) Pop (12.93)	**Periphery** Surface (0.43) Pop (1.09)	**Residual (*core*)** Surface (0.10) Pop (0.02)	**Surface (0.87)** **Pop (14.04)**	**Metropolitan territory**
Sub-poles	**Sub-poles Nuclei** Surface (0.41) Pop (10.58)	**Suburban** Surface (4.35) Pop (21.58)	**Residual (sub-poles)** Surface (1.76) Pop (0.75)	**Surface (6.52)** **Pop (32.91)**	
Metropolitan fringe	**Transition Centers' Nuclei** Surface (0.11) Pop (2.24)	**Periurban** Surface (5.62) Pop (27.23)	**Residual (fringe)** Surface (18.84) Pop (3.95)	**Surface (24.57)** **Pop (33.42)**	
Non metro	**Rural** (-)	**Rural** Surface (3.54) Pop (10.81)	**Residual** Surface (63.60) Pop (3.87)	**Surface (67.14)** **Pop (14.68)**	

Metropolitan exclaves in non-metropolitan territory	**Service and Turistic Centers** **Surface (0.90)** **Pop (4.94)**	**Residual** **(-)**

Source: our elaboration on Istat data 2001.

Fig. 29 – Map of Lombardy Metropolitan zoning, year 2001.



Source – Our elaboration on Istat 2001 Census Data (Censimento della Popolazione e delle Abitazioni e Industria e Servizi) and Boffi and Palvarini (2011).

The territorial structure emerged from this classification shows a strong variety of morphologies and settlements, confirming the image and interpretation proposed by Lanzani (2005) among the many, who stated correctly that:

> appena ci soffermiamo sulle immagini di territorio e più specificatamente sulle molte idee di paesaggio che sempre più guidano la stessa costruzione di questo territorio urbanizzato, emerge una realtà insediativa variegata, plurale, intrecciata, frammentata e discontinua. […] le pratiche diffuse dell'abitare […] ricercano nuove ecologie abitative quotidiane pur nel quadro di nuove offerte edilizie ancora strutturalmente ripetitive e omogenee.[63]
>
> (Lanzani, 2005, p. 139)

The classification is quite complex, and a deeper look is needed in order to highlight the differences among areas. We will proceed radially starting from the center of the MA to the external areas (Fig. 29).

- **Metropolitan Area's Core**

Metropolitan Core; core periphery; residual of the core

This is the area with the highest values of the metropolitan index, enclosing the municipality of Milan. It represents the spaces with high level of urbanity in the highest class of the metropolitan index: the metropolitan **Core.**
Just around this spaces are the **peripheral** areas of the Core, characterized by a medium level of urbanity. The areas with low levels of urbanity but enclosed in the metropolitan Core are defined as **residuals.**

- **Sub-poles and suburban areas**

Sub-poles nuclei; suburban

Around the metropolitan Core and around the other main centers of the MA (usually provincial capitals like Varese, Como, Lecco, Bergamo, Monza, Brescia, Pavia) an intermediate level of metropolitan function concentration can be found, highlighting two main patterns. In the first case these areas include the metropolitan **suburbs** (in particular the settlements around Milan), showing an intermediate level of urbanity, in continuity with the peripheries of the core city. These settlements are strongly interrelated and interconnected as can be seen from the continuity of their morphology, a continuous area extending in the northern part of the MA. The higher levels of urbanity present in these territories constitutes the nuclei of the centers' agglomeration. In the other cases, around the main cities (sub-poles) the intermediate levels of urbanity constitute their peripheries, without continuity solution from the sub-poles nuclei. In these areas

[63] As soon as we stop the sight on the images of the territory and more precisely on the many ideas of landscape that more and more drive the development itself of this urbanized territory, a variegated, plural, intertwined, fragmented and discontinuous settlement structure [...] the diffused living practices [...] look for new daily living ecologies even if in the framework of new development supply still structurally homogeneous and repetitive. (our translation)

too, the low levels of urbanity have been classified as residual areas of the metropolitan suburban and sub-poles (they account for the 5% of the region surface).

- **Metropolitan fringes and Peri-urban areas**

Periurban; Centers in Transition's Nuclei

Proceeding downstairs in the metropolitan hierarchy we find the metropolitan fringe territories, the first level of *metropolitanity* of the MA. Intermediate levels of urbanity in these areas have been defined as peri-urban settlements: their location in the fringe and the peculiar morphology (isolated settlements divided from the main agglomerations or urban centers) suggest the opportunity of a differentiation from the analogous urbanity level areas in the suburbs. The urbanization in these territories looks more scattered and fragmented, with few examples of settlements' continuity. Two main territorial patterns seem to emerge from the observation of this context: a northern group of settlements, concentrated in the areas between the main sub-poles of the region above Milan, in the north-west part in particular, where peri-urban settlements are more concentrated and interconnected and few examples can be found of CTN (Centers in Transition's Nuclei), or of high level of urbanity in peri-urban centers. This band of territory corresponds mainly to the *territorio pedemontano* and *fascia periurbana* (cfr. Chapter 4.3.2), two of the 3 macro-areas distinguished by Palermo (1997) in his classification of the urban region territorial contexts. On the other side we can find another portion of the region, the South/South-East, where settlements are more scattered and of small dimensions, but with a higher proportion of CTN. This kind of divide is probably due to the functional and also historical characteristics of the Lombardy urbanization, with a North more urbanized since long time and strongly interconnected with the close big center of Milan, and a south and eastern part more agricultural and connected also to other regional or over-regional centers. This is the case of Brescia, in the east of the region, historically linked to the Veneto area, but still included in the extreme part of the metropolitan area of Milan.

The higher presence of CTN among the peri-urban settlements stands for the existence of high urbanity cores due in part to the ancient presence of urban centers in these areas and in part, mainly for the settlements closer to the major centers like Milan, to the increase of the relevance in terms of functions and size, due to the contiguity to these main poles. This could be maybe the prelude of their transition to higher level of *metropolitanity* (from peri-urban to suburban for example).

Another class composing these areas is constituted by the low urbanity spaces, also in this case classified as residual (12,67% of the regional surface). It shares similar characteristics with the other residual classes already cited but with a higher amount of agricultural spaces.

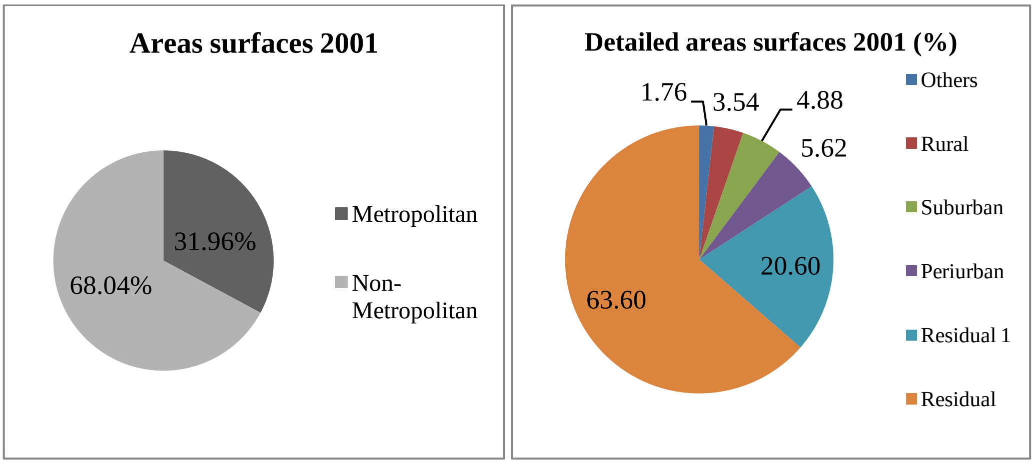
- **Non-metropolitan and rural contexts**

Rural centers; Service and Turistic Centers; Residual

The metropolitan fringe separates the metropolitan territories from the non-metropolitan ones. This portion of land is constituted by medium and high urbanity settlements that, due to the exclusion from the metropolitan context, are not considered peri-urban, even if sharing a similar value of urbanity. In the previous paragraphs we debated the differences between these contexts, highlighting the lower interaction and connection existing between the main centers and the surrounding ones. The level of *metropolitanity* stands also for this property (including the density of commuting flows) and is adopted as a methodological criterion of distinction. Always in this territory can be found also exclaves of low level of metropolitan index (the same of the fringe), isolated and not included in the boundaries of the MA (cfr. paragraphs above for further discussion on these settlements).
Finally an extended surface of residual territory is classified, including the 64% of the regional territory, composed mainly by forests or natural areas and rural contexts.

In order to simplify as much as possible the classification of the territories we proceeded to the aggregation of some classes according to the closeness and contiguity of them (following an homogeneity criterion).
- The classes **core periphery** and **residual** of the core area have been merged together and then added to the suburban category, due to the strict contiguity of the areas and to the low percentage of population and territory contained (less than the 2% if summed).
- The residual areas of the fringes and of the sub-poles have been merged as well, in order to group the residual territory internal to the metropolitan area. The new class covers the 20% of the territory but includes only almost the 5% of the total population (cfr. Tab 12).
Aerogram below summarizes the composition of regional territory according to the zoning produced:

Graph 3- region territorial composition: % of metropolitan and non-metropolitan territory (left) and detailed structure (right), year 2001.

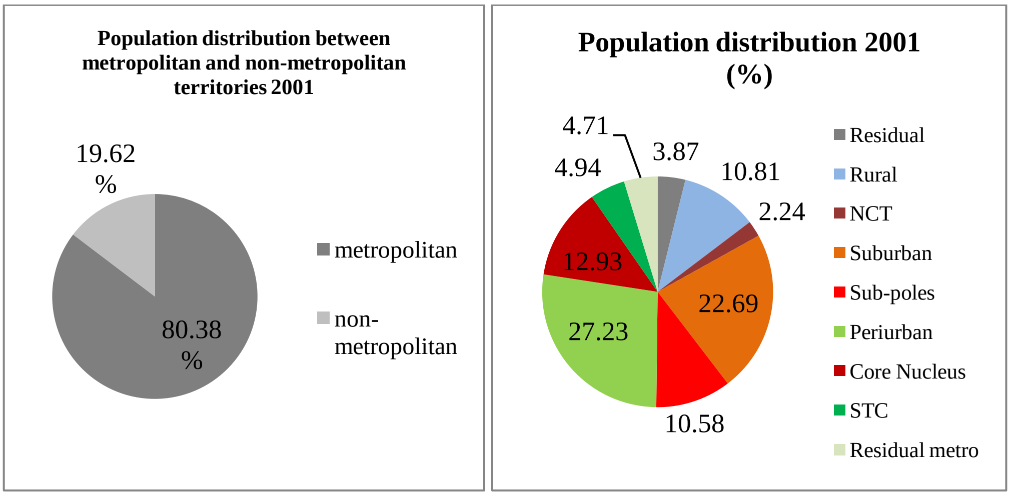


Source: our elaboration on Istat data 2001.

As we can see 1/3 of the regional surface is covered by metropolitan territories, while the outer areas are composed by rural settlements and residual areas, including small scattered settlements and prevalent agricultural, productive and natural areas.
Inside the metropolitan context the widest portion of territory is covered by fringes' residual space, territories with a low level of urbanity, located in the metropolitan fringe. The other kind of areas cover the last 12% c.a. of regional land, with the peri-urban settlements having the main amount of it, followed by the suburban.

Looking to the population distribution the main part of the region's residents are located in the metropolitan area and in particular, almost the 50%, in the peri-urban or suburban settlements:

Graph 4 - region population distribution: % of metropolitan and non-metropolitan territory (left) and detailed structure (right), year 2001.



The third most populated class of areas is the metropolitan core (12,93%), followed by the metropolitan sub-poles (10,58%). The huge difference between surface covered and population included respectively in the periurban-suburban and Metropolitan Core and Sub-poles is a clear evidence of diversity of these kind of settlements: the delta of the two indicators is much bigger for the areal extension than for the population amount, showing the extremely higher density of the latter compared to the former.

6.2 A temporal comparison: the metropolitan zoning in 2001 vs 2011

The same method has been applied to the same territory (the Lombardy region) updating the data with new datasets from the 2011 Census. The aim of this phase was to compare the results of the two years in order to stress the eventual differences emerging from the analysis. A socio-demographic analysis will be then run to analyze the sociological composition or the various kind of territories and the changes occurred between the two periods.

6.2.1 The Milan Metropolitan Area in 2011

The same procedure has been adopted for the detection of the *urbanity* and *metropolitanity* properties in the region for 2011. As well as for the 2001 the urbanity morphological index is computed, adopting the same municipalities-samples, except for Cura Carpignano since it results located outside of the metropolitan fringe and so not respecting one of the criteria for the samples selection (cfr. Section 6.1.1.2).

Urbanity index

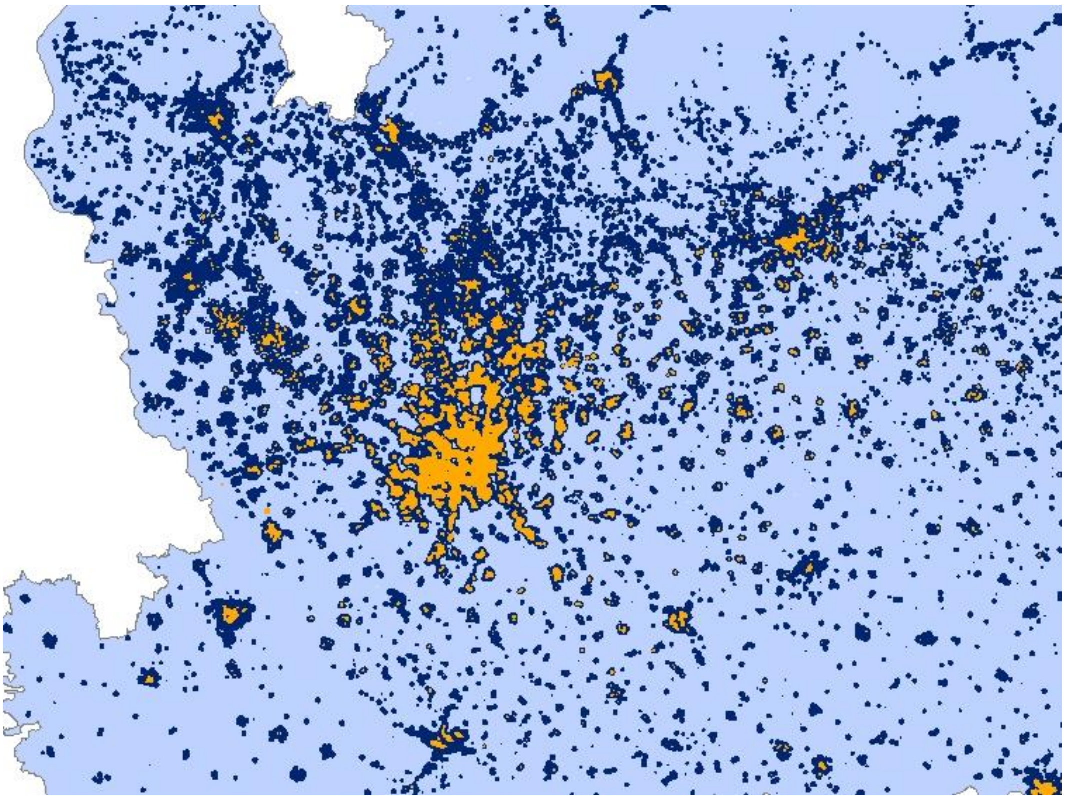
A first comparison between the two years in the urbanity classes extension shows an increase in the high urbanity level areas (in yellow in

Fig. 30), not appreciable visually, due to the small scale of the changes, but evident from the areas data.

If in 2001 the high urbanity surface was 224km^2, in 2011 it reached 311 km^2 (almost 39% increase in ten years), due to the expansion of pre-existing high urbanity surfaces, and to the emergence of new high level locations in the periurban and suburban areas[64]. At the same time medium and low level urbanity areas decrease in the time interval considered.

[64] The number of polygons enclosing high urbanity areas in fact increate from 770 to 1.463, doubling.

Fig. 30 – urbanity morphological index in 2011.

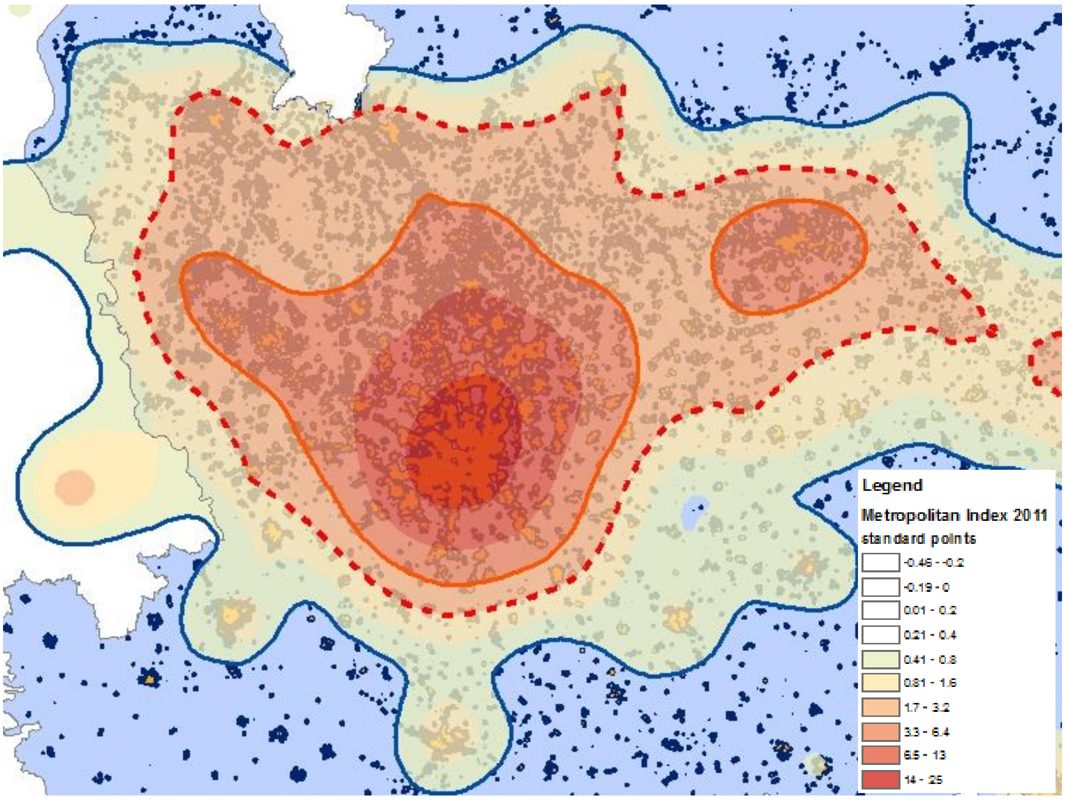


Source: our elaboration on Istat data (Censimento della Popolazione e delle Abitazioni 2001)

Metropolitanity index

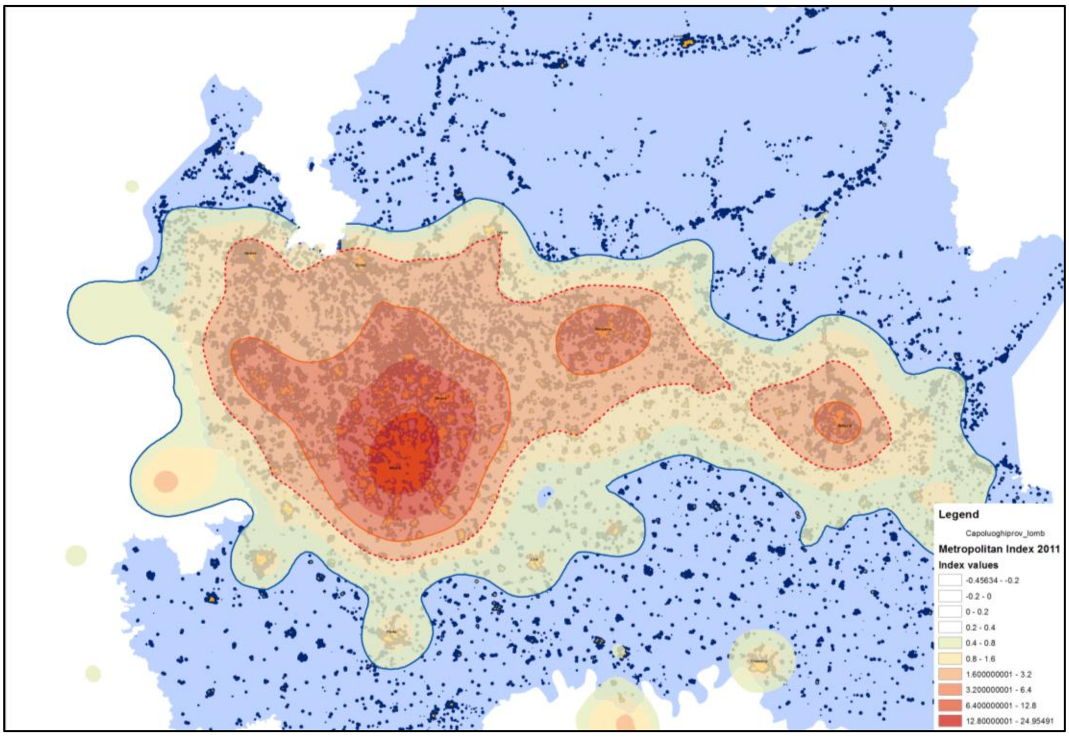
Another relevant change has to be highlighted also for the metropolitanity index, whose distribution shows important differences between the two years: the image in 2011 in fact is more complex than in the past. The range of values are similar (in 2001 min.= -0,15 max.= 24,90 standard points; in 2011 min.= -0,45 max.= 24,95 standard points), but their internal distribution is quite different.

Fig. 31 – Metropolitan index distribution and Milan metropolitan area (and sub-areas) boarder in 2011. Zoom on Milan city zone.



Source: our elaboration on Istat 2001 Census Data (Censimenti della Popolazione e delle Abitazioni e Industria e Servizi) and Boffi and Palvarini (2011).

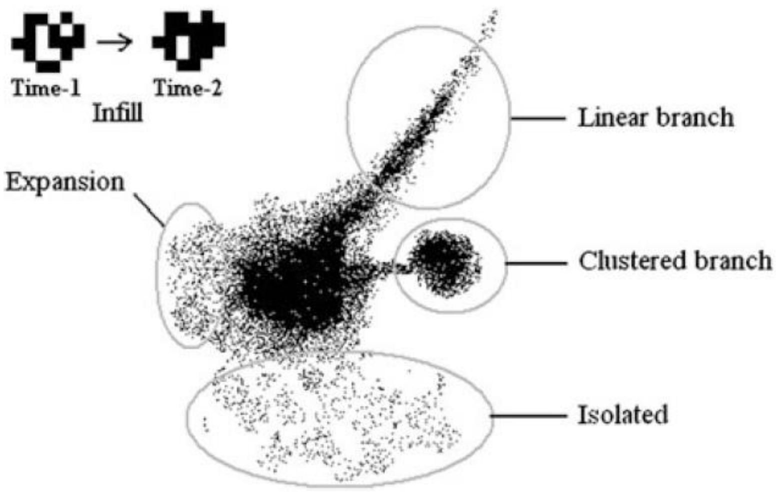
Fig. 32 - Metropolitan index distribution and Milan metropolitan area (and sub-areas) boarder in 2011.



Source: our elaboration on Istat 2001 Census Data (Censimenti della Popolazione e delle Abitazioni e Industria e Servizi) and Boffi and Palvarini (2011).

We can define a first border, dividing the metropolitan from the non-metropolitan territory (blue line), but the densification of the index is quite clear from the presence of higher levels of *metropolitanity* inside the MA. As can be seen in Fig. 31 the internal structure of the metropolitan area shows a first internal threshold[65] that is not morphologically similar to the 2001 structure (even applying a common classification criterion, with geometric intervals). If the former sub-poles zones are still partially visible around Milan and Bergamo (orange line), a new band appeared in between those areas and the metropolitan border (blue line). Such a result highlights the wider distribution of the variance of index values and an expansion of high metropolitanity surfaces inside the metropolitan context.
The variations in the *metropolitanity* index values for the two years can be better appreciated computing the difference between the two rasters.
The Fig. 34 presents the difference between absolute values of the two indexes, and shows how the positive values (increase from 2001 and 2011) are concentrated in the "new" area emerged in this time interval, located in the internal part of the metropolitan area. There has been not an increase of the values outside of the metro area, meaning the MA has not expanded in the territory, but that on the contrary, it has developed more in the spaces left empty inside it. This can be considered in part a product of the infill process (one of the sprawling patterns classified by Battha (2010), cfr. Fig. 33) on the one hand, and also of densification and increase in the level of *metropolitanity*.

Fig. 33 – Examples of sprawl patterns according to Bhatta.



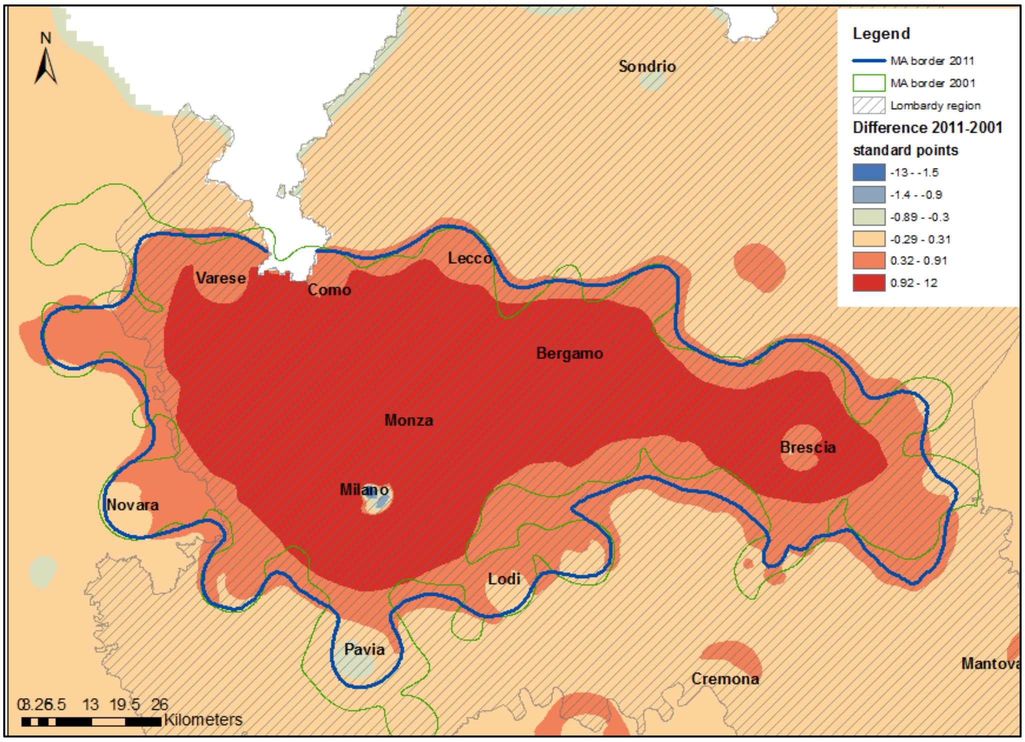
Source: B. Bhatta (2010), Analysis of urban growth and sprawl from remote sensing data. Springer, Heidelberg, p 172

Another significant indicator of this kind of process is given by the decrease (or stability) of *metropolitanity* that can be found in correspondence of the main

[65] Corresponding to 1 standard deviation of the Getis-Ord Gi* statistic, in 2001 used to highlight sub-poles.

centers, the sub-poles (the old and the current ones), but also of the metropolitan core of Milan. The nuclei of these areas show a loss of metropolitan value (Pavia, Lodi, Varese, Como, Lecco, Brescia, Novara), compensated by the increase in the areas just surrounding them.

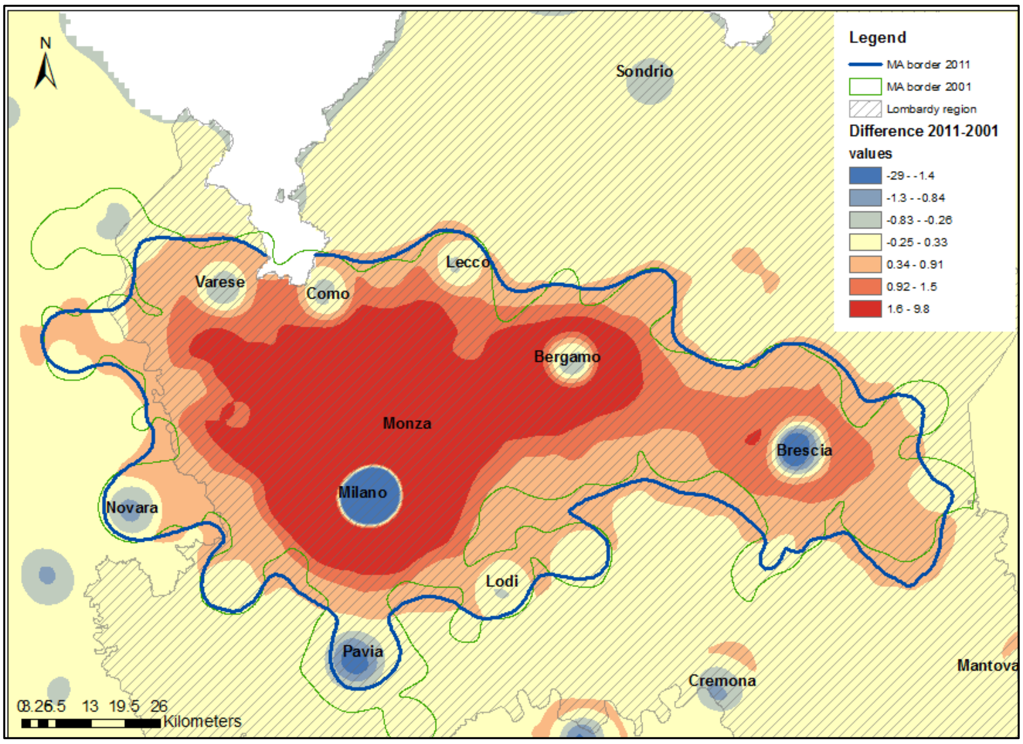
Fig. 34 – Metropolitan index values difference between 2011 and 2001.



Source: our elaboration on Istat 2001 Census Data (Censimenti della Popolazione e delle Abitazioni e Industria e Servizi) and Boffi and Palvarini (2011).

The same picture is given by the observation of the variation of the values normalized into standard deviations (Fig. 35): the representation is clearer, showing a slow increase or decrease of the index in the zone just inside the metropolitan border (in this case present also in the metropolitan sub-poles, but the centers of Cremona, Lodi, Pavia and Novara are also in this representation decreasing).

Fig. 35 – Metropolitan index (standardised) values difference between 2011 and 2001.



Source: our elaboration on Istat 2001 Census Data (Censimenti della Popolazione e delle Abitazioni e Industria e Servizi) and Boffi and Palvarini (2011).

The highest rates of growth are concentrated in the inner territories (dark red zones), with the exception of the core nucleus (Milan). This is due probably to high weight in the metropolitan index computation of the population density, one of the main drivers of the index, and in particular the strongest (Tab. 13).

Tab. 13 – Correlation matrix between metropolitan index components 2011.

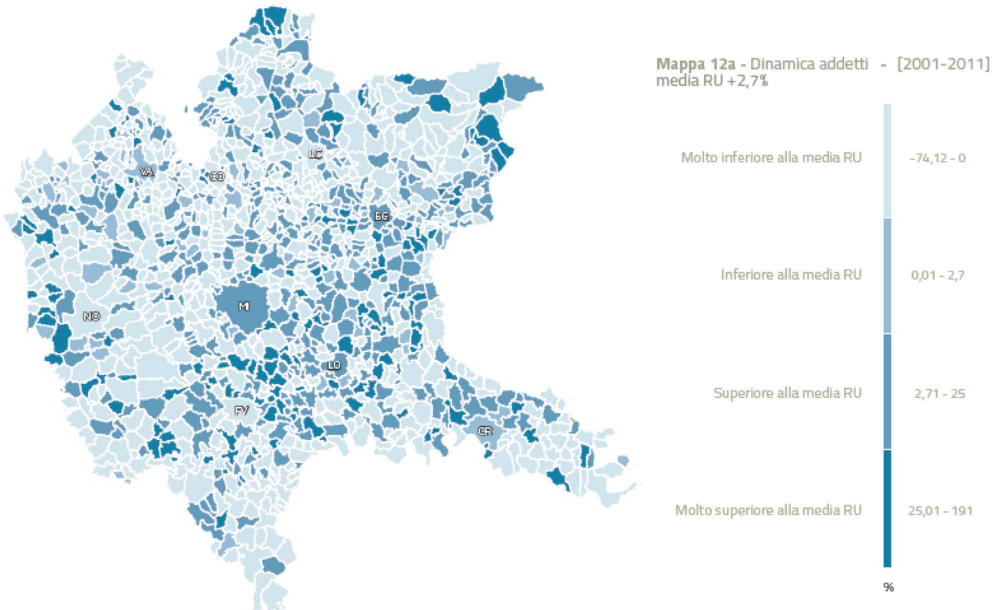
	Mobility	Residing	Manufacture	Services	**M. Index**
Mobility	1	0.50096	0.31916	0.43019	0.59957
Residing	0.50096	1	0.8207	0.85047	0.94511
Manufacture	0.31916	0.8207	1	0.84587	0.90171
Services	0.43019	0.85047	0.84587	1	0.93839
M. Index	0.59957	0.94511	0.90171	0.93839	1

Such a result is in line with the findings published by the PIM[66] Milano in its report 2016, that shows how in the whole Milan Urban Region (encompassing all the Lombardy provinces plus Novara), a growing trend of employees has taken place in the last years in the south-east area of the UR (Fig. 36), while at the same time the population rate followed a different trend (Fig. 37), presenting a more homogeneous evolution among the municipalities of the UR internal fringes,

[66] Piano Intercomunale Milanese, institute born in 1961 to coordinate the planning of the Milan hinterland and metropolitan area municipalities.

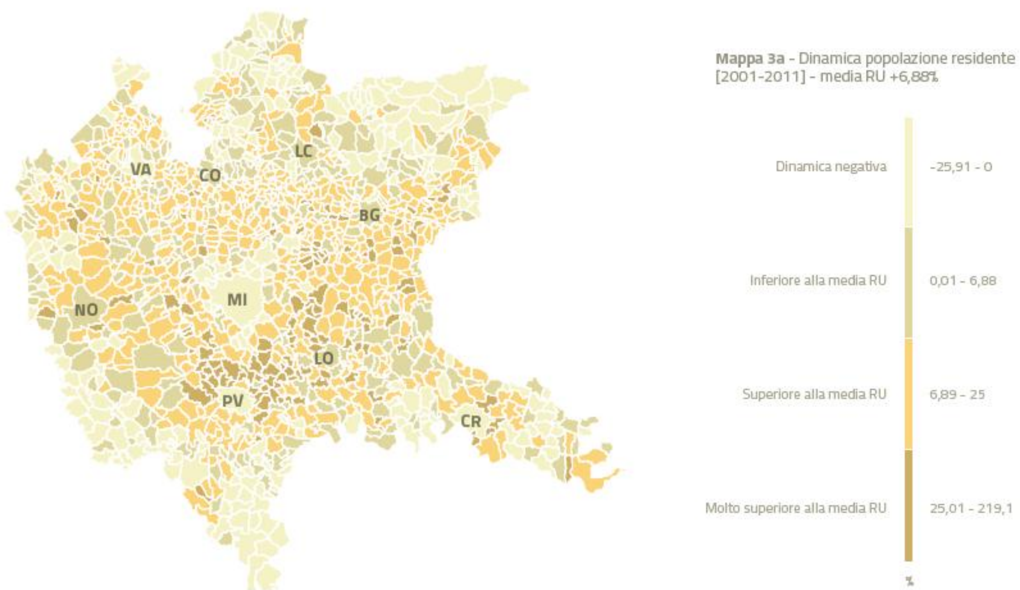
highlighting the potential existence of an in-filling phenomenon in the metropolitan interstices.

Fig. 36 – Employees dynamic 2001-2011 in the Milan Urban Region.



Source: *Spazialità Metropolitane* (Argomenti e Contributi, n.15 - 2016), PIM, p.28.

Fig. 37 – Population dynamic 2001-2011 in the Milan Urban Region.



Source: *Spazialità Metropolitane* (Argomenti e Contributi, n.15 - 2016), PIM, p.17.

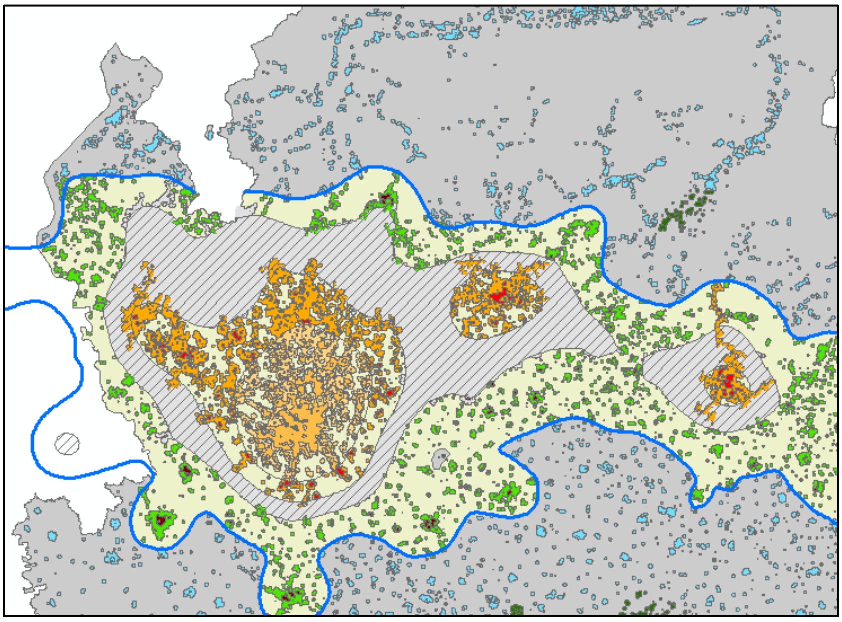
Moreover, as observed also by the authors of the report, the mismatch between employed people and population growth can be due to the specific composition of

these areas: fringe areas in fact are those in which there is an higher amount of young people with children, that increase the denominator of the employment rate (gross employment rate) lowering its relevance.
The fringe areas also experienced the main growth in third sector's employees, showing an extrusion of these activities from the center poles, following the sprawl of functions and of residences (and, as a consequence, of population).
What emerges from our analysis is that the increase of the metropolitan area in Milan is not due to its extension in surface, but in its densification, following the investments in transport infrastructures, mainly extending from the metropolitan core of Milan.

6.2.2 Comparison between metropolitan zoning in 2001 and 2011.

Crossing the two indexes (urbanity and metropolitanity) a new zoning is computed updated to the 2011 (Fig. 38). The new band emerged from the zoning (gray and lined surface in the picture) introduces 3 new zones that have an hybrid nature between metropolitan fringes and sub-poles. This could be addressed as a ***Lower* Sub-poles** area, where the metropolitan hierarchical structure shows a further level just below the Sub-poles' one with a lower degree of metropolitanity.
As can be seen from the comparison of the two zonings' distributions of population and territory (Tab. 15) the new metropolitan sub-area includes partially territories in 2001 belonging to the fringes and to the Sub-poles: for example the residual of the fringe (residual 1) seems to be divided in terms of surface in 2011 into the fringe as well as in the past, but also in the new residual 2 (lower sub-poles residual) and partially into the residual 3 (sub-poles residual).

Fig. 38 – The new zonal band in metropolitan zoning 2011.



Source: our elaboration on Istat 2001 Census Data (Censimenti della Popolazione e delle Abitazioni e Industria e Servizi).

Due to variation in shape, number of the polygons created through the method it is not possible to explain precisely what part of what zone has changed its classification level, but looking at the maps and the table data some hypothesis can be made.

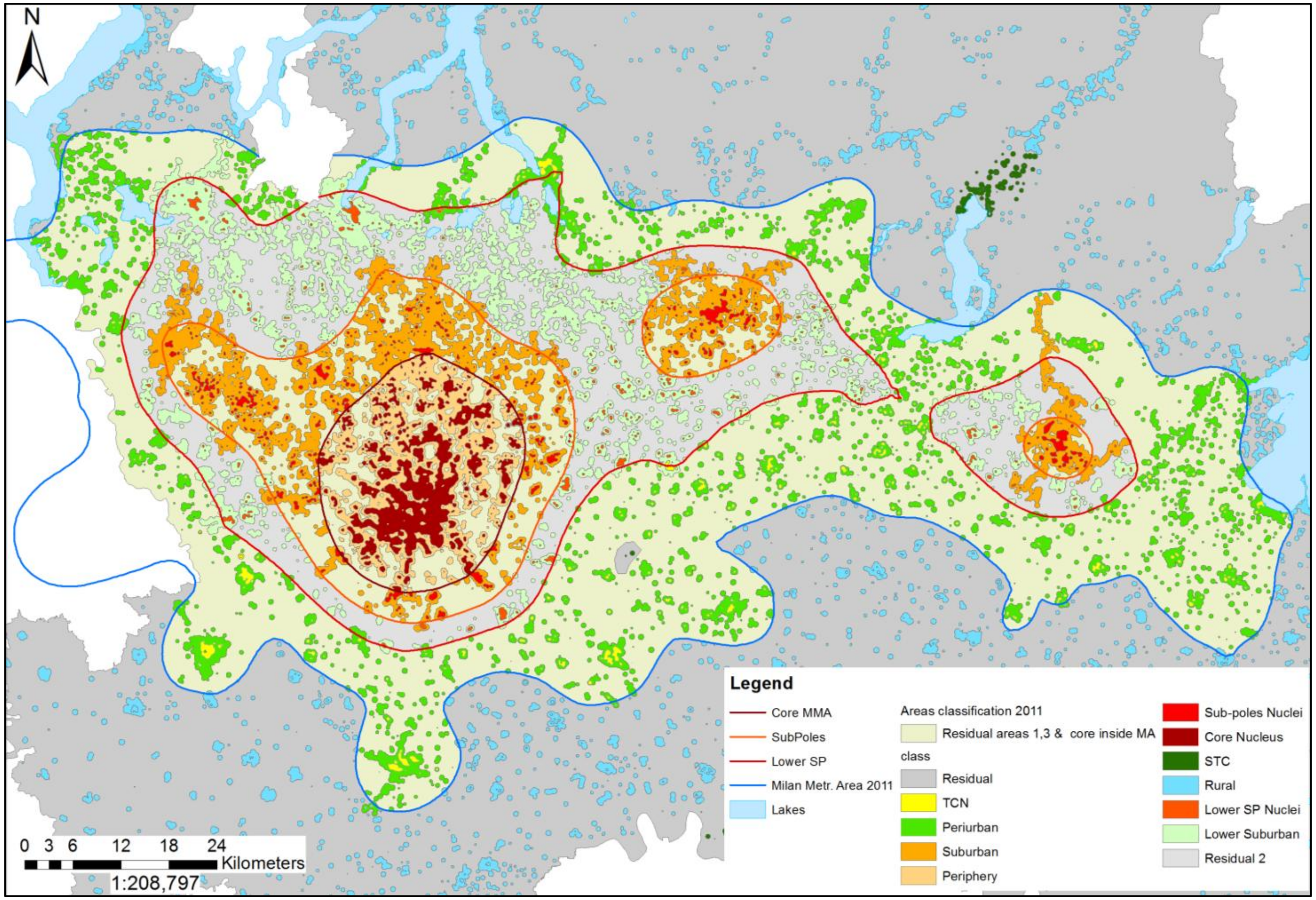
Tab. 14 - Product of the crossing of the *Urbanity* and *Metropolitanity* indexes. Percentage values in parentheses are computed on the whole region as a total (surface: 23.844 km^2; population 2001: 9.704.151).

Metropolitan index	Urbanity: high	medium	low	*total*	
Core	**Core Nucleus** Surface (0.67) Pop (19.59)	**Periphery** Surface (1.02) Pop (5.74)	**Residual (*core*)** Surface (0.70) Pop (0.17)	Surface (2.39) Pop (25.5)	**Metropolitan territory**
Sub-poles	**Sub-poles Nuclei** Surface (0.25) Pop (4.84)	**Suburban** Surface (2.54) Pop (15.45)	**Residual 3 (sub-poles)** Surface (5.52) Pop (2.02)	Surface (15.46) Pop (22.45)	
Lower subpoles	**Lower Sub-poles Nuclei** Surface (0.14) Pop (2.10)	**Suburban 2** Surface (2.76) Pop (13.41)	**Residual 2(lower sub-poles)** Surface (1.95) Pop (0.62)	Surface (4.85) Pop (16.13)	
Metropolitan fringe	**Centers in Transition's Nuclei** Surface (0.15) Pop (2.42)	**Periurban** Surface (2.79) Pop (11.64)	**Residual 1 (fringe)** Surface (12.67) Pop (2.16)	Surface (6.46) Pop (16.08)	
Non metro	**Rural** (-)	**Rural** Surface (4.37) Pop (13.71)	**Residual** Surface (64.06) Pop (3.76)	Surface (68.43) Pop (17.47)	

Metropolitan exclaves in non-metropolitan territory	**Service and Turistic Centers** Surface (0.39) Pop (2.38)	**Residual** (-)	

Source: our elaboration on Istat data 2011.

Fig. 39 - Map of Lombardy Metropolitan zoning, year 2011.



Source: Our elaboration on Istat 2001 Census Data (Censimento della Popolazione e delle Abitazioni e Industria e Servizi) and Boffi and Palvarini (2011).

Tab. 15 – Comparison of the regional Surface and Population proportions belonging to the different zones produced in the two zonings 2001 and 2011 (% values).

Urbanity

Metropolitan index

	high		**medium**		**low**		***total***	
Core	***Core Nucleus***		***Periphery***		***Residual (core)***		**2001**	**2011**
	2001 Surface (0.34) Pop (12.93)	2011 Surface (0.67) Pop (19.59)	2001 Surface (0.43) Pop (1.09)	2011 Surface (1.02) Pop (5.74)	2001 Surface (0.10) Pop (0.02)	2011 Surface (0.70) Pop (0.17)	Surface (0.87) Pop (14.04)	Surface (2.39) Pop (25.5)
Sub-poles	***Sub-poles Nuclei***		***Suburban***		***Residual 3 (sub-poles)***		**2001**	**2011**
	2001 Surface (0.41) Pop (10.58)	2011 Surface (0.25) Pop (4.84)	2001 Surface (4.35) Pop (21.58)	2011 Surface (2.54) Pop (15.45)	2001 Surface (1.76) Pop (0.75)	2011 Surface (5.52) Pop (2.02)	Surface (6.52) Pop (32.91)	Surface (8.31) Pop (22.31)
Lower subpoles	-	*Lower Sub-poles Nuclei* Surface (0.14) Pop (2.10)	-	*Lower Suburban* Surface (2.76) Pop (13.41)	-	*Residual 2 (lower subpoles)* Surface (1.95) Pop (0.62)	-	Surface (4.85) Pop (16.13)
Metropolitan fringe	***Centers in Transition's Nuclei***		***Periurban***		***Residual 1 (fringe)***		**2001**	**2011**
	2001 Surface (0.11) Pop (2.24)	2011 Surface (0.15) Pop (2.42)	2001 Surface (5.62) Pop (27.23)	2011 Surface (2.79) Pop (11.64)	2001 Surface (18.84) Pop (3.95)	2011 Surface (12.67) Pop (2.16)	Surface (24.57) Pop (33.42)	Surface (6.46) Pop (16.08)
Non-metro	***Rural***		***Rural***		***Residual***		**2001**	**2011**
	(-)	(-)	Surface (3.54) Pop (10.81)	Surface (4.37) Pop (13.71)	Surface (63.60) Pop (3.87)	Surface (64.06) Pop (3.76)	Surface (67.14) Pop (14.68)	Surface (68.43) Pop (17.47)

Metropolitan territory

2001
surface (31.96)
population (80.38)

2011
surface (22.01)
Population (80.19)

Metropolitan exclaves in non-metropolitan territory	***Service and Turistic Centers***		***Residual***		
	2001 Surface (0.90) 2001 Pop (4.94)	2011 Surface (0.39) 2011 Pop (2.38)	**(-)**		

Source: our elaboration on Istat data 2001 and 2011

In order to identify the existence of commonalities among the various zones and define not only geographical and territorial, but also sociological idealtypes we decided to apply an hierarchical cluster analysis to the different 2001 and 2011 areas, defined by the zoning procedure, analyzing the grouping tendency according to their socio-demographic characteristics.
We selected, among the available data from the Censuses, 14 indicators, that could be useful to better understand the characteristics of these contexts.

Tab. 16 – List of the socio-demographic and morphological indicators selected for the zoning profiling.

	indicator	description	property
1	Employed people	Percentage computed on the 15-65 age range population	Socio-demographic
2	Unemployed people	Percentage computed on the 15-65 age range population	Socio-demographic
3	Families composed by max. 2 people	Percentage of families composed by maximum 2 people	Socio-demographic
4	Number of components of the family	Number of members/family	Socio-demographic
5	Index of dependence	Proportion of people 0-14 and 65+ on the population in working age (15-65).	Socio-demographic
6	Foreigners	Percentage of residents foreigners (on the whole population)	Socio-demographic
7	Households renting	Percentage of households residing in a rented habitation	Socio-demographic
8	Households owning	Percentage of households residing in an owned habitation	Socio-demographic
9	Residences with 2 floors max	Percentage of residential habitations with max. 2 floors (on the whole residential stock)	Morphological
10	Residences recently built	Percentage of residential habitations built after 1981 (for 2001) 1991 (for 2011) (on the whole residential stock)	Morphological
11	High educated	Percentage computed on the 15+ age range population	Social status (proxy)
12	Medium educated	(cfr. 11)	Social status (proxy)
13	Low educated	(cfr. 11)	Social status (proxy)
14	Commuters	Percentage of people commuting for working or studying reasons (on the whole population)	Functional interrelations

Some of these indicators have been already used in various international studies about the metropolitan territories social composition. As highlighted by French literature for example, the family structure changes according to the kind of area considered: in urban areas, and in particular in cities and major centers, a prevalence of young families with children is found and, on the contrary, a smaller percentage of families with just one or two members (Le Jeannic, 1997c). Such a distribution is partially due to the individual preferences of people and to the housing costs, decreasing the farer from the main centers. For a similar reason the inclusion of the ownership/renting regime of houses could give information on the socio-demographic characteristics of the different zones.
The presence of cheaper housing in suburban and periurban zones is also linked to the higher presence in these areas of independent homes instead of flats and apartments. The percentage of residences constituted by 2 levels maximum can probably intercept this property.
Due to the prevalence of young couples with children (and in general a young and active population) in the metropolitan fringes, the index of dependence, composed by the share of population more fragile (since still not employed or no more due to the retirement) on the population in active age (15-65), is supposed to be lower in those areas than in the more urbanised zones.
Another dimension that could be considered useful in distinguishing the different zones is the social status of their population: even if it is not clear in the literature whether exist or not a social polarization between the population living the suburban/periurban areas and the one settled in the more central and urbanized areas, considering such a dimension is potentially informative. As a proxy for the social status of the population we will use the education level, since it can be associated with a higher economic and social position (on average).
Since the metropolitan fringes are the zones in which the urbanization process is stronger, investing former rural and agricultural areas, we would hypothesise the existence in these areas of a higher presence of recently built-up houses. For 2001 we will consider *recent* those houses built after 1981, while for 2011 those built after 1991.

Clustering the zones

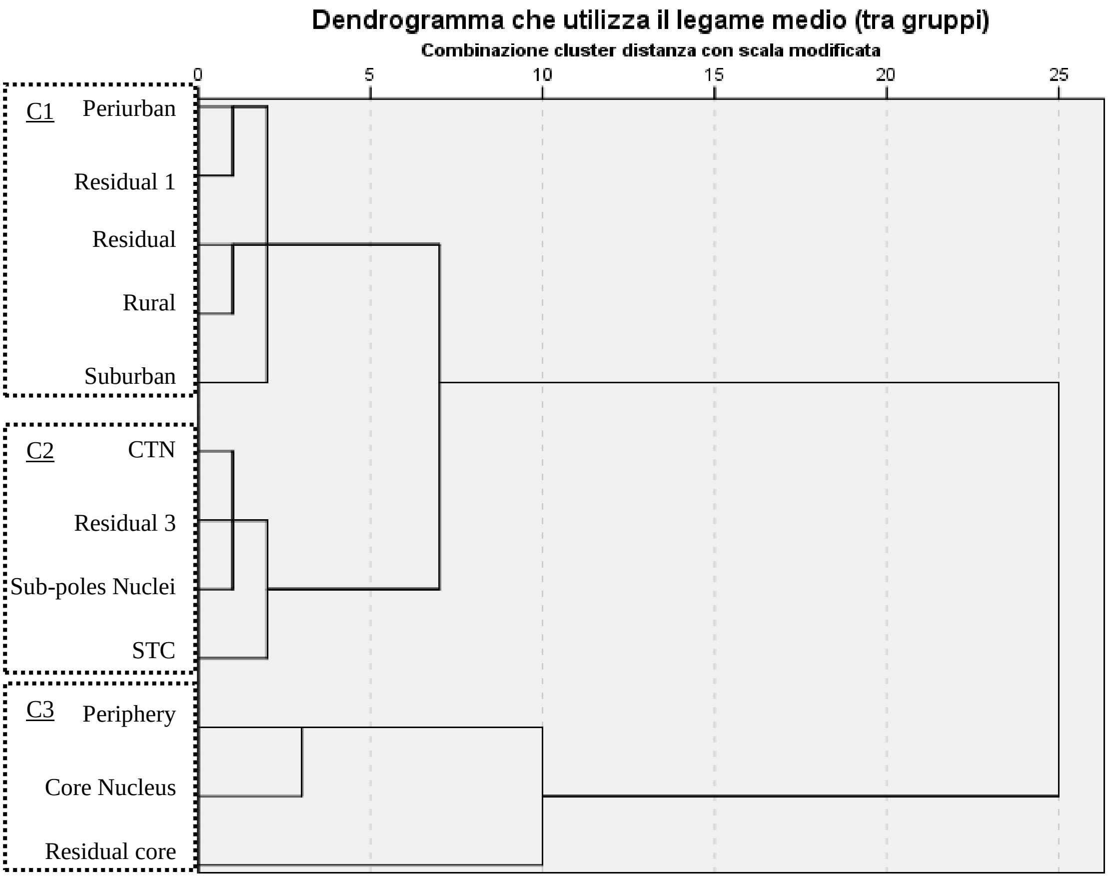
If we apply a hierarchical clustering procedure to the data we can see how the different zones are more or less close in terms of indicators values average. This is intended just as an explorative procedure, in order to drive the interpretation of the data and the zones' nature.
The structure of the two zonings due to the differences in the kind of areas designed in 2011, is quite diverse.
The clustering for 2001 (Graph 5) shows 3 main groups of areas, characterized by a different combination of urbanity/metropolitanity levels. The first cluster (Periurban, Residual 1, Residual, Rural, Suburban,) includes areas belonging to the non-metropolitan territories and metropolitan fringe or sub-poles, and mainly

with a low or middle level of urbanity (**medium-low metropolitanity and medium-low urbanity**).

The second cluster is composed by zones with an **high level of urbanity**, and a various degree of metropolitanity (CTN, Sub-poles Nuclei, STC, Residual 3 of the Sub-poles).

The third cluster (Core Nucleus, Periphery of the Core, Residual of the Core) is composed by zones included into the metropolitan core (sharing a **high level of metropolitanity**).

Graph 5 – Hierarchical Clustering of the 2001 zoning classes.



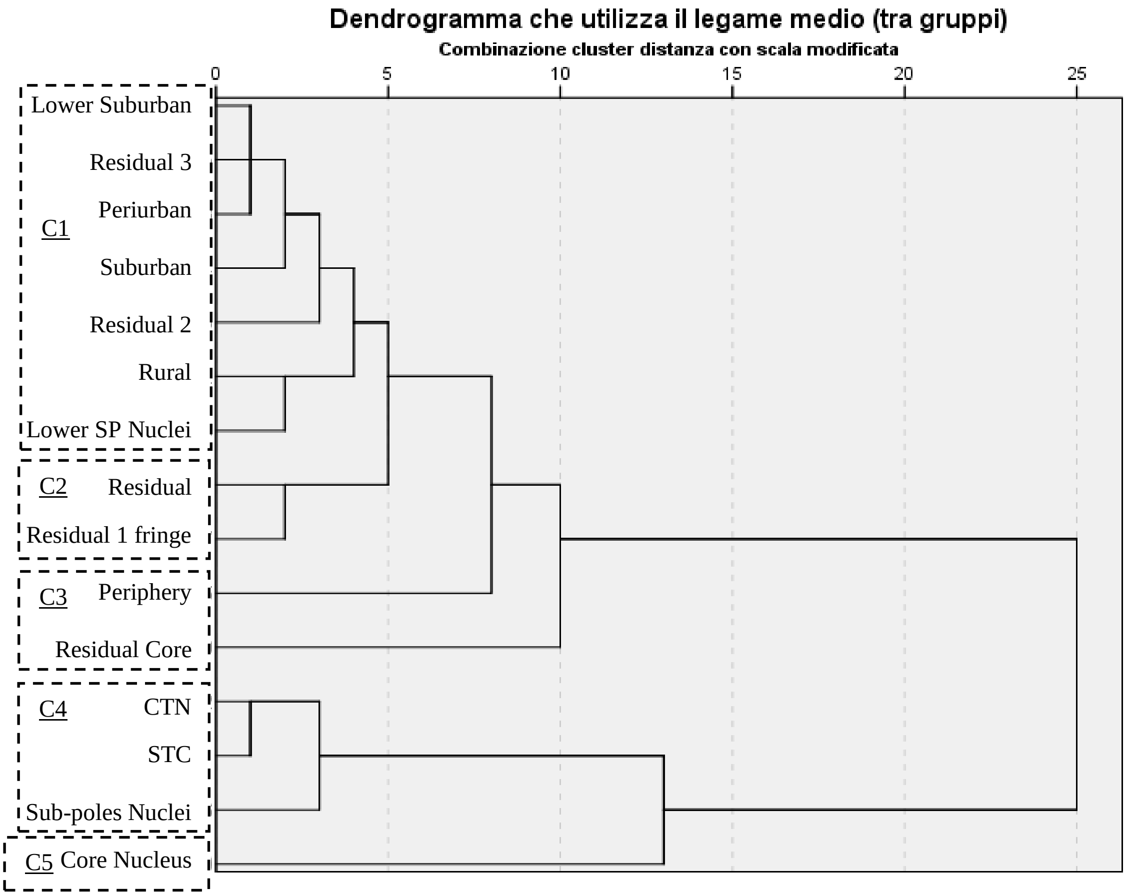
The image given by the 2011 zoning is partially different. How can be seen, 5 clusters can be defined:

The first one includes the zones Lower Suburban and its Nuclei, Periurban, Suburban and its Residual areas (residual 3), plus the Rural, grouping areas characterized by a **intermediate-low level of urbanity** (and a **medium-low level of metropolitanity**).

The second cluster is composed by the non-metropolitan Residual and the fringe Residual, **low level of urbanity** zones at the limits and outside of the metropolitan realm.

The Periphery of the core and its residual compose the third cluster, including a **medium-low level of urbanity** contexts but located in an **high metropolitan** zone.
The fourth cluster is similar to the second one found for 2001, including the main **high urbanity** classes (Core excluded).
The Core nucleus represents the **highest urbanity and metropolitanity** level cluster, close to the high urbanity one, but constitutes a separated cluster (number five).

Graph 6 - Hierarchical Clustering of the 2011 zoning classes.



Observing the two clustering procedure results (Tab. 17), we can see the effects of the densification of the internal areas of the metropolitan area and of the complexification of its structure.
If in 2001 intermediate levels of urbanity in the fringes (suburban and periurban) did share a common cluster with the lower levels of urbanity (but not residual 3 of the suburbs), in 2011 the situation seems to be more differentiated in terms of metropolitan/non metropolitan, since the non metropolitan Residual seems to be separated from the other metropolitan contexts (except the close, in geographical and urbanity level terms, Fringe Residual), and, on the other hand, more complex inside.

The expansion of the metropolitan core area is also probably at the base of the inclusion in 2011 of parts of the core area in a different cluster. In 2001 in fact the Core, together with Periphery and Residual of the core, were grouped in a common block, keeping high metropolitanity zones separated from the others.

Tab. 17 – 2001 and 2011 clusters comparison.

	Zoning 2001	**Zoning 2011**
Cluster 1	Periurban Residual 1 Suburban Residual Rural	Lower Suburban Residual 3 Periurban Suburban Residual 2 Rural Lower SP Nuclei
Cluster 2	CTN Residual 3 Sub-poles Nuclei STC	Residual 1 fringe Residual
Cluster 3	Periphery Core Nucleus Residual core	Residual core + Periphery
Cluster 4	-	CTN STC Sub-poles Nuclei
Cluster 5	-	Core Nucleus

The zonings here proposed are quite complex and an effort to simplify that complexity is needed. In order to proceed in such a task we decided to adopt both the cluster analysis and a reasoned criterion: always considering at first the cluster results we decided to merge zones according to their contiguity and relevance in terms of population percentage hosted. In this way we tried to keep together contexts territorially close and not too relevant in terms of demographic size.

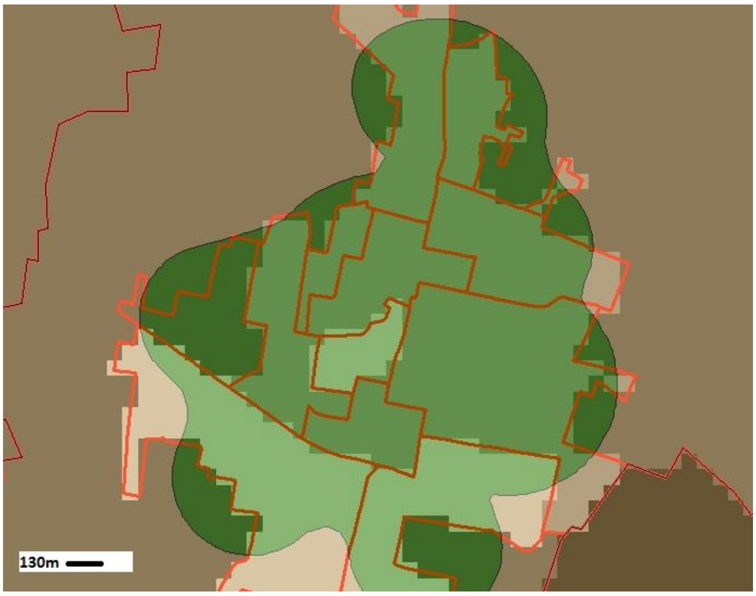
In the analysis of the socio-demographic composition of the various zones we will merge the *Residual of the Core* with the *Periphery* class (belonging to the same cluster and also contiguous), encompassing about the 1% of the regional population in 2001 and less than 0.2% in 2011 and being contiguous one to the other.

6.2.3 Socio-demographic composition of the metropolitan zoning 2001 and 2011

After having defined different zones composing the metropolitan zoning, we would like to analyse their composition in terms of socio-demographic characteristics of the population inhabiting the various areas. Our scope is to check the existence of sociological idealtypes overlapping the diverse areas found through the metropolitan classification of the Lombardy territory: are these areas characterized also by a specific kind of population?

In order to answer to such a question we had to adopt a specific procedure, applied into an GIS environment (ArcMap software in particular), in order to populate of data these areas, not corresponding to any administrative or statistical level geography. Our starting point are the census data by Istat, at the census tract level of detail. In order to attribute to the various polygons composing the zoning the data belonging to the census tract we transformed the indicators they contained into density indexes[67]. Then all the census tracts have been transformed from polygons into rasters (cells of 50x50m), where each cell contained the density value of the census from which it was originated (Fig. 40).

Fig. 40 – Example of Zonal Statistics application.



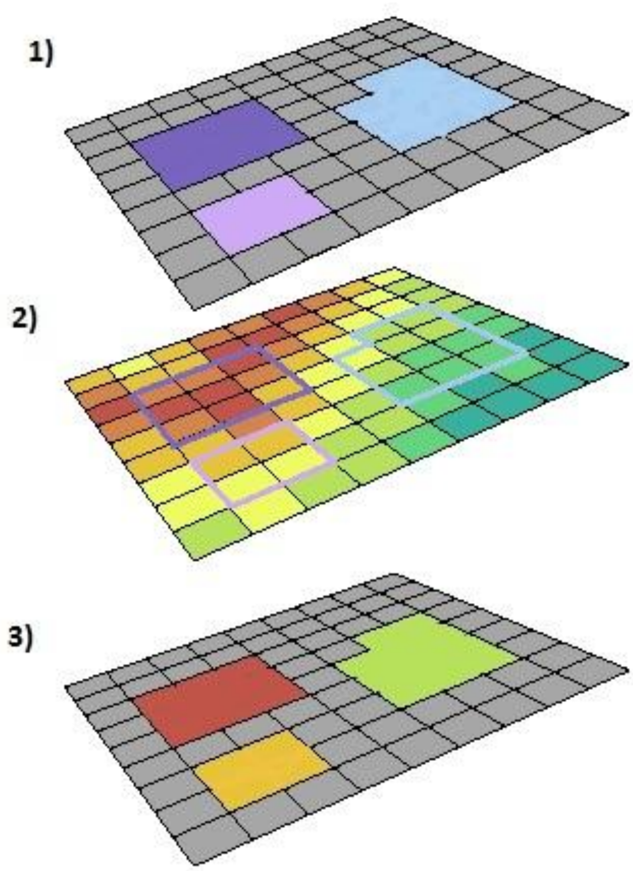
Source: Our elaboration on Istat data (Census 2001). The image shows of the poligons created (transparent green) overlapped to some census tracts (bordered in orange), divided into squares of 50m side each (that can be seen in correspondence of the limits between tracts). Each cell has the same value of the census tract it belongs to for the property represented (the various shades of color correspond to the different values of the property analised in the tract)

[67] for example: the number of employed people was transformed into n. employed/km^2, according to the surface of the census tract itself.

This allowed us to apply the Zonal Statistics tool from ArcGis software, thanks to which we attributed to all the polygons composing the zoning the values of the cells (or better, the result of a computation on the values of the cells) falling into them.

In Fig. 41 the functioning of the tool is described: the first layer represents the zoning polygons, to which the values of a further underlying layer (composed by the census tracts transformed into rasters) are attributed. The attribution is produced applying specific calculations on all the values taken from each cell of the raster falling into the polygons (in our case we computed the mean)[68]. Thanks to such an operation we could build tables showing the distribution of the indicators values in the various zones composing the zonings.
We must highlight that the data attribution to the polygons produced a certain degree of imprecision in the overall computation: if merged together all the zones, the overall values for each property differs from the overall region values of some percentage points (it varies from 0,02 points to 2.15 in 2001 and 0.01 to 4.75 in 2011, for some indicators). For this reason the values should be compared only with the average computed and not the regional average from other sources.

Fig. 41 – Functioning of Zonal Statistics Tool in ArcGis.



Source: ArcGis website (http://desktop.arcgis.com/en/arcmap/10.3/tools/spatial-analyst-toolbox/h-how-zonal-statistics-works.htm).

[68] As an example: if a polygon includes 20 cells of a tract whose value for a specific property is 4, 50 of a second tract with value 6 and a third one whose values is 3, the value sof the property for that polygon would be: V = [4*(0,2)+6*(0,5)+3*(0,4)] / 3 = 5

The computation of the different indicators help us to better understand the composition of the clusters, and what elements are at the base of their formation.
In Tab. 19 and **Errore. L'origine riferimento non è stata trovata.** we coloured in green the values of the indicators when higher than the average, and highlighted with a red square, for each cluster, the block of values when higher than the average, creating a commonality and a distinctive pattern inside the clustering zones. In some cases, due to the extreme closeness of the zone to the average value of the considered indicator and if just one zone was excluded inside the cluster, we drawn a dashed lined square.
All the values must be intended as pure tendencies, since also the differences and distances from the average value are not always very strong. They anyway give an information on the territorial structure and characteristics of the different zones.
In

Tab. 18 the profiles of the various clusters are summarized, highlighting the indicators showing values higher than the average.
From the analysis of the indicators'values distribution we can see that the employed/unemployed rate seems not to play a relevant role, since all the zones show close levels for those properties.
The index of dependence has an ambiguous role, since its variation can be due both to an high level of elders or children, producing different figures: for the periurban areas its low level could be linked to the second situation, while in the rural areas to the first one. A further analysis is needed in this sense.
In both zonings anyway can be seen as in the lower metropolitanity and urbanity zones a higher number of members in the family is found (on the contrary a lower proportion of families with maximum two members), following the findings in the literature. Lower levels of education are also found, showing that in the main centers the rate of highly educated people is usually higher.
High commuting is also a common characteristics of the population inhabiting these zones, meaning that a major amount of people is pushed out of its municipality for working or studying reasons.
People tends to own more often their house in lower metropolitanity and urbanity contexts, confirming the hypothesis on the cost-linked residential choices. Houses are also usually more recent in suburban, periurban and residual areas inside the metropolitan area, due to the urbanization process expansion in those contexts and mainly around the main centers.
If the structure in 2011 is more fragmented the main tendency is anyway confirmed. Closeness between cluster 4 and 5 emerges, while cluster 3 shows the existence of an intermediate situation. A more detailed analysis of some of these indexes could give further information on the micro-changes among contexts.

Tab. 18 –2001 and 2011 Clusters' profiles.

	Zoning 2001	profile	Zoning 2011	profile
Cluster 1	Periurban Residual 1 Suburban Residual Rural	- High n. family components - owned habitation - habitations max. 2 floors - Recently built - High commuting - Lower educational level	Lower Suburban Residual 3 Periurban Suburban Residual 2 Rural Lower SP Nuclei	- High n. family components - *owned habitation* - *Recently built* - *High commuting* - *Lower educational level*
Cluster 2	CTN Residual 3 Sub-poles Nuclei STC	- *High family max.2 components* - *Higher index of dependence*	Residual 1 fringe Residual	- High n. family components - owned habitation - Lower educational level - *High commuting*
Cluster 3	Periphery Core Nucleus Residual core	- High family max.2 components - foreigners - rented homes - medium/high educational level	Residual core + Periphery	- High n. family components - owned habitation - Recently built - medium/high educational level - High commuting
Cluster 4	-		CTN STC Sub-poles Nuclei	- High family max.2 components - foreigners - rented homes - medium/high educational level
Cluster 5	-		Core Nucleus	- High family max.2 components - foreigners - rented homes - medium/high educational level

Tab. 19 – 2001 Zoning classes profile (displayed according to clusters belonging).

		1	2	3	4	5	6	7	8	9	10	11	12	13	14
2001 zoning		**employed**	**unemployed**	**Fam 2com**	**Comp. fam**	**Dep. index**	**foreigners**	**rented**	**owned**	**Habitations 2f**	**Habit. Post '81**	**High ed**	**Medium ed**	**Low ed**	**commuters**
	mean	**63.75**	**2.54**	**55.76**	**2.45**	**46.37**	**3.82**	**22.60**	**69.64**	**53.29**	**13.09**	**8.84**	**29.54**	**30.01**	**24.66**
Cluster 1	**Suburban**	63.64	2.56	51.55	2.56	43.54	2.69	19.02	74.29	61.16	15.14	8.07	30.54	30.18	30.49
	Periurban	63.87	2.22	50.54	2.58	43.31	2.89	16.96	75.02	68.05	19.43	5.64	27.51	33.42	32.57
	Residual 1	64.58	2.07	48.39	2.65	42.15	3.39	14.42	74.13	71.41	18.96	5.32	26.10	35.33	31.97
	Residual	63.82	2.19	52.87	2.55	48.41	3.87	13.22	74.77	72.27	15.33	4.56	24.42	36.06	25.73
	Rural	62.44	2.40	54.45	2.48	49.18	3.08	15.99	74.75	66.07	15.39	4.66	24.98	34.78	27.09
Cluster 2	**CTN**	63.25	2.74	56.67	2.42	46.53	3.11	26.86	67.25	53.85	12.09	7.51	29.42	30.08	28.35
	Subpoles Nuclei	63.04	2.95	57.68	2.39	45.69	3.36	28.15	67.18	43.78	9.33	10.16	31.26	27.59	26.90
	STC	61.93	2.54	57.71	2.38	48.75	2.80	25.15	67.83	59.28	17.20	8.85	30.43	28.92	20.60
	Residual 2	64.78	2.37	55.12	2.47	47.74	3.69	23.20	67.48	48.09	12.10	10.75	31.41	28.29	25.40
Cluster 3	**Periphery**	64.41	2.92	59.66	2.35	44.47	6.29	31.84	62.87	26.50	5.98	13.20	34.98	24.56	13.33
	Core Nucleus	65.51	2.99	68.70	2.10	50.33	6.84	33.77	60.52	15.68	3.05	18.53	33.90	20.89	8.87

Source: our elaboration on Istat Data 2001.

Tab. 20 - 2011 Zoning classes profile (displayed according to clusters belonging).

2011 zoning		1 employed	2 unemployed	3 Fam 2com	4 Comp. fam	5 Dep. index	6 foreigners	7 rented	8 owned	9 Habitations 2f	10 Habit. Post '81	11 High ed	12 Medium ed	13 Low ed	14 commuters
	Mean	**67.23**	**3.72**	**60.06**	**2.35**	**53.66**	**9.82**	**18.55**	**73.67**	**60.85**	**16.51**	**13.90**	**38.70**	**65.49**	**29.69**
Cluster 1	**suburban**	67.33	3.63	57.91	2.40	52.32	7.62	14.81	78.37	63.40	16.90	13.60	40.13	65.13	34.28
	Lower Suburban	67.06	3.55	56.68	2.44	51.23	8.31	14.90	77.76	65.43	19.73	11.82	38.18	68.34	36.13
	Residual 2 & 3	68.14	3.33	56.31	2.45	50.74	7.67	14.44	76.34	69.08	19.34	13.05	38.34	67.05	35.50
	periurban	66.20	3.67	57.32	2.42	51.18	9.93	16.98	75.21	68.65	19.13	11.07	36.82	69.95	32.40
	Lower SP Nuclei	66.43	4.10	59.65	2.36	52.93	12.14	20.40	73.62	58.73	17.62	11.78	37.56	68.14	33.25
	Rural	65.63	3.47	59.48	2.36	54.47	9.39	16.07	75.33	64.04	15.89	9.49	36.59	71.45	29.03
Cluster 2	**Residual 1 (fringe)**	66.81	3.43	54.98	2.49	49.66	8.87	13.80	75.24	74.58	17.69	9.57	35.27	73.14	32.89
	Residual	66.91	3.21	58.54	2.39	54.14	8.95	12.22	76.20	72.10	13.72	8.69	35.69	73.34	29.04
Cluster 3	**Periphery & Residual core**	67.99	3.91	58.98	2.37	51.90	7.70	17.19	76.65	60.13	18.73	16.44	43.13	59.22	31.47
Cluster 4	**Sub-poles Nuclei**	67.57	4.20	63.73	2.24	55.43	11.89	23.56	70.35	48.62	12.43	17.91	40.78	59.46	28.05
	CTN	66.47	3.91	63.12	2.26	56.94	12.46	25.30	67.54	53.81	14.50	16.61	37.85	63.05	24.47
	STC	67.69	3.78	65.07	2.21	57.45	10.10	25.70	67.57	55.69	18.40	17.07	41.62	59.86	22.03
Cluster 5	**Core Nucleus**	69.74	4.13	68.95	2.09	59.25	12.61	25.82	67.55	36.71	10.53	23.61	41.11	53.20	17.48

Source: our elaboration on Istat Data 2011.

6.1.1.6. Comparison of some most significant indicators

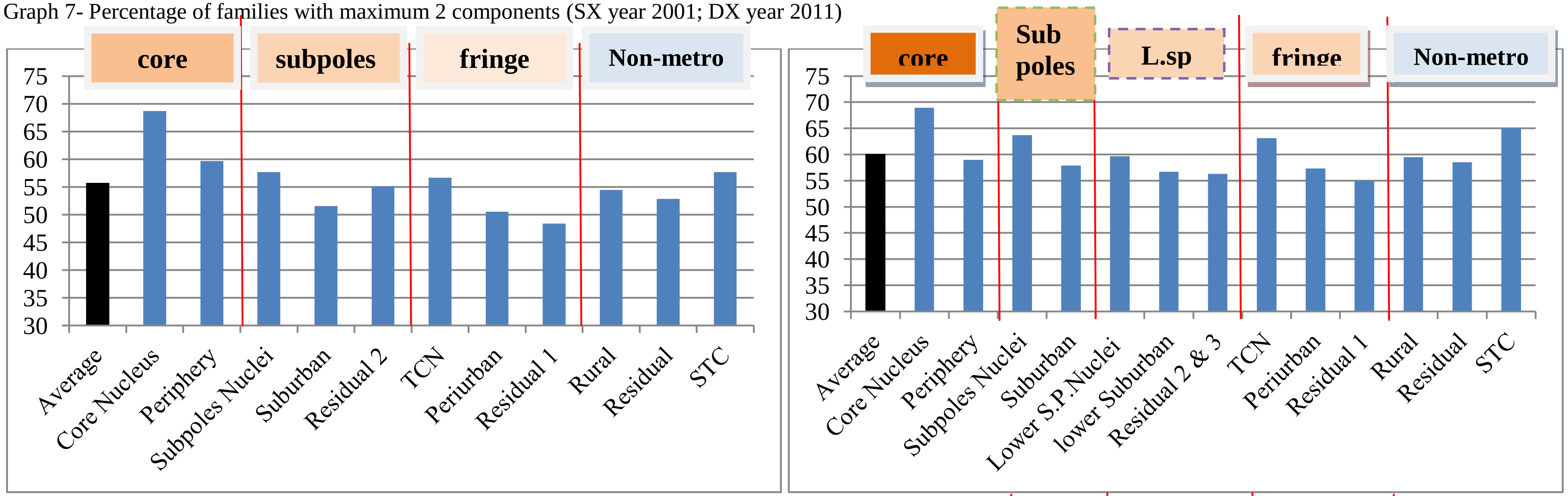
In order to highlight better the differences in terms of socio-demographic indicators values in the different zones defined we will compare some of the indicators showing the highest variation in the two classifications:

Tabella 21 – Indicators selected to show zoning classes trends.

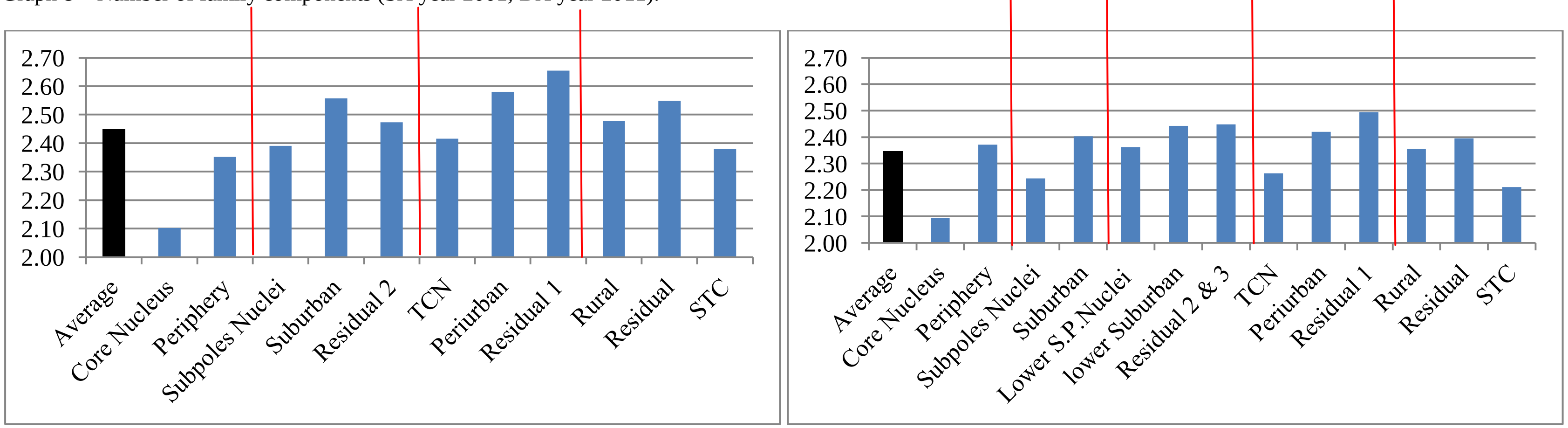
	indicator	**description**	**property**
3	Families composed by max. 2 people	Percentage of families composed by maximum 2 people	Socio-demographic
4	Number of components of the family	Number of members/family	Socio-demographic
6	Foreigners	Percentage of residents foreigners (on the whole population)	Socio-demographic
8	Households rented	Percentage of households residing in an owned habitation	Socio-demographic
9	Residences with 2 floors max	Percentage of residential habitations with max. 2 floors (on the whole residential stock)	Morphological
11	High educated	Percentage computed on the 15+ age range population	Social status (proxy)
14	Commuters	Percentage of people commuting for working or studying reasons (on the whole population)	Functional interrelations

Looking at the specific zones compared is useful to highlight the differences in the values distinguishing between the effect of the urbanity level and of the metropolitanity: for some indicators in fact the differences are based mainly on the first dimension, for others on the second dimension. In general it can be aid that the position inside the metropolitan hierarchy is more relevant in the 2001 zoning, due to the complexification of the 2011 one.

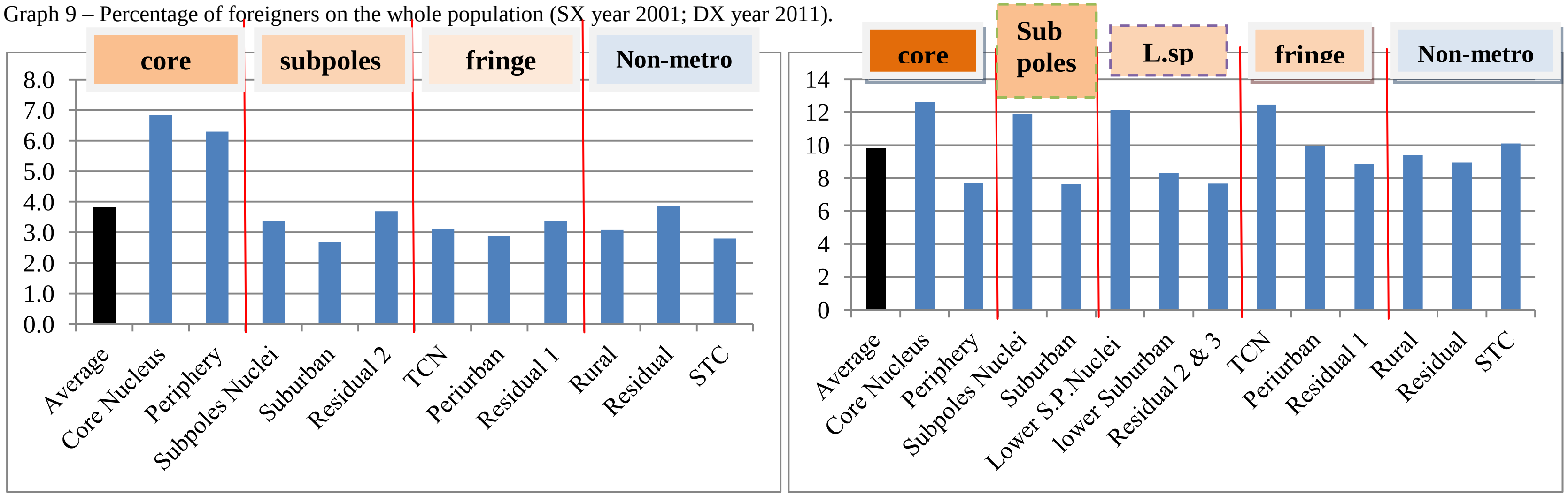
Graph 7- Percentage of families with maximum 2 components (SX year 2001; DX year 2011)



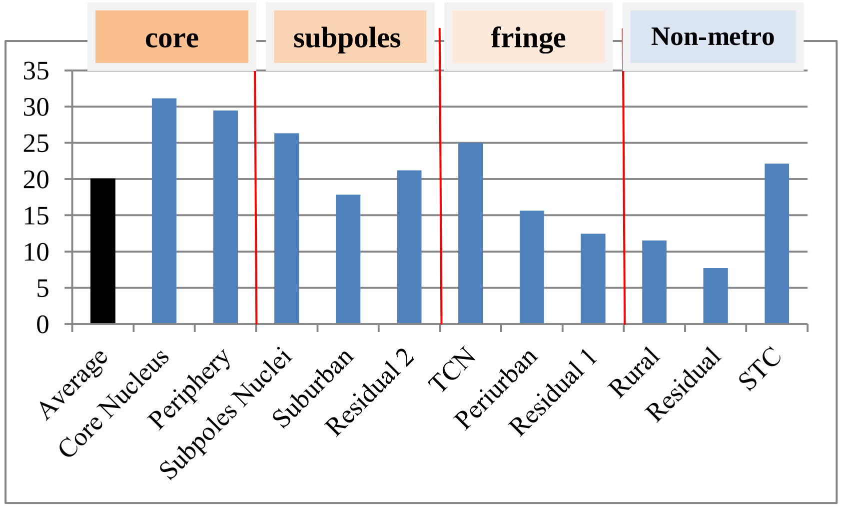
Graph 8 – Number of family components (SX year 2001; DX year 2011).

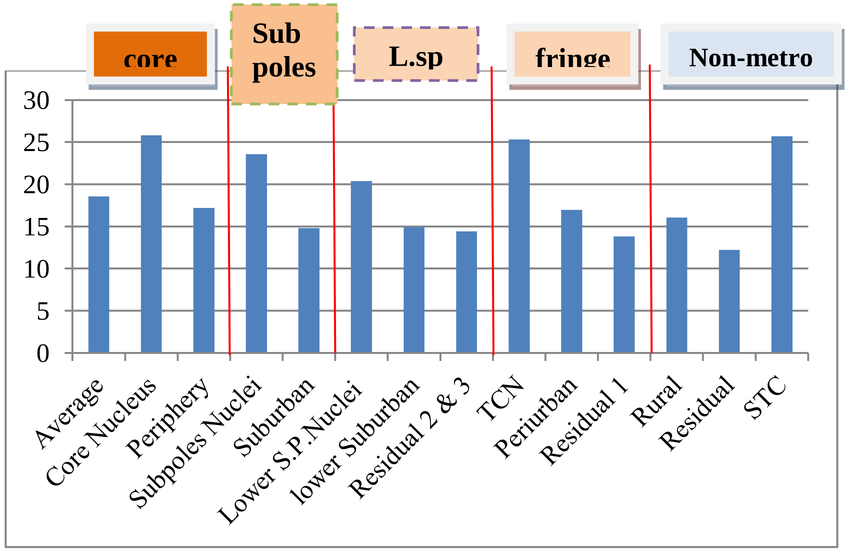


Graph 9 – Percentage of foreigners on the whole population (SX year 2001; DX year 2011).

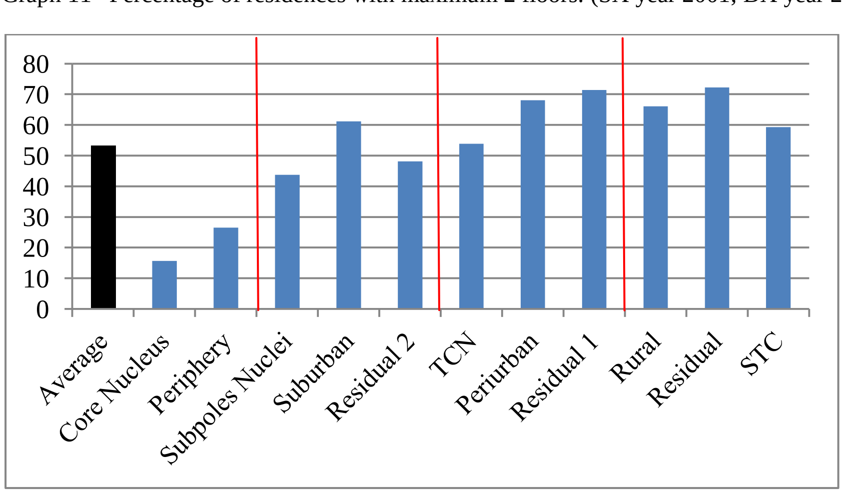


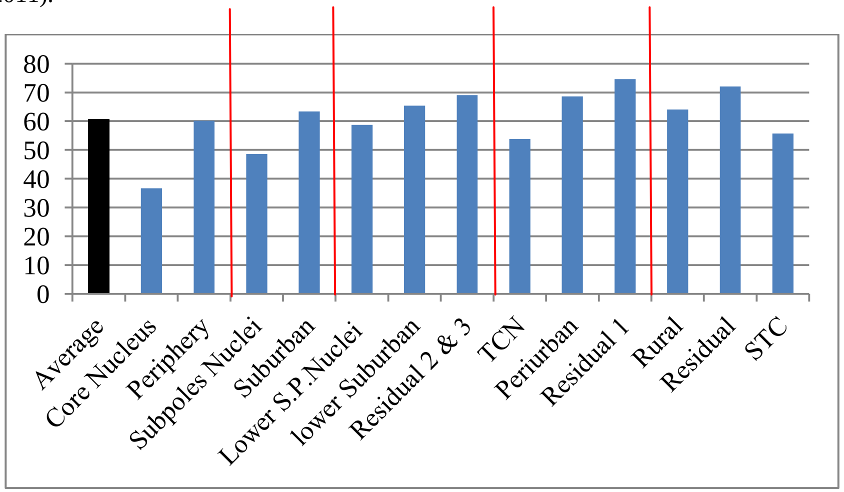
Graph 10 – Percentage of rented houses (SX year 2001; DX year 2011).



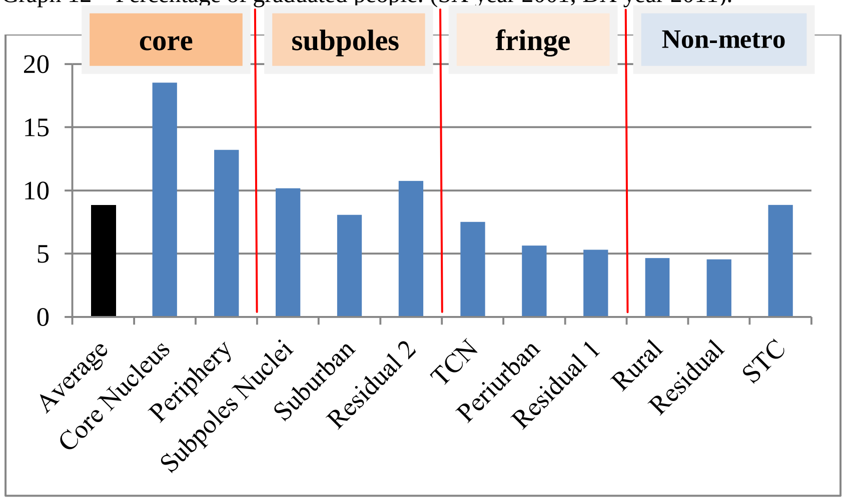


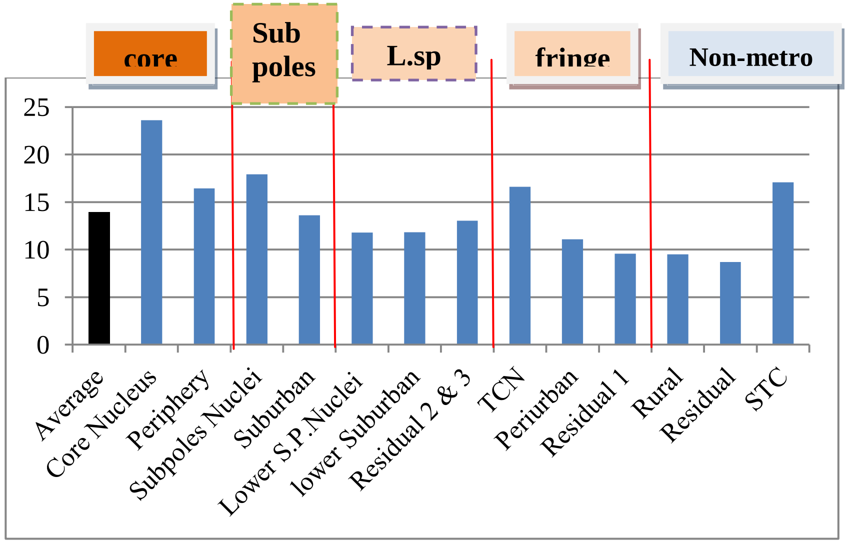
Graph 11 –Percentage of residences with maximum 2 floors. (SX year 2001; DX year 2011).



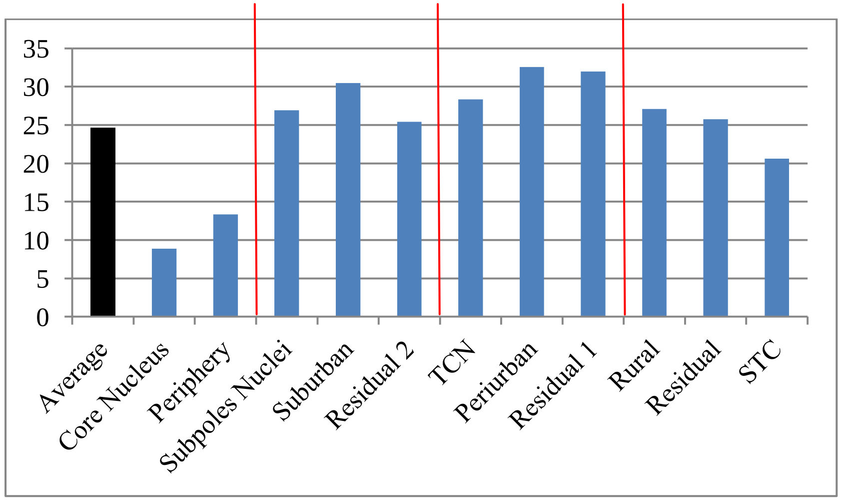


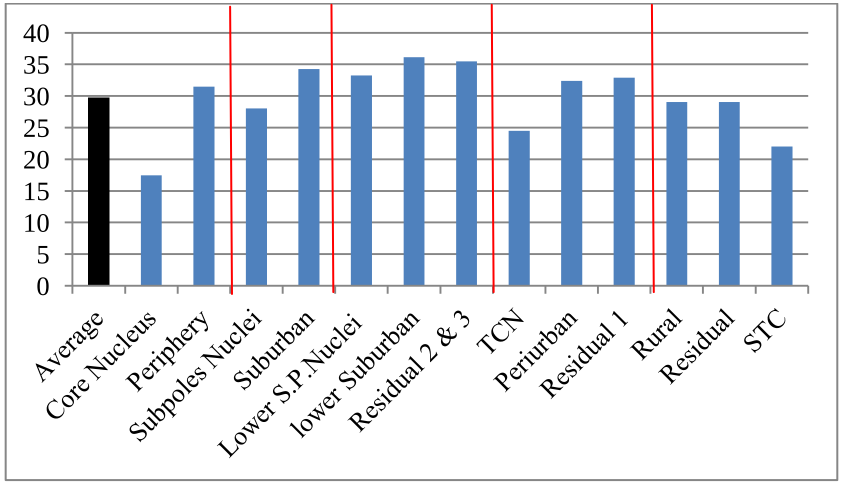
Graph 12 – Percentage of graduated people. (SX year 2001; DX year 2011).





Graph 13 – Percentage of commuters travelling outside the residence municipality for working or studying reasons. (SX year 2001; DX year 2011).





Families with maximum 2 components are more frequently located in high metropolitanity areas, but in particular, inside each metropolitan hierarchical zone, in the higher urbanity spaces. Urbanity level appears to be more important in 2011. Exactly the opposite is the figure for the number of family members, more concentrated in less or non metropolitan areas, and in particular in the medium and low urbanity spaces.
Foreigners seems to be less concentrated in high metropolitan zones, while more in the high urbanity spaces (especially in 2011), dimension that seems to play the major role. This phenomenon could be due to the progressive integration of the foreign population (and their residential moving in areas far from the metropolitan core, main attractor for foreigners), that statistically include in Italy also people residing in the country since long time, or even born in the country, but that have not obtained the citizenship.
Rented houses[69] are more common in high urbanity spaces, with a weaker metropolitan effect in 2011, probably due to the higher costs of buying a house in the main centers, and for the more residentially mobile population living in the cities. The opposite figure is produced by the distribution of houses with maximum 2 floors, more common in less urban contexts and lower metropolitan zones (probably always due to housing costs and space availability).
The percentage of high educated people (graduated) follows the same distribution both in 2001 and 2011, with higher urbanity and metropolitanity zones showing an higher concentration (and apparently a stronger influence of metropolitanity).
Commuters are more frequently residents of low metropolitan contexts, but, due to the expansion of the core area in 2011 zoning, the difference is weaker than in the past.

[69] A specification here is needed: the rate has been computed in 2001 on the whole buildings and not only on the ones for residential purposes. In 2011 the variable was available as "number of families living in a rented house", and computed as a consequence as a proportion of the overall number of families.

Conclusions

Three main results and conclusions can be derived from this analysis.
1) The application of our approach for the classification of Lombardy region territory has produced two different images of it in the two years considered, 2001 and 2011. As we already showed, in 2011 the densification of the internal areas of the metropolitan domain brought to the increase in complexity of the metropolitan territory. The densification is mainly due to the population increase in the interstices of the metropolitan nodes, a tendency highlighted also in the PIM report of 2016. Along with the population also other, low level, services and activities expands, following the population distribution. The densification seems to be the product of such a double and parallel process.
2) Defining and measuring the different levels of urbanity allows to differentiate between contexts characterized by different socio-demographic and morphological profiles. But urbanity alone can explain just part of the variety in the population conditions, since an important role is also played by the location of settlements into the metropolitan hierarchy. Combined the two dimensions give a more complete image of the territorial composition of the whole regional context.
3) Urbanity levels play a different role (more or less important) in relation to the specific year considered: in this case we could see how the complexification of the metropolitan context blurred the contribution of the metropolitan dimension, while the urbanity keeps its distinctive power.
In our analysis we just wanted to show tendencies, and not precise measures: this is due to the method adopted (as already said) that brought us to attribute to the different zones average values of the properties considered. Also the changes in the metropolitan classification caused the impossibility to directly compare the zones values of 2001 with the ones of 2011. We could just discuss in terms of clusters and urbanity/metropolitanity dimensions. Anyway a common trend in the main city regions seems to be present also in Lombardy: the densification of their contexts, like stressed by Soja in his last contributions on the topic and its definition of regional urbanization:

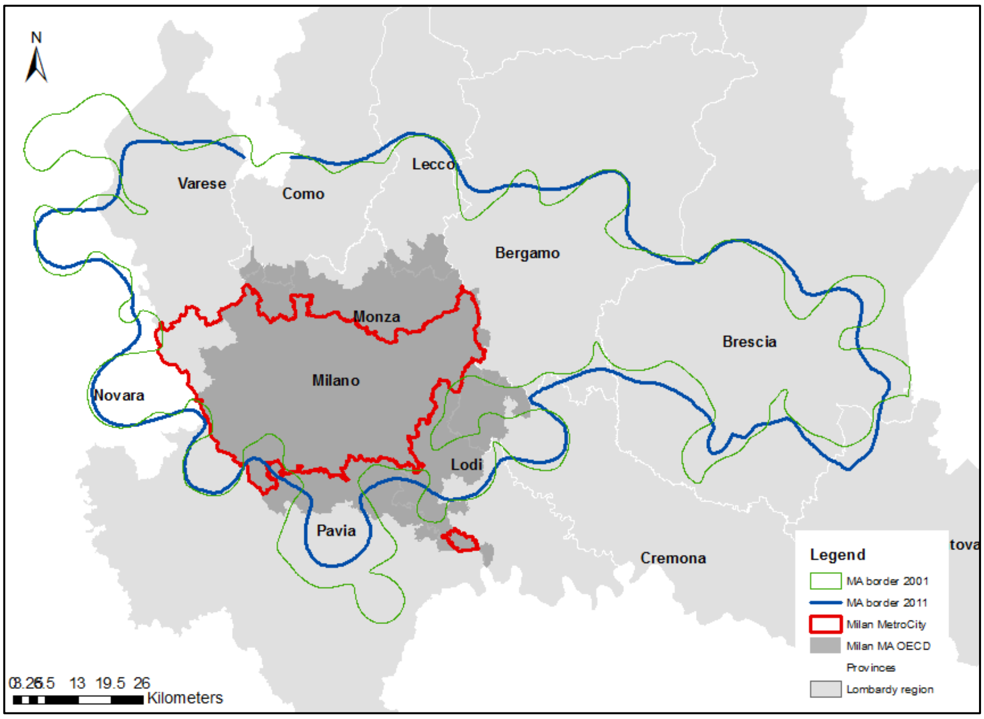
> Briefly described, regional urbanization is characterized by a densification if not urbanization of traditional suburbia and usually a flattening out of the density gradient from the peak level in the central city. In many large metropolitan areas, the outflow of domestic populations from the urban core has been matched by the influx of even larger numbers of transnational migrants. As a result, the once recognizable boundaries between urban and suburban ways of life are blurred in a new and more heterogeneous mixture of race, class, and culture;

Soureli, K., & Youn, E. (2009). Urban Restructuring and the Crisis: A Symposium with Neil Brenner, John Friedmann, Margit Mayer, Allen J. Scott, and Edward W. Soja. *Critical Planning, 16*(1), 35-59.

The post-metropolitanization of the Milanese area seems to be on going[70], but further analysis is needed to better understand its dynamics.

The method adopted allowed to highlight the strong influence the city of Milan has on the surrounding environment, able to expand well beyond the regional borders. In both the years considered its domain reached the city of Novara on the west side, and the borders of Veneto region on the eastern side.
The extension is much wider than the one proposed by the OECD method (see chapter 4), that present a surface of 2.635km^2 and encloses in 2011 (even if, we must remind it, the OECD MA limits computation is based on 2000 data) 4.084.606 residents (3.867.226 in 2001). Our proposal encloses almost 8 million (about 7.978.000) inhabitants and 7.911 km^2 in 2011(Piedmont territories included, while 5.254km^2 only in Lombardy), of those 7.700.000 ca inhabitants resides in Lombardy.

Fig. 42 – Comparison between our Metropolitan Area proposal for 2001, 2011, the OECD one (2016) and the Milan Metropolitan City boundaries.



Source: our elaboration on Istat data 2001, 2011, and OECD.

What appears to lack in OECD proposal is the inclusion of the northern territories between Como, Varese and Milan, some of the more urbanized contexts and also extremely interconnected with the core.

[70] See on the issue the contribution by Balducci, A., Curci, F., Fedeli, V., & Pucci, P. (2016)., "Milano, post-metropoli?", *TERRITORIO*, v.76, 35-45.

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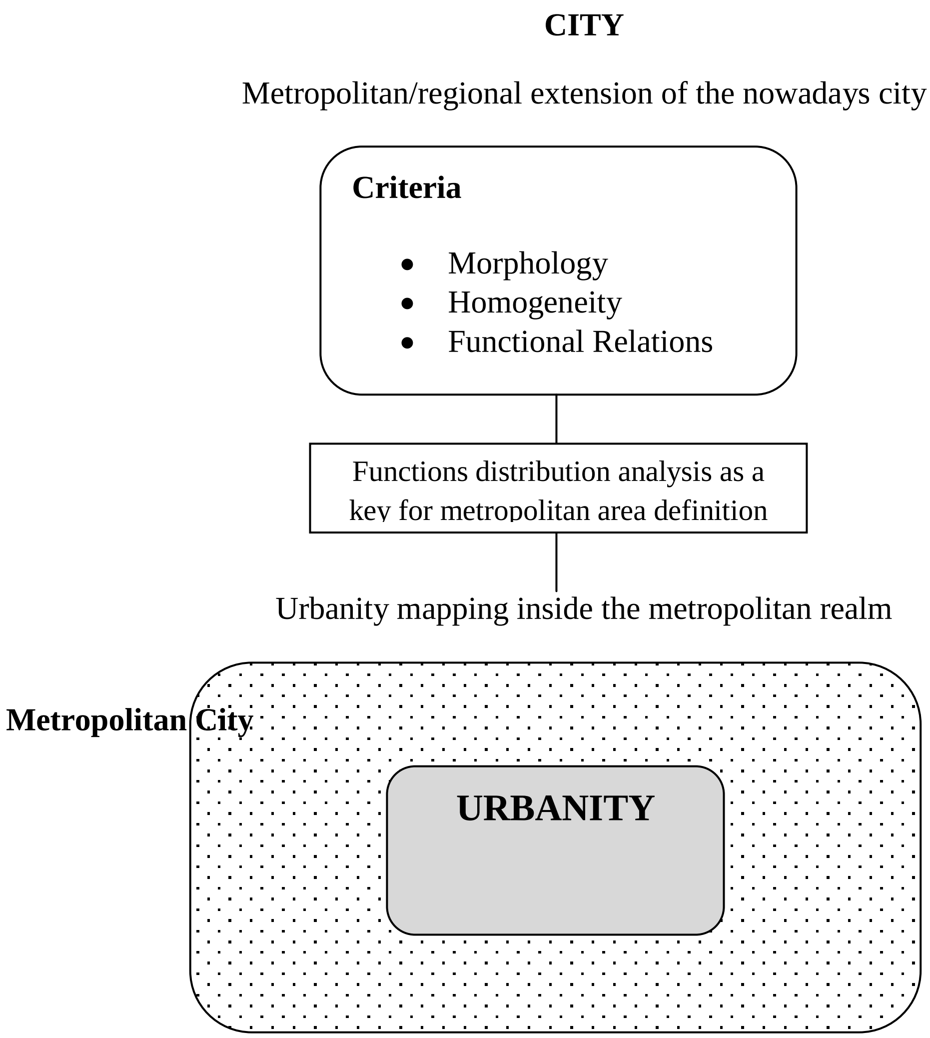
It is interesting to see how also in the OECD classification the boundaries of the official Metropolitan City of Milan are overpassed, highlighting the not-sufficient extension of the current institutional body: the OECD correctly includes into the MA limits the territory of the Monza and Brianza province (at least a part of it), and the south-eastern spaces around Lodi, that also in PIM report appeared to be one of the directions of the nowadays metropolitan development.
Another time so it is stressed how the Metropolitan issue in the case of Milan should be debated again, since it is clear that we are still far from a satisfying and definitive (if it could ever be) representation.

Conceptual diagram



Chapter 7

The Application of the metropolitan areas definition to the French case

7.1 Adapting the metropolitan area definition to the French context

As already stated at the beginning of this work our purpose is also to compare two case studies: the Milanese one, presented in the previous chapter 6 and the Lyon's one. We introduced the two cases in Chapter 4, highlighting the complexity that is common to both the territorial contexts in terms of metropolitan definition and territorial classification.

As we saw in chapter 5 the current Milan Metropolitan City does just intercept a part (smaller or bigger depending on the definition considered) of the functional extension of its metropolitan area. The same has to be discussed for the Lyon Metropolis.

The method we will adopt for the Lyon metropolitan boundaries delimitation is the same already presented for the Milan case: the analysis of the metropolitan functions distribution is carried on, working on Census data 2011, provided by the INSEE (*Institut National de la Statistique et des Études Économiques*). In particular the same functions defined for the Italian case have been considered: Residing (operatively defined as Resident Population), Manufacturing economic activites (Employees in manufacturing sector according to NACE classification), Service economic activites (Employees in all the other NACE sectors not included in the first sector nor manufacturing) and Mobility (commuting flows for studying and working reasons from and to municipalities). As a methodological annotation we must highlight that the economic activities' classification has changed in 2007/2008, due to its harmonisation to the European classification NACE (***n****omenclature statistique des* ***a****ctivités économiques dans la* ***C****ommunauté* ***e****uropéenne*).

It regarded also the Italian ATECO (*ATtività ECOnomiche*) classification, that in 2007 changed, producing a partial mismatch between the 2002 version and the current one.[71] In Tab. 22 the correspondence between the two Italian classifications and, as a consequence, to the French version (harmonised to the NACE in the same years as well) is reported.

[71] In the same way the National French economic activities' nomenclature changed in 2008, due to the shift from the NAF (nomenclature d'activités française) 2003 to the NAF rev.2 (updated in 2015). The NAF structure follows the same of the NACE, and corresponds as well nowadays to the Italian ATECO 2007 version.

Tab. 22 – List of the metropolitan functions considered and the indicators used for their operationalization and changes occurred in the economic classifications after 2007 introduction of NACE.

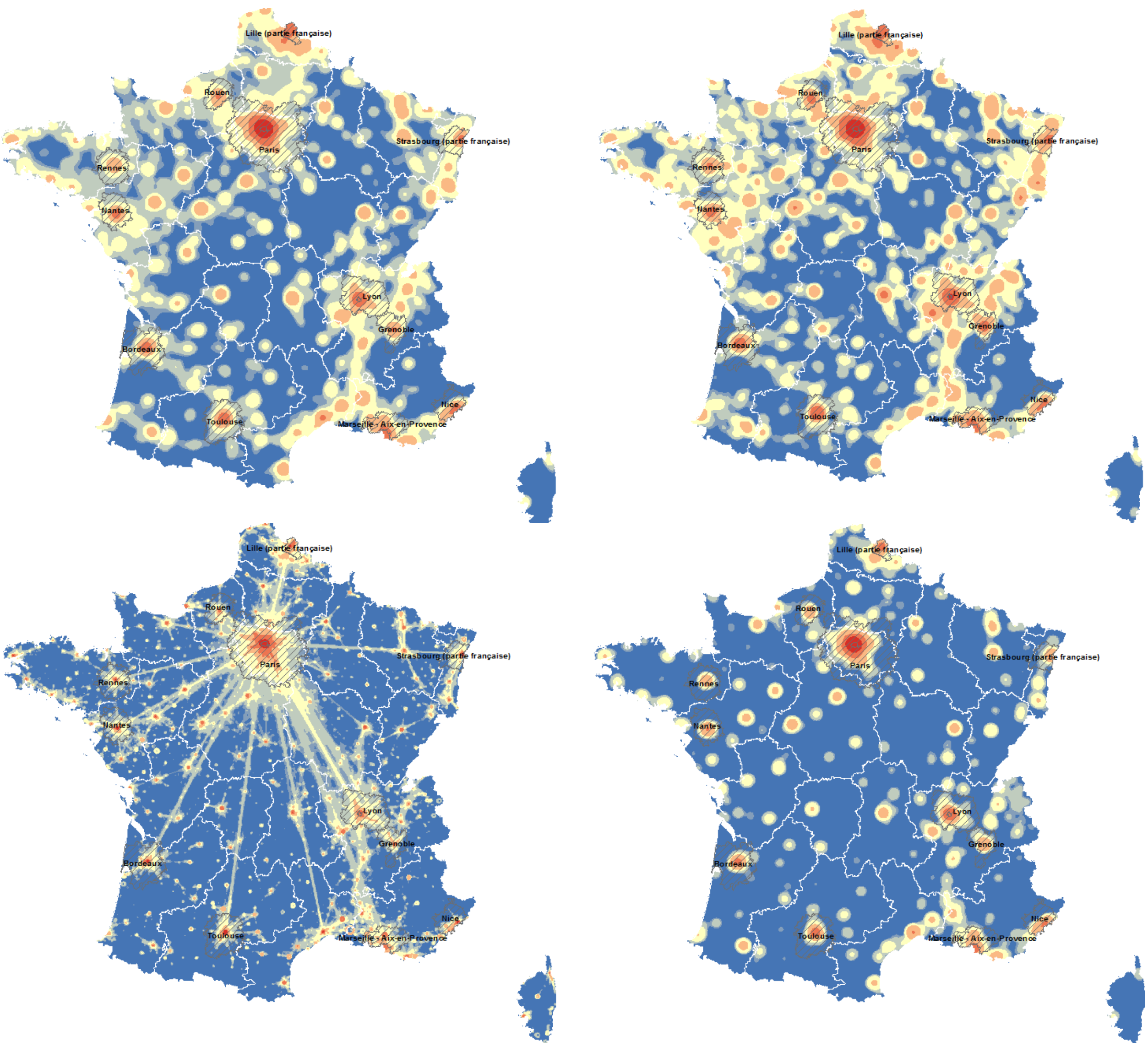
Class	***Metropolitan Function***	*Indicator2001 (ATECO 2002 for the activities)*	*Indicator 2011 (ATECO 2007 and NAF rev.2 ,common to NACE, for activities)*
Residential	18. Residing	Resident population	Resident population
Work	19. Manufacturing activities	Employees in sections C, D, E, F (no group 221)	Employees in sections C, D, F (no groups 581, 592)
	20. Financial and insurance activities	Employees in section J	Employees in section K
	21. RE activities	Employees in group 701, 702, 703	Employees in section L
	22. Information and communication	Employees in group 221, 642, 721-724, 726, 921-922, 924	Employees in section J (no 590-1-2) and group 731.
	23. Professional, scientific and technical activities	Employees in group 731-732, 741-744	Employees in group 690-700-710, 632, 740, 780, 800, 820
Commercial and leisure services	24. Commerce	Employees in group 521-524	Employees in group 450-60-70, 770, 810, 950, 960
	25. Accommodation and food service activities	Employees in group 551, 553-555	Employees in group 550-563
	26. Associationism	Employees in group 991-913	-
	27. Arts, cultural and sport activities	Employees in group 923, 925-927	Employees in group 590-2, 790-9, and sector R
Public services	28. Human health and social work activities	Employees in group 851	Employees in group 750, and sector Q (no 870-880)
	29. Secondary Education	Employees in group 802	Employees in group 853
	30. Tertiary Education (Universities)	Employees in group 803	Employees in group 720-2, 854
	31. Public Administration	Employees in group 751-753	Employees in group 360-70-80-90
	32. Social Assistance	Employees in group 853	Included into metropolitan function n. 11
	33. Transports	Employees in section I activities (no group 642)	Employees in group 449-550-551-552-553
Fluxes	34. People Mobility	Study and Work-related commuting flows	Study and Work-related commuting flows

Data territorial level is the **municipality**, following the same approach adopted in the Italian case, even if the extremely fragmented situation of the country's administrative structure (36.000 municipalities for France, 8.000 in Italy, while the countries extensions ratio is almost 1:2 for France) can produce some representational differences in the outputs, due to the higher territorial detail of data.

In Fig. 43 can be seen the representations of the functions' density distribution in Metropolitan France (European continent's French territories), that compose the Metropolitan Index: Population density in the first top-left image, Manufacturing employess in the second image top-right, Commuters mobility fluxes in the third one bottom-left and service sector employees in the bottom-right last one.

From the images is highlighted the centripetal structure of the country, where Paris acts as an attractive core for all the nation (it is clear in particular from the fluxes distribution), even if other relevant centers emerge, without being able to compete with it. Among the most important appears Lyon (in the South-East), showing to be one of the centers of a massive agglomeration connecting Grenoble, Saint Etienne and, through the north-South axe, the costal territories of Marseille and its surroundings. Strasbourg and Lille are also focal centers, enjoying their status of border cities, acting somehow as a development engine (the cities work as connection and transit gates to the close countries: Germany and Belgium respectively). Other relevant, but more isolated, territorially speaking, poles rise in the west and south-west part of the country (Nantes, Rennes, Bordeaux, Toulouse).

Fig. 43 – Density distribution of Population (year 2011), Manufacturing employees (year 2011), commuting fluxes (year 2012) and services employees (year 2011) in France.



Source: our elaboration on INSEE data 2011 and 2012.

7.2 The metropolitan structure of the French territory

The application of a Factor Analysis on the different functions'density surfaces produces also here an index highlighting the different levels of *metropolitanity* of the country (Fig. 44). The image produced by the index distribution (ranging from -0.41 to 34 standard points, a wider interval than the Italian one, showing a higher degree of metropolitan functions presence in the country) highlights the existence of agglomeration nuclei, corresponding to the main urban areas of the country, classified as Metropolitan Areas by the INSEE itself. 12 poles can be found: Paris, Lyon, Marseille, Lille, Toulouse, Bordeaux, Nantes, Rennes, Strasbourg, Nice, Grenoble, Rouen, but also other urban areas emerge here like Saint-Etienne and Montpellier. The structuring nature of the mobility fluxes can be appreciated from the evident connection lines emerging from Fig. 44, where the fluxes densities are visually clear. From the DATAR fluxes mapping produced in 2012, is clear the relevance of the mobility skeleton in the urban and metropolitan structure definition (Fig. 45): the more internal part of the country seems to be the less urbanized, producing a distinction between two Frances: a north-western one and a South-SouthEastern. Such a situation is highlighted by the population and manufacturing activities distribution in particular, while the mobility fluxes work to keep connected these different territorial contexts. The stronger relevance of the fluxes function component is also highlighted by the correlation matrix between the various dimensions composing the index itself:

Tab. 23 – Correlation matrix between the different functions composing the metropolitan index and the index itself.

Layer	Residential	Manufacture	Services	Mobility	**Metro Index**
Residential	1	0.978	0.976	0.805	0.988
Manufacture	0.978	1	0.958	0.795	0.978
Services	0.976	0.958	1	0.808	0.974
Mobility	0.805	0.795	0.808	1	0.811
Metro Index	0.988	0.978	0.974	0.811	1

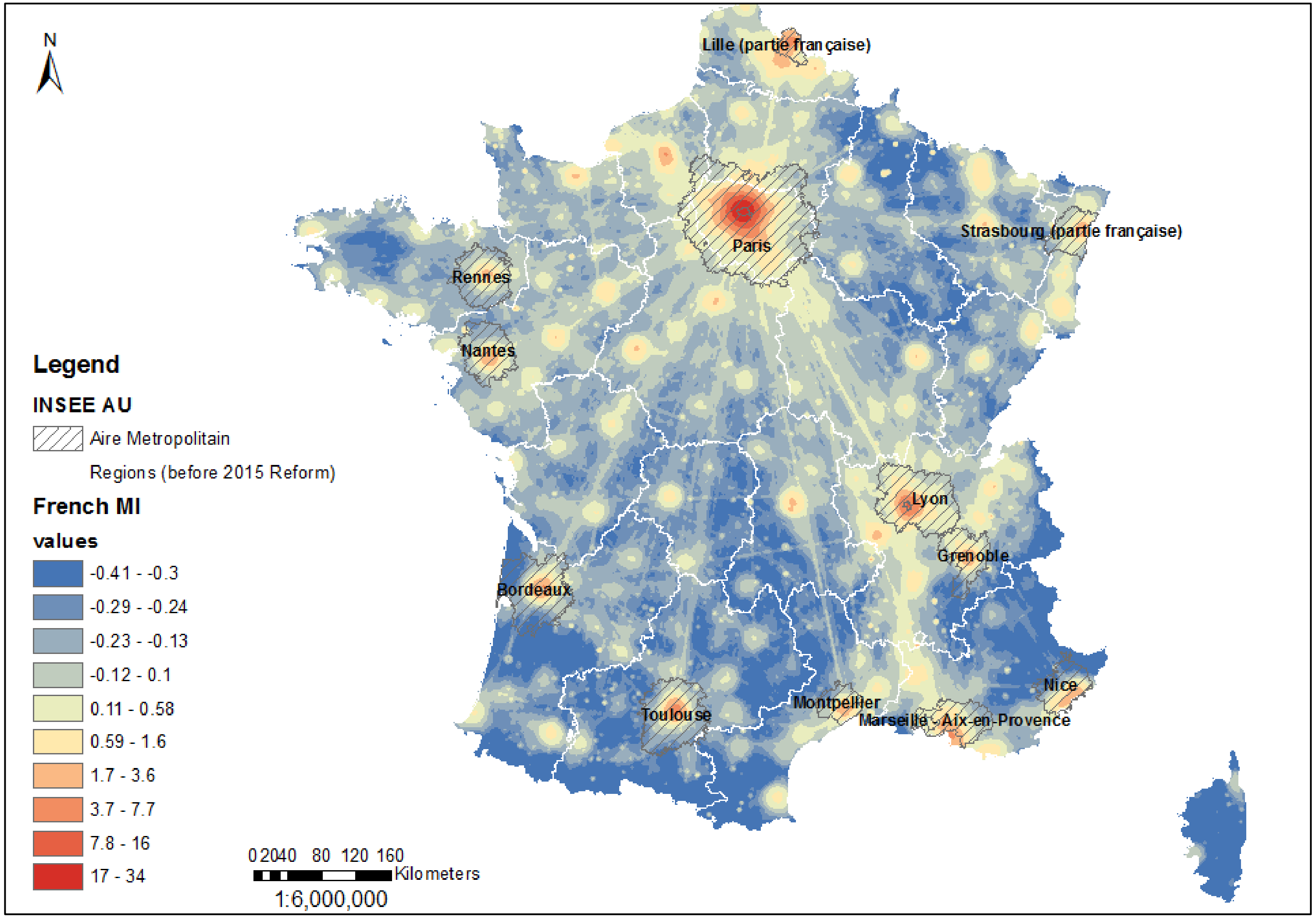
Differently from the Italian case, here the correlation is much higher[72], probably due also to the more detailed territorial disaggregation of the data.

The territorial divide is mainly due to geographical reasons, being the central core of the country a mountainous area, occupied by the Massif Central, working as a *clivage* like the Appenninni mountains in Italy.

[72] Italian Metropolitan Index components correlation matrix

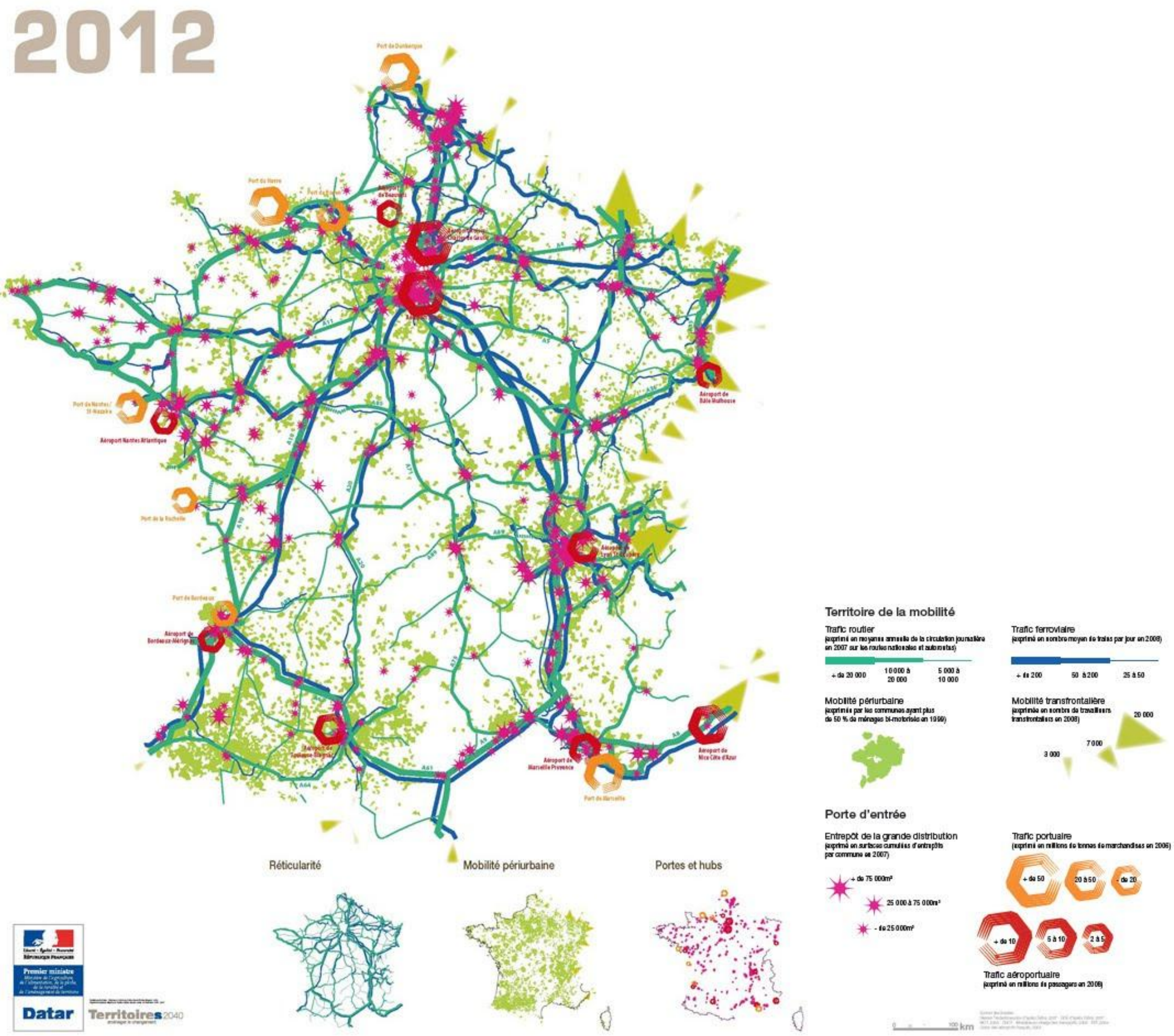
	Mobility	Residential	Manufacture	Services	**M. Index**
Mobility	1	0.50096	0.31916	0.43019	0.59957
Residential	0.50096	1	0.8207	0.85047	0.94511
Manufacture	0.31916	0.8207	1	0.84587	0.90171
Services	0.43019	0.85047	0.84587	1	0.93839
M. Index	0.59957	0.94511	0.90171	0.93839	1

Fig. 44 – Metropolitan Index distribution in France (France Metropolitain) in 2011.



Source: our elaboration on INSEE data 2011 and 2012.

Fig. 45 - Les portes d'entrée de la France et les systèmes territoriaux des flux



Source: DATAR, from the publication "Dynamiques de metropolisation" Agence d'Urbanisme Lyon-St.Etienne, 2015, p.7

In order to better define the extension and functional realm of the metropolitan poles in the whole country a Getis-Ord Gi* statistics is computed on the raster cells of the metropolitan index, as well as done for the Italian case study. The computation of the statistics is done with a fixed band criterion, producing in this way a new representation of the metropolitan Index (Fig. 46). The image allows to highlight the metropolitan functions influence on the territory, showing significant territorial clusterings. Different figures emerge: the various Metropolitan Areas show different conglomeration tendencies, with Rennes, Nantes, Bordeaux, Toulouse and Nice maintaining a strongly concentrated shape. On the contrary Lyon seems to be strongly connected and interrelated with Grenoble and St.Etienne area, but also with all the centers located on the communication and infrastructure channel linking its metropolitan area to the Mediterranean, and in particular with Marseille and its surroundings.

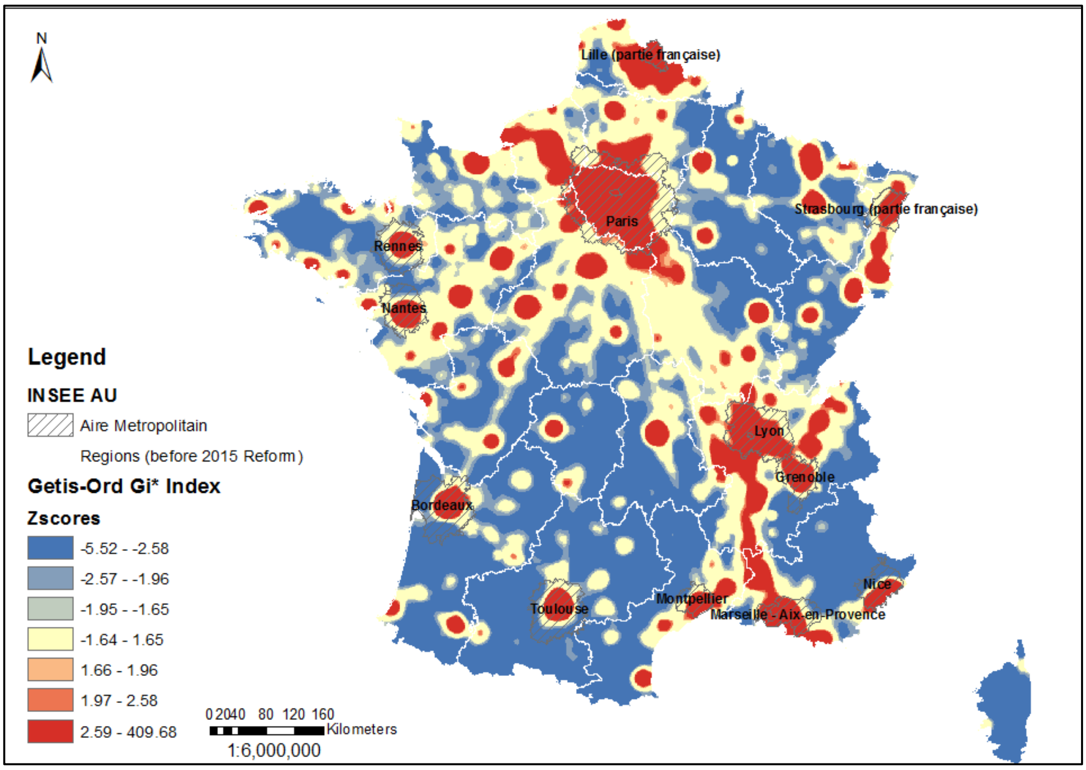
On the north-east part of the country Strasbourg shows an important interconnection with Colmar and Mulhouse, while Lille in the north represents an agglomeration pole acting on a wide territorial extent (extended also to the

Belgian territory, but, due to lack of data, such a structure cannot be confirmed here).

Finally Paris is confirmed to be the biggest and widest metropolitan context in the country, connecting in our representation its area with the Rouen's one.

Such a threshold represents a first representation of French metropolitan functions extent: in order to highlight the metropolitan cores' domains a further threshold is in fact then considered.

Fig. 46 – Z-scores and significant MI clusters after the computation of the Getis-Ord Gi* statistics on metropolitan index values (fixed distance criterion).



Source: our elaboration.

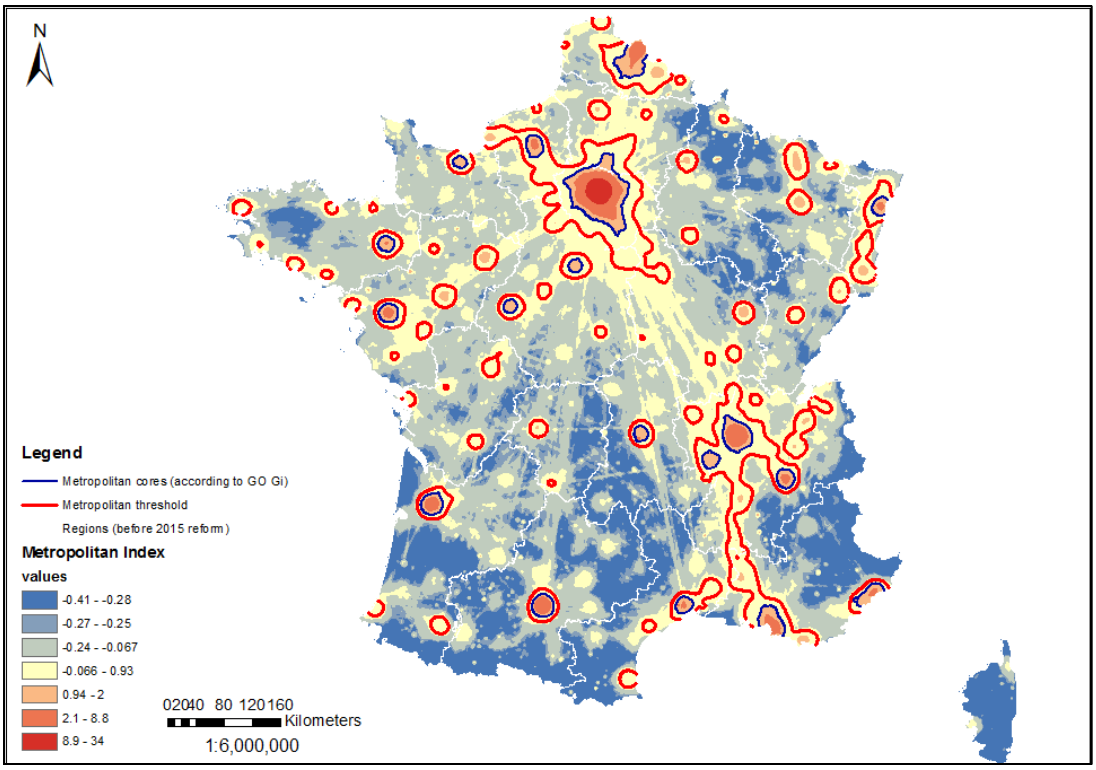
A 1 standard deviation from the mean is assumed as the index value defining the main poles of the metropolitan areas[73], the spatial concentration of the higher level of metropolitanity. The application of the Getis-Ord Gi* statistics with an inverse distance criterion allows to highlight those nuclei who are more reasonably metropolitan, due to the stronger concentration of high values of the Metropolitan Index. In Fig. 47 the Metropolitan Index is showed in order to highlight the 1 standard deviation threshold. In blue line the nuclei so defined, where the Getis Ord Gi index assumed a significant value, underlining the existence of a high metropolitanity cluster. From the combination of these selection criteria we found 14 metropolitan areas, characterised by a wide variety of morphologies (Fig. 48):

[73] A similar values is obtained applying to the metropolitan index the Getis-Ord Gi* statistics computed with an inverse distance criterion. The Inverse distance allows to stress better the concentration of values of the cells, since a bigger weight is given to the closer cells in the statistics computation, emphasizing the clusters of highest value.

(1) Bordeaux, (2) Caen, (3) Clermont Ferrand, (4) Lille, (5) Lyon-Grenoble-St.Etienne-Marseille-Aix en Provence, (6) Montpellier, (7) Nantes, (8) Nice, (9) Orléans, (10) Paris-Rouen, (11) Rennes, (12) Strasbourg, (13) Toulouse, (14) Tours.

INSEE in 2011 defined 12 Aires Urbaines of metropolitan level, according to their population dimension, employees density and the share of employees in those that were defined as *metropolitan level functions* (Brutel, 2011)[74]. The data came from the Census 2006 and enlisted the following metropolitan areas: Paris, Lyon, Marseille, Lille, Toulouse, Bordeaux, Nice, Nantes, Strasbourg, Rennes, Grenoble et Montpellier.
According to INSEE classification Tours, Orléans, Rouen, st.Etienne and Clermont Ferrand don't reach the metropolitan Status, even if they can be considered as Big Urban Areas (*Grandes Aires Urbaines*).

Fig. 47 - French potential Metropolitan contexts (red borders) and high metropolitanity density areas (blue borders).



Source: our elaboration on INSEE data 2011 and 2012.

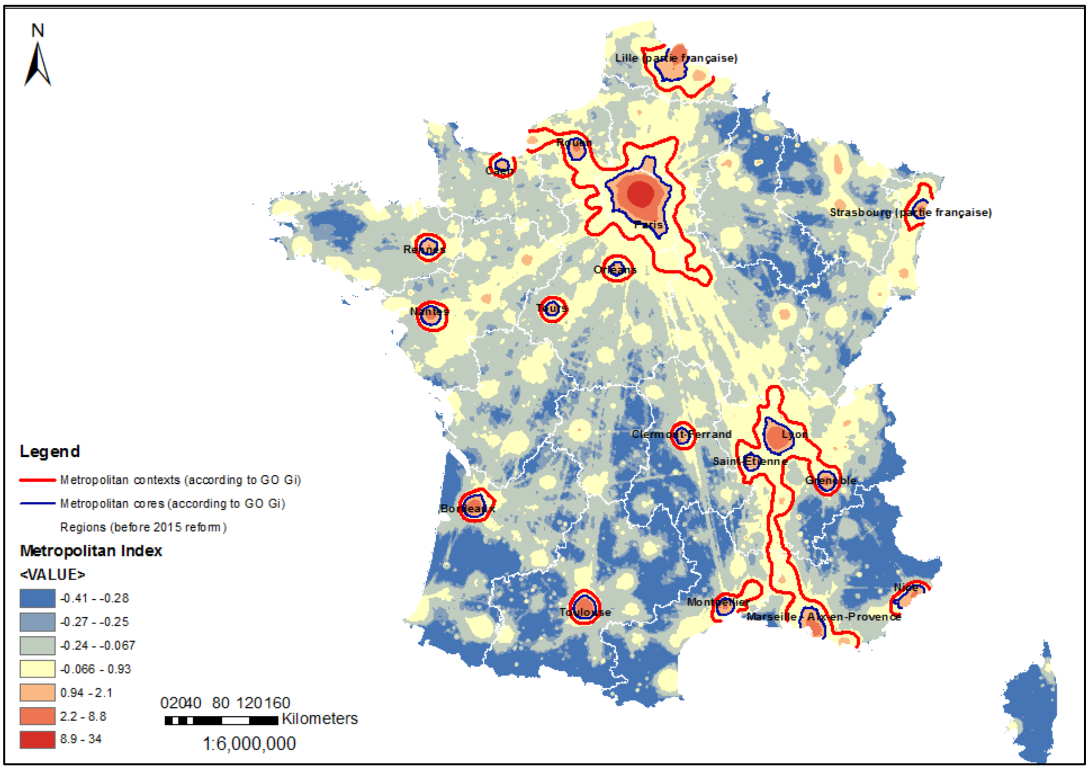
[74] The rule called *Range-taille* defines as a population threshold 500.000 inhabitants, and 20.000 *cadre de fonctions métropolitaines*.

Tab. 24 – Extension and population inhabiting the metropolitan agglomerations defined (in bold those exceeding 1 million inhabitants).

n.	*Metropolitan Areas*	*Km²*	*Pop 2013*
1	Paris-Rouen	20.295	14.124.090
2	Lyon-Saint-Etienne-Grenoble-Marseille-Aix en Provence	16.303	6.736.535
3	Lille	4.479	2.816.728
4	Montpellier	1.803	882.598
5	Bordeaux	1.611	954.073
6	Toulouse	1.512	1.035.472
7	Strasbourg	1.435	730.519
8	Nantes	1.349	727.241
9	Nice	1.222	1.006.590
10	Orléans	1.161	342.370
11	Rennes	1.136	503.045
12	Clermont Ferrand	965	403.350
13	Tours	942	373.742
14	Caen	874	341.466

Source: our elaboration on INSEE data.

Fig. 48 - The 14 French Metropolitan contexts (red borders) hosting an high metropolitanity density core (blue border).



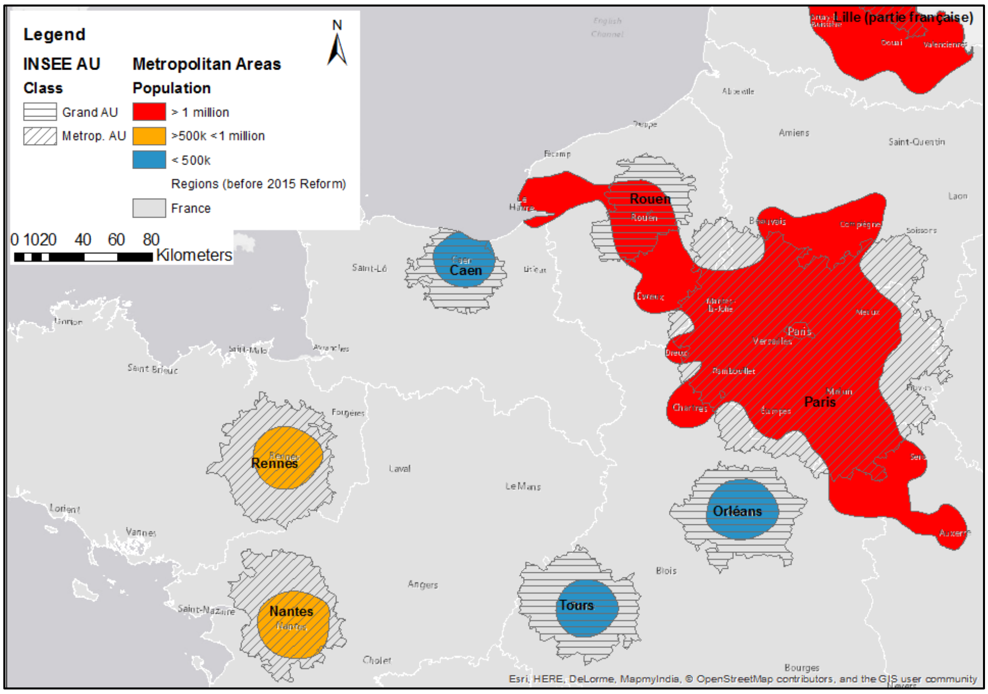
Source: our elaboration on INSEE data 2011 and 2012.

The Lyon context is for sure one of the most interesting, due to the important extension of its domain: the interconnection with the centers disposed along the A7 route constitutes a continuous surface linking its agglomeration with the Marseille/Aix-en-Provence one. Its Metropolitan domain encloses a territory of

16.303 km^2, the second for dimension in this classification after Paris-Rouen. It extends on the most part of the Rhone-Alpes area (former region before the merge with Auvergne) constituting somehow a City-region entity. An analogous role is played by the cities of Strasbourg and Lille, that respectively in *Alsace* (today part of *Grand Est* region) and *Nord-Pas-de-Calais* (today part of the *Hauts-de-France* region) act as main metropolitan poles, functionally covering as well the most part of the former regional areas.

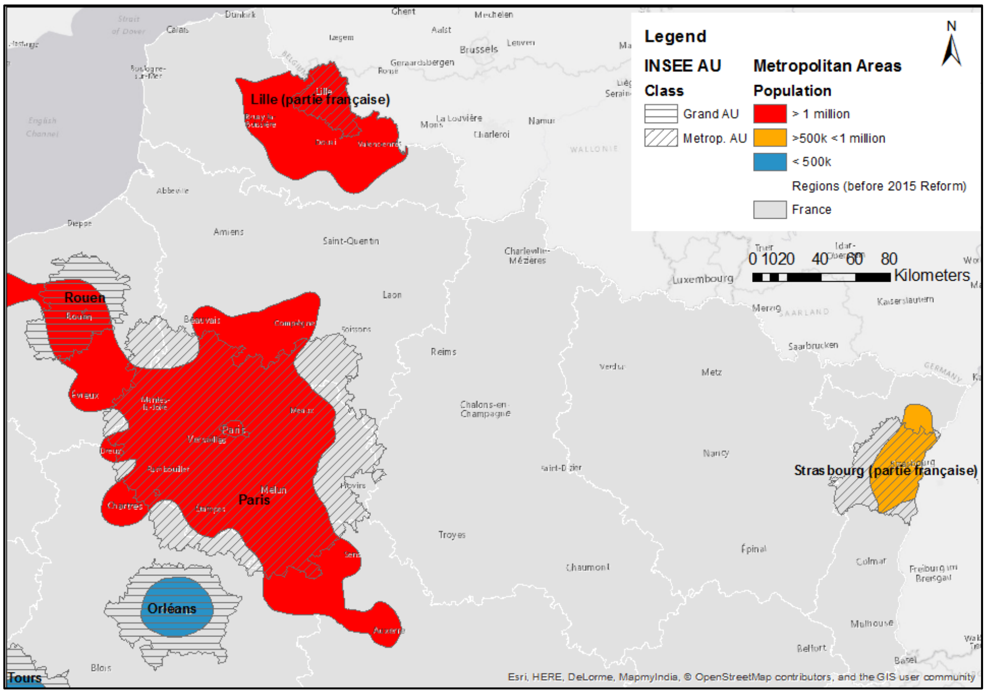
If compared to the INSEE Aires Urbaines, and in particular those classified by the institute as Metropolitan Urban Areas, we can see as in general our classification results don’t correspond in extension to those (Fig. 49, Fig. 50, Fig. 51, Fig. 52): INSEE territorial delimitation of the Metropolitan Areas is usually wider than ours, except for the Lyon/Grenoble/Marseille contexts, where the definition of a common metropolitan basin overpasses completely the INSEE classification borders.

Fig. 49 – North-West view of the French country and its metropolitan contexts.



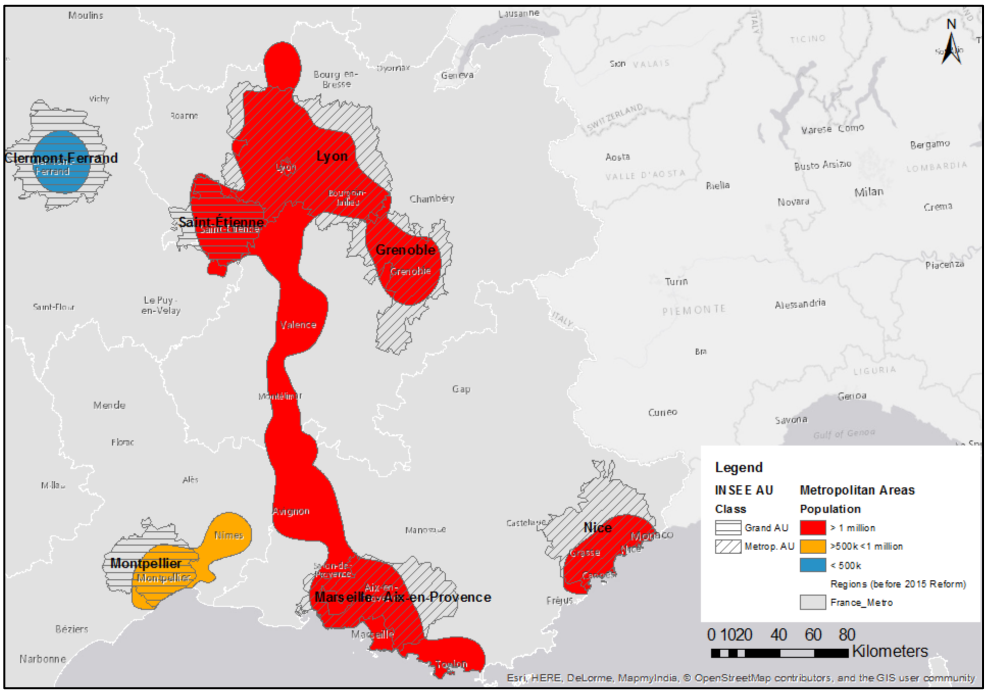
Source: our elaboration on INSEE data.

Fig. 50 - North-East view of the French country and its metropolitan contexts.



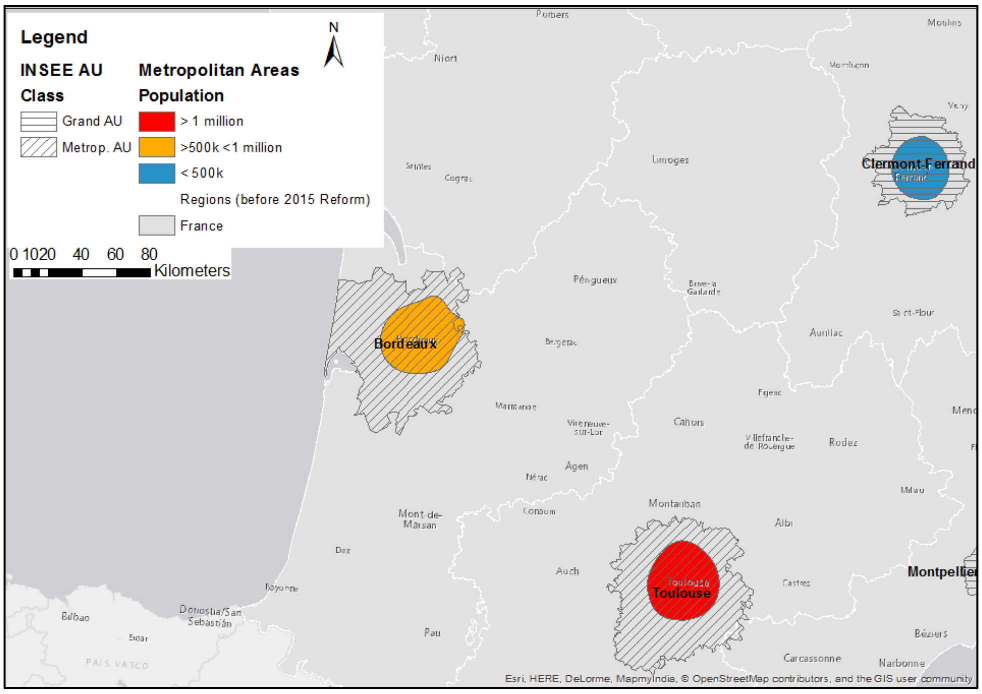
Source: our elaboration on INSEE data.

Fig. 51 - South-East view of the French country and its metropolitan contexts.



Source: our elaboration on INSEE data.

Fig. 52 - South-West view of the French country and its metropolitan contexts.



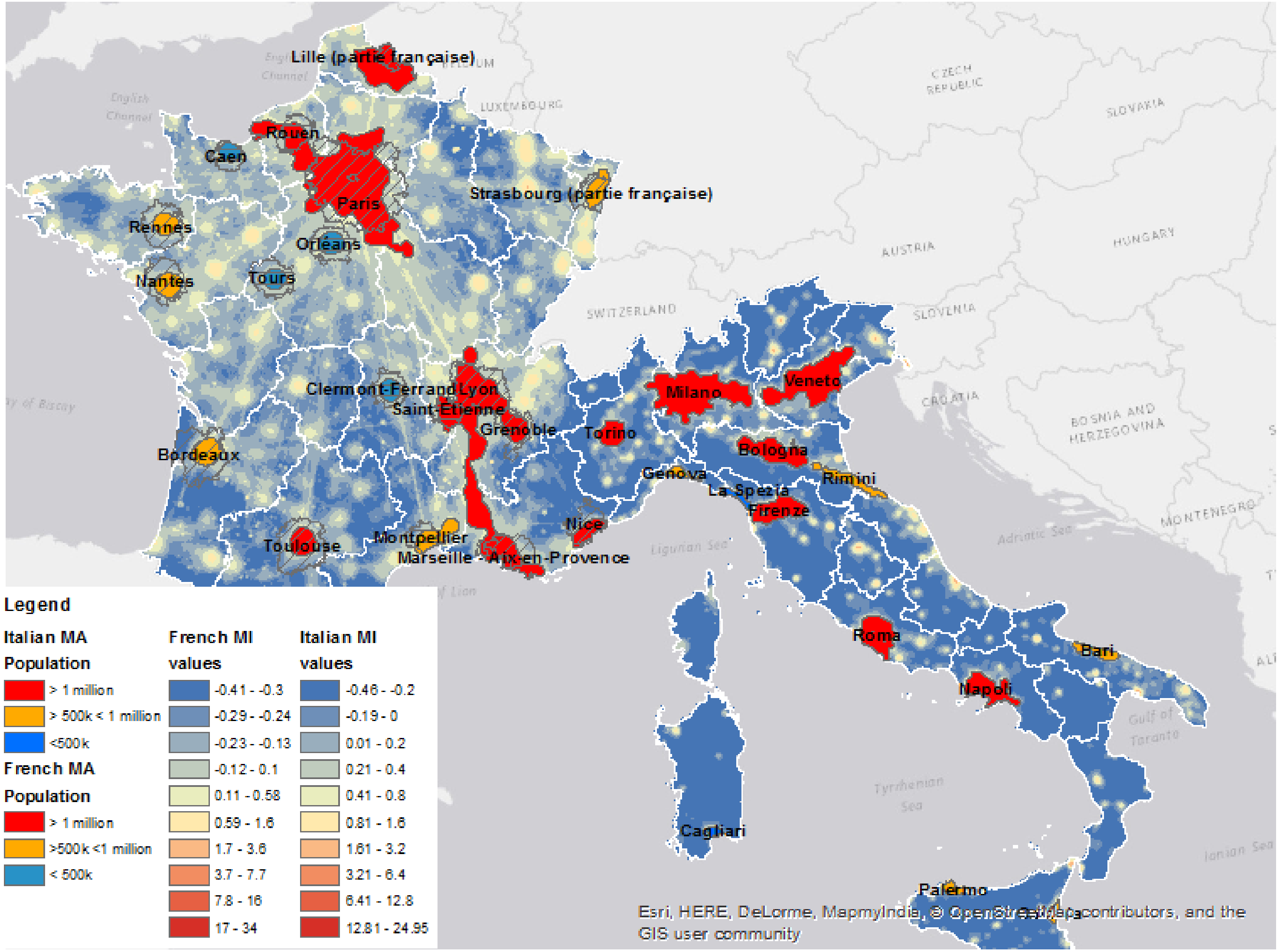
Source: our elaboration on INSEE data.

7.3 Metropolitan areas in France and Italy: a comparison.

If compared with the Italian Metropolitan Areas obtained with the same method, what emerges immediately is **(1) the general similar extension among French MAs, while the Italian ones show a higher variability**. Another element to be stressed is **(2) the higher density usually found in Italian cases**, where the proportion between population size and territorial extension is much bigger than in France. **(3)** on 14 French metropolitan Areas only 5 includes a population higher than 1 million inhabitants (even if the agglomerations of Lyon-Saint-Etienne-Grenoble-Marseille-Aix en Provence embraces more big centers, reducing the number of the over-million ones), while in the Italian case 7 have a population size higher. Among the other 7 areas delimited in Italian context just two of them include a population lower than 500.000 inhabitants.

It seems so that the Italian urbanization and metropolitanization processes are more concentrated in space than the French one, also due to particular geographical characteristics of the country, where few plain zones are available, while numerous are the potential geographical limits to the urban expansion (mountainous areas extension among the main ones). The areas showing similar phenomena in terms of metropolitan extension is the Milanese and Vento area, where the two metropolitan contexts are divided but close one to the other, forming ideally the Megalopolis introduced by Turri (2000) (see chapter 4).

Fig. 53 – Comparison of the metropolitan indexes of France and Italy and the respective Metropolitan and Urban Areas drawn on it.



Source: our elaboration on INSEE and ISTAT data

Tab. 25 – population and surfaces of the main Metropolitan and Urban Areas of France and Italy according to our definition of metropolitan areas (derived from Boffi and Palvarini, 2011).

degree		Population (2013)	Km^2	degree		population	Km^2
1	Paris-Rouen	14.124.090	20 295	1	Milan	7.978.000	7 911
1	Lyon-St.Etienne-Grenoble-Marseille-Aix en Provence	6.736.535	16 303	1	Naples	4.404.196	2 404
1	Lille	2.816.728	4 479	1	Veneto	3.632.626	6 343
1	Toulouse	1.035.472	1 512	1	Rome	3.578.899	2 617
1	Nice	1.006.590	1 222	1	Bologna	1.839.620	3 041
2	Bourdeaux	954.073	1 611	1	Firenze	1.750.056	2 494
2	Montpellier	882.598	1 803	1	Turin	1.728.471	1 382
2	Strasbourg	730.519	1 435	2	Bari	966.590	811
2	Nantes	727.241	1 349	2	Rimini	935.199	1 415
2	Rennes	503.045	1 136	2	Palermo	909.673	449
3	Clermont Ferrand	403.350	965	2	Catania	761.062	460
3	Tours	373.742	942	2	Genova	723.697	468
3	Orléans	342.370	1 161	3	La Spezia	499.972	522
3	Caen	341.466	874	3	Cagliari	367.296	298

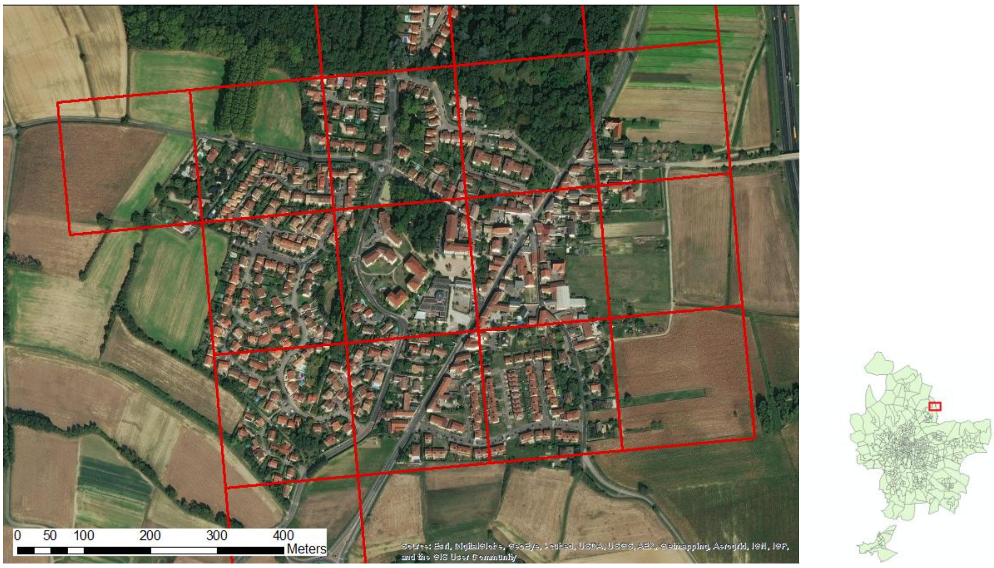
Source: our elaboration on INSEE (2013) and ISTAT data (2011).

7.4 Urbanity index definition for the French case study: the Rhone-Alpes Auvergne context.

As well as for the Italian case, also in the French context we aimed to build an urbanity index in order to construct a zoning of the metropolitan area of Lyon.
In the Italian case study in order to build the Accessibility basins and the Neighbourhood Areas we adopted data at the smallest scale available: the Census Tract, in order to be able to approximate at their centroids the location of both residences and activities. For the French case we could not rely on a similar source, forcing us to find a solution to the lack of the equivalent of Census tracts data for the indicators constituting those elements (Residential Population for NA, and employess in neighbourhood shops, bars, and primary and elementary schools). The French Census in fact, since 1999, does not provide census tract data anymore, limiting the smallest level data availability at the IRIS[75] level. IRIS represent a portion of the territory in which all the centers with at least 10.000 inhabitants (but also a part of the municipalities between 5.000 and 10.000 inhabitants) are divided, and including about 2000 inhabitants (min. 1.800 maximum 5.000 ca, INSEE). All the country is divided into about 16.000 IRIS, but their extension is too big if compared to Italian Census Tracts in order to apply the same method adopted as for Lombardy.
In fact the census tract was already an approximation of the residences and activities locations, possible due to the small size of them (especially in the urban contexts), but a wider territorial unit would be too big for a similar approximation. This brought to the need to find a new source of data for the French case.
A solution was found, for the Neighbourhood Areas computation in the Données carroyées at 200m, a data source on population provided by the INSEE for the year 2010 (December 2010/January 2011 depending on the variables), and representing an approximation of the population distribution on the whole country, on the base of a grid of 200x200m cell, built according to the analysis of satellite orthophotos and crossed with administrative data sources. Such a surface covers the whole country and produced an approximation of the detailed distribution of country population on a very small scale.
In Fig. 54 is showed an example of the grid coverage of a small municipality in the North-East part of the Lyon Metropolis, Rilleux-la-Pape, that, due to its small dimension would have been included in just one IRIS, not suitable for the residences approximation. After having transformed the grid cells into points, the same method for the Neighbourhood Areas building have been applied, producing a population density surface through a 400m radius Kernel Density model.

[75] Ilots Regroupés pour l'Information Statistique

Fig. 54 – example of the Données Carroyées database by INSEE. Grid cells covering part of the Rilleux-la-Pape municipality.



Source: our elaboration on INSEE and ESRI data

A similar solution needed to be found for the employees data and activities locations, since also in this case the only sources providing information on the number of employees in the different economic activities were at the municipal or IRIS level (and in this case at a level of classification detail to much aggregated for our purposes, limited to 2 digits in the NACE classification instead of the 3 digits needed). The only alternative was to employ data on the establishments collected and stored by the SIRENE archive, the data collection database for information on country's companies and establishments characteristics. From January 2017 the access has been opened to the public for free, while in the past only by payment, making those data finally easily available and accessible.
The database contains a wide variety of information also at the establishment level, with a high detail in the activity sector classification (up to 4 digits). Unfortunately the information on the number of employees per establishment is provided only for bracket (ranges), limiting the precision of the computation. Moreover, in the Rhone-Alpes Auvergne area taken as comparative case study, about the 5% of the whole establishments have not been updated with this kind of information, while 72,3% has been having employees recorded during the year but not anymore at the end of it.

Tab. 26 – Frequencies of the activity establishments distinguished for different employees sizes in Rhone-Alpes Auvergne region (2012).

Employees bracket	**Number of establishments**	**percentage**	**percentage**
00	622 950	72.3	72.3
1 to 2	88 633	10.3	82.6
3 to 5	43 558	5.1	87.7

Employees bracket	Number of establishments	percentage	percentage
6 to 9	24 867	2.9	90.5
10 to 19	20 719	2.4	92.9
20 to 49	13 220	1.5	94.5
50 to 99	4 660	0.5	95.0
100 to 199	1 927	0.2	95.2
200 to 249	334	0.0	95.3
250 to 499	616	0.1	95.4
500 to 999	202	0.0	95.4
1 000 to 1 999	81	0.0	95.4
2 000 to 4 999	35	0.0	95.4
5 000 to 9 999	3	0.0	95.4
10 000 and more	1	0.0	95.4
NN	39 694	4.6	100.0
Total	861 500	100.0	

Source: our elaboration on SIRENE data 2017.

NN	Unités non employeuses (pas de salarié au cours de l'année de référence et pas d'effectif au 31/12) ou unités sans mise à jour d'effectif
00	0 salarié (unités ayant eu des salariés au cours de l'année de référence mais plus d'effectif au 31/12)

We attributed at least one employees to those establishments, but anyway this produced a relevant underestimation of the employees presence. In fact, after having geocoded all the establishments in order to map their distribution on the whole Rhone Alpes-Auvergne region, and attributed them to the same grid cells adopted for the population distribution analysis, the output of the Accessibility Basins computation was not satisfying, producing an unreal density distribution of the employees, not suitable for the application of our urbanity detection method.
For this reason we had to quit the computation of the *urbanity* in the Rhone-Alpes. Unfortunately the lack of time in finding an alternative solution to the issue forced us to abandon the objective of a full comparison between the two contexts and the building of a similar metropolitan zoning also for the French case. We can only focus on the metropolitanity analysis, and that we will do in the last paragraph of this chapter.

Lyon MA and the different interpretations of its territory

The metropolitan index computation run in this chapter has showed the strong interconnection existing between Lyon, the main centers around its urban area (St.Etienne and Grenoble) and the agglomeration of Marseille on the Mediterranean coast. The portion of this area closer to the Lyon city seems to fit well to some of the already seen territorial representation of the Lyon metropolitan context (see chapter 4). The DTA domain in particular fall almost completely inside the metropolitan boundary drawn here (Fig. 55), showing a good matching between the territory considered strategical for the local development by the central State and the functional extension of the metropolitan functions located there (at least according to our representation).

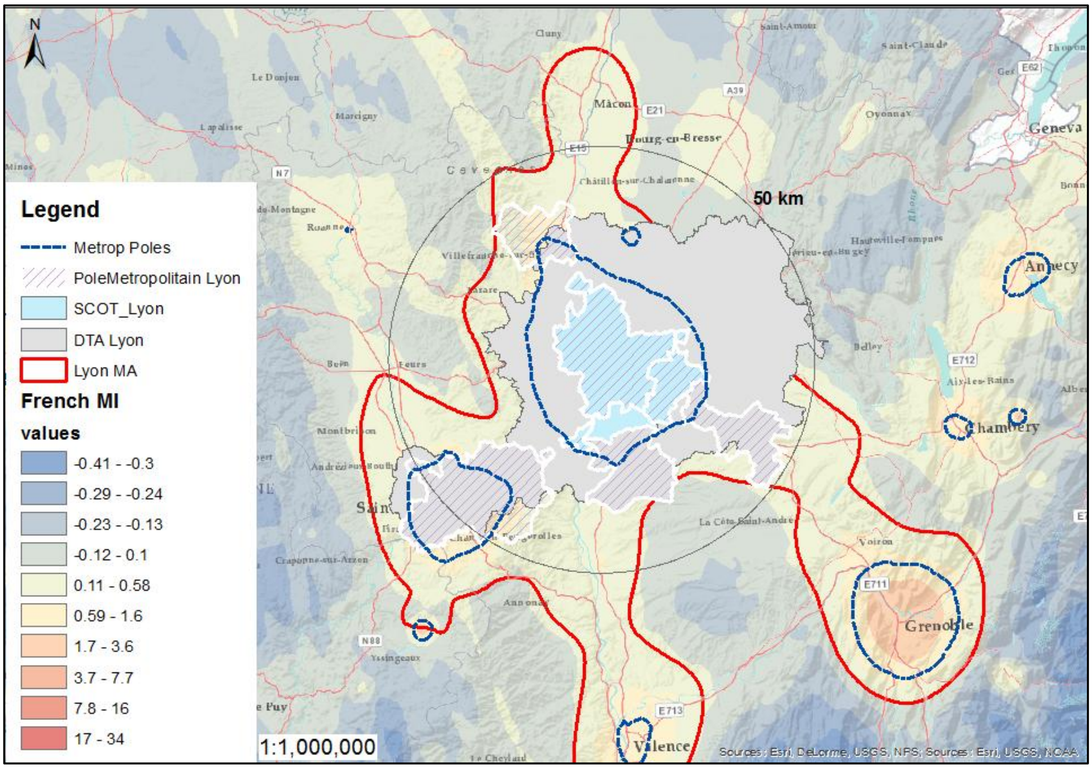
If we look at the metropolitan poles, that we identified considering as a threshold 1 st.deviation from the mean of the metropolitan index value, the one including Lyon contains the areas composing the Lyon SCOT, highlighting the strong functional closeness of the territorial components of that body.

The Lyon Pole Metropolitain as well fall perfectly inside the metropolitan boundary, integrating in this way further localities to the extent of the DTA.

On the other hand, other territorial representations of the Lyon area don't correspond so well to the proposed metropolitan domain: the InterSCOT of Lyon exceeds in fact all the functional representations of Lyon metropolitan area, both INSEE and OECD ones. It consists in a very wide domain, that extends on the North-West side of the area, towards the far but strong attractor Paris. We can see that the metropolitan Index density expands on the same axis, tracing somehow a potential development tendency intercepted by the planning scheme of the InterSCOT.

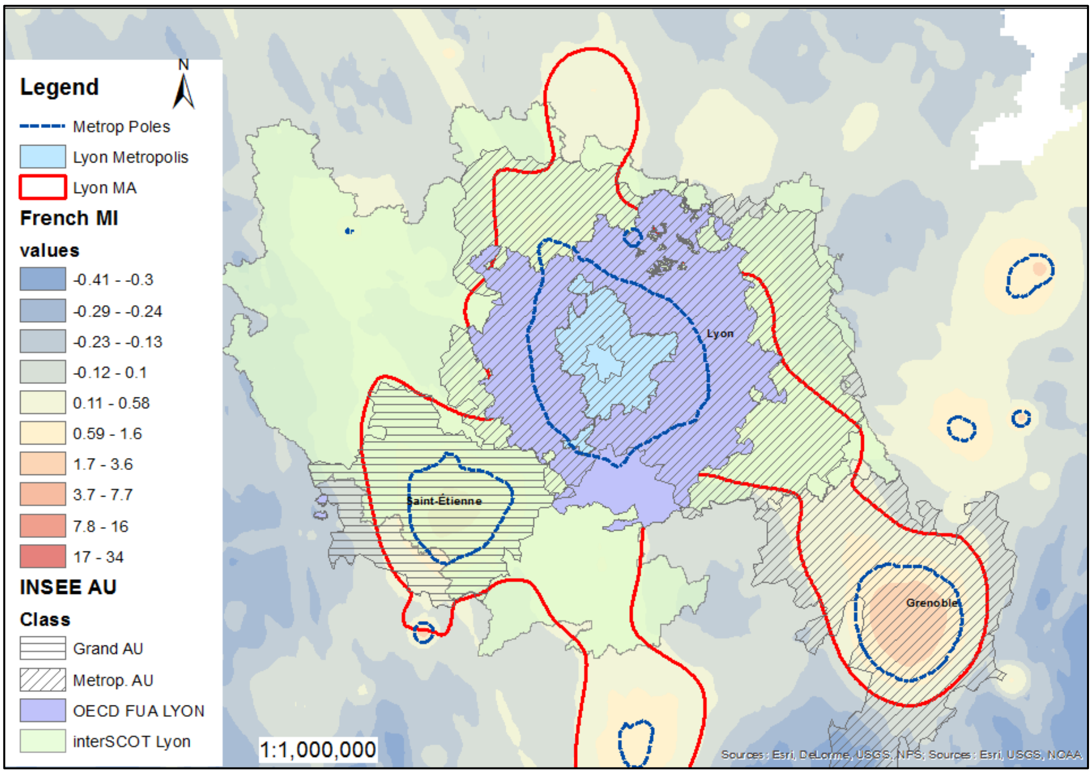
What emerges here is anyway the agglomeration between the main Urban Areas of Lyon, Grenoble (classified as Metropolitan by the INSEE) and the Big Urban Area (Grand Aire Urbain) of St.Etienne. The most part of them is included into the metropolitan boundary drawn in this chapter, and corresponds to the main poles of this portion of MA (Fig. 56).

Fig. 55 - Lyon area Metropolitan representations: Metropolitan Area, DTA, Pole Metropolitain and Lyon SCOT.



Source: our elaboration on INSEE, DREAL – Auvergne Rhone-Alpes data 2017 and ESRI data.

Fig. 56 – Lyon area Metropolitan representations: Metropolitan Area, OECD FUA, INSEE Urban Areas and InterSCOT.



Source: our elaboration on INSEE, DREAL – Auvergne Rhone-Alpes data 2017, OECD 2000 and ESRI data.

Conclusions

Our representation has emphasised the importance of considering the interrelations between Lyon and the main centers of St.Etienne and Grenoble. Even if they are conceived and classified as different Urban Areas their closeness and high metropolitanity degree push for a common functional interpretation of their territories. The southern channel towards Marseille is mainly produced by the bridging role and position of the two interposed cities of Valence and Avignon, that work as intermediate metropolitan functions agglomerations.

If for St.Etienne territorial forms of collaboration and connection already exist (the Pole Metropolitain, the DTA), for Grenoble there is still room to better analyse the opportunity of developing common territorial of functional relations, probably existing but not yet formalised into territorial agreements.

Chapter 8

Walkability assessment in the two case studies of Milan and Lyon

8.1.Measuring walkability: a literature review

Walkability has risen as a relevant scientific research field only recently in urban studies, mainly pushed by the research in preventive medicine, where, as already showed in chapter 3, the relevant health issues like obesity, cardio-vascular diseases, strokes, etc…, have been associated with a lack of healthy living attitudes, and in particular with a poorly active lifestyle. Among the various factors affecting individual attitudes and behaviours, built environment and specifically pedestrian accessibility and walkability of life spaces have been identified as main ones (Giles-Corti, Macintyre, Clarkson, Pikora, & Donovan, 2003; Tilt, Unfried, & Roca, 2007), raising a growing interest into the research on their evaluation and promotion.
In order to provide useful tools to such a task a huge amount of literature has been produced on the issue, proposing different ways and methods for walkability detection and measure. Here we would like to present the most interesting examples in order to introduce our proposal of walkability detection we applied on the two case studies of the Metropolitan City of Milan and the Lyon Metropolis. We will also compare it with the already presented pedestrian accessibility index, in order to stress the differences or similarities in detecting the degree of urbanity of spaces.

The origins of a legacy

If the literature on the relevance of urban space conceptualization for walkers and pedestrians friendliness of cities has a deep tradition dating to the first works of John Fruin (1971), recently more and more attention has been given to the aim of finding the best elements useful to measure the pedestrian suitability of spaces, focusing on those characteristics of the built environment able to promote or obstacle walking activity.
At the beginning of this new trend in the literature can be cited the work of Chris Bradshow, Canadian former municipal officer and eco-activist, who in 1993 proposed at the 14th International Pedestrian Conference in Colorado, a tool for the walkability measure, in order, using his words, "to provide a motivation to induce more people to become 'local heroes', by re-establishing their links with their streets and neighbourhoods and committing personal resources to rebuild their local physical and social infrastructure, so necessary to human life and the ecology of 'the commons' ".

His proposal was born from a practical issue risen in his own neighbourhood: the high walkability and good quality of his residential environment increased also the value of the houses and buildings, producing an increase in property taxation computation. In order to check and measure this *worth* property he decided to realize a specific tool for the detection of this “good living” quality.
The first step in its index definition consisted in the identification of the dimensions composing the *walkability* property, conceived by the author as:

1) A **man-made environment** made of wide level sidewalks, small intersections, narrow streets, lots of litter containers, good lighting, and an absence of obstructions.
2) A **full range of useful,** active **destinations within walking distance**
3) A natural environment able to **moderate the extremes of weather** and **protected from pollution and risks.**
4) A **local culture that is social and diverse.**

In order to operationally define these dimensions he listed 10 indicators:

Tab. 27 – Indicators composing walkability in Bradshaw’s view.

	Indicator
1	Residential density
2	Parking places off-street per household
3	Number of sitting spots on benches per household
4	Chances of meeting someone you know while walking
5	Age at which a child is allowed to walk alone
6	Women's rating of neighbourhood safety
7	Responsiveness of transit service
8	Number of neighbourhood "places of significance"
9	Parkland (green public spaces)
10	Sidewalks

Source: Bradshaw (1993).

Its index included some of the most considered indicators in the literature about built environment impact on people behaviour, detecting both objective and subjective properties of space, in order to measure its qualities but also people perceptions of them.
From that proposal many other studies have been run, following and integrating the Bradshaw proposal, and better delineating the dimensions at the base of the walkability detection. As constitutive of the classifications and proposals anyway lies always the need to find the elements able to shape and modify the active mobility behaviours and in particular walking activity. The main distinction is between **individual** (socio-demographic characteristics of people) and

environmental (built-space characteristics and morphology[76]), but always more and more is acknowledged the relevance of considering also the interaction between these main realms and properties (see for example the debate on the self-selection bias introduced in chapter 3).
One of the most influential in the last years is for sure the one developed by Frank et al. in 2008, contribution in which they proposed a new method for walkability measure to be adopted in their Neighborhood Quality of Life Study. They highlight that many sources of information are usually included into walkability analysis: expert opinion about community typology (Saelens et al., 2003), census data and systematic observations (Hoehner et al, 2003; Moudon & Lee, 2003), land-use databases using Geographic Information Systems (GIS) (Cervero, & Duncan, 2003). However not all of them have had the same success in walkability measure attempts, due to the difficulties in data provision.
From the analysis of this literature emerges that among the most relevant elements impacting on people walking behaviour (and in general active mobility behaviours) can be included: mixed land-use (where higher the mix, higher the walkability), street connectivity (number of potential directions and destinations choices), residential density, and combinations of these variables. Some of the works produced in this legacy worth to be cited, acting as milestones in the field.
Cervero and Kockelman (1997) proposed, in a famous contributions on the travel behaviour drivers, their method for built environment evaluation in terms of impact on travel behaviour, introducing the 3Ds conceptualisation (then expanded to 5Ds, Ewing and Cervero, 2001, with the adding of Destitation accessibility and Distance to transit). In their work they highlight the relevance of Density, Diversity and Design in shaping people behaviours: using travel diary data and land-use records from the U.S. census, regional inventories, and field surveys, they estimate models that relate elements and characteristics of the built environment to variations in vehicle miles travelled per household and mode choice, mainly for non-work trips. In particular density, land-use diversity, and pedestrian-oriented designs were found to generally reduce trip rates and encourage non-auto travel in statistically significant ways (even if not in a dominant degree).
An analogous work has been proposed by Krizek (2003), in which urban built environment has been evaluated and operationalised into 3 main variables: *density* (as the number of housing units per square mile), *density of employees in local shops activities* and *street pattern*[77]. All the data came from the National Census, then processed on the base of a homogeneous grid of 150m side cells. In this way the analytical and representational limits given by the administrative and

[76] Saelens and Handy define them as: "[…] land use patterns, the distribution across space of activities and the buildings that house them; the transportation system, the physical infrastructure of roads, sidewalk, bike paths, etc., as well as the service this system
provides; and urban design, the arrangement and appearance of the physical elements in a community." (Saelens & Handy, 2008, p.550)
[77] computed as the average block area per grid cell, hypothesising that wider blocks are correlated with more suburban-styled settlements and planning schemes.

statistical boundaries were avoided, adopting an universal territorial unit of analysis. As well as for Cervero and Kockelman's study, also in this case a lower VMT is found in the higher walkable contexts.

Beside the reported variables, other are usually considered in the literature like: sidewalks presence and characteristics, traffic calming elements, and street intersection characteristics (Handy et al. 2002; Sallis et al., 2004; Cervero and Kockelmann, 1997; Forsyth et al. 2008). Unfortunately detailed street design information are usually very difficult to collect, and for this reason their availability in existing datasets is very rare (unless for specific and limited portion of urban spaces). Some attempts have been done to avoid such a stuck in the data collection, implementing urban audits aiming at detecting urban space characteristics and classification/evaluation (Clifton, Livi Smith, and Rodriguez, 2006; Brownson et al., 2009), but it requires usually a high time and resources consuming work (Victor et al., 2015). Alternatives in order to reduce collection costs have been proposed focusing on the use of web map navigation services like Google Street View (Lee & Talen, 2014), but the process is still heavy.

The aim of Frank et al. was to find the elements more relevant in walkability assessment, and whose operationalisation could have been more feasible adopting secondary data. Following the main works on the topic they derived an index of walkability for each blockgroup, their territorial unit of analysis, as a function of four elements:

1) net residential density,
2) retail floor area ratio (FAR),
3) land use mix,
4) and intersection density.

Tab. 28 – Walkability Index components in Frank et al. proposal (2007)

Measure	Definition	Data source
Net residential density	Residential units divided by acres in residential use	2000 Census and King County parcel-level land use database
Street connectivity	Intersections per square kilometer	Street centerline file
Land use mix	A/(ln(N)) (see note)	King County parcel-level land use database
Retail floor area ratio (FAR)	Retail building floor area (sq. ft.) divided by retail land area (sq. ft.)	King County parcel-level land use database

Note: Land use mix = A/(ln(N)) where
$A = (b_1/a)*\ln(b_1/a) + (b_2/a)*\ln(b_2/a) + (b_3/a)*\ln(b_3/a) + (b_4/a)*\ln(b_4/a) + (b_5/a)*\ln(b_5/a) + (b_6/a)*\ln(b_6/a)$
a = total square feet of land for all six land uses present in buffer
b_1 = square ft. of building floor area in education uses
b_2 = square ft. of building floor area in entertainment uses
b_3 = square ft. of building floor area in single-family residential uses
b_4 = square ft. of building floor area in multifamily residential uses
b_5 = square ft. of building floor area in retail uses
b_6 = square ft. of building floor area in office uses
N = number of six land uses with FAR > 0

Source: Frank et al., 2007, p.77

Density and *mixed land use* have been chosen due to their capacity to measure and detect the degree of heterogeneity given by the co-location of functionally different uses in space. As Leslie et al. highlight "The more compact and intermixed an urban environment is, the shorter the distances between destinations" (Leslie et al., 2007, p.113) and for walking choices this is crucial since the relative utility of walking compared to other means of transport drops rapidly (Frank, 2004).

Net retail area ratio is adopted as a tool to detect the friendliness of retail areas for pedestrians, considering locations with a high retail floor area ratio as less dangerous for them, since less auto dominated like happens in large parking lots that sever sidewalks from building entrances.

Connectivity is as well a relevant element since direct connection are able to facilitate walking trips, reducing the time spent in travelling, and also the availability of different routes to reach the local territorial attractors is a further element useful for walking behaviour improvement, increasing travel opportunities. This happens usually in regular grid pattern urban spaces (Saelens et al., 2003;

Frank et al., 2003).

The 4 variables have been standardized and then combined into an additive index.

8.2. An example of walkability index application: the CURHA Project experience in Luxembourg

On the same literature is based also a recently developed project, we had the opportunity to study from very close, run between different international institutes, Université de Montreal, Luxembourg Institute of Socio-Economic Research; INSERM – Institut National dela Santé et de la Recherche Médicale. The project named CURHA[78] was addressed to the study and understanding of the characteristics of urban environments able to influence active mobility, social participation, and well-being, for elders and ageing individuals (Kestens et al., 2016). A part of the research, run on Luxembourg City and Luxembourg whole national territory, was focused on the need to define a walkability index for the evaluation of urban space suitability for pedestrians, in particular the aged ones, the study population of the research project. The index consisted in an additive measure, computed inside a GIS environment, composed of 5 different elements/dimensions considered relevant for the task, and partially derived from the studies previously reviewed:

1) *Population density*
2) *Land Use Mix*
3) *Connectivity*

These were assumed as basic dimensions, while further two have been added:

4) *Proximity to services*, computed as closeness of individual residences to relevant local services (distinguished in terms of importance through their frequency of use in three classes: daily, weekly, monthly, in decreasing order of weight).
5) *Greenness*, measured through the amount of greenery present in the walking area, considered as further element able to improve walking behaviours.

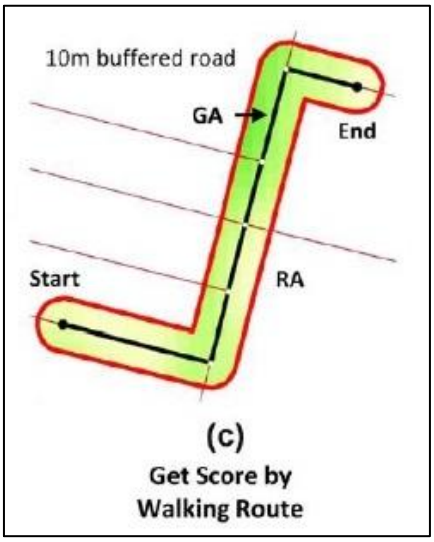
What is remarkable in this new method is the **territorial unit of analysis defined for the walkability detection.** It derives from a local peculiarity of the Luxemburgish context: the lack of territorial statistical areas comparable to the census tracts as a form of data provision. Such an obstacle could have been overcome thanks, on the other hand, to a point of local strength: the availability of socio-demographic and socio-economic data at the micro-scale of the individual. This allowed to work at a very detailed level, and to build an original and closer to

[78] *Understanding the Role of Contrasting Urban Contexts in Healthy Ageing: An International Study of Daily Mobility and Active Living Using Wearable Sensor Devices across Cohorts* (CURHA). For more information: https://www.liser.lu/?type=module&id=39&tmp=138 (26/11/2017)

the reality territorial unit, since not limited by administrative boundaries and criteria: the **walking area.**

The concept of walking area has been derived from a work by Achuthan et al. (2007), and consists in the construction of a buffer around the portion of street that can be walked by the subjects (Fig. 57). In the CURHA project the length of walkable street has been defined considering the path reachable in 15 minutes by a walking person, at the average speed of 3 km/h (derived from the literature as the average walking speed of an elder person).

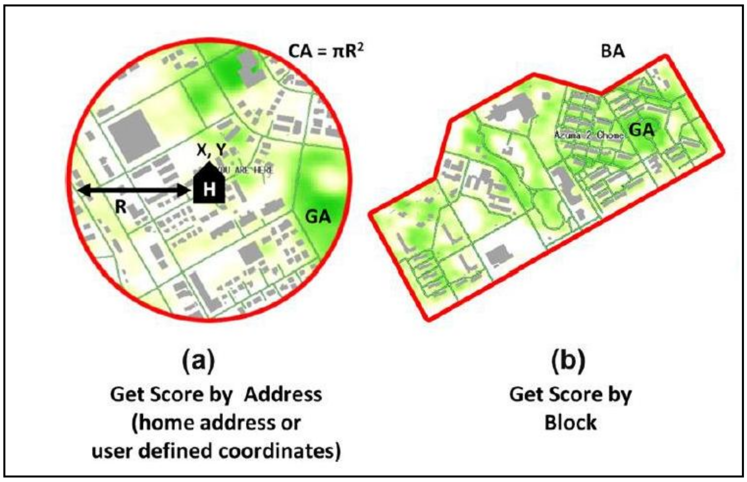
Fig. 57 – walking area definition network-based method



Source: Klein, Gutierrez, Escobar (2015).

This allowed to define a more realistic portion of space covered by walk, instead of the traditional methods, based on a gravity model approach or a block (census trac or residential block) area (Fig. 58). (Achuthan, et al 2007)

Fig. 58 – Crow-fly and block territorial data computation methods.



Source: Klein, Gutierrez, Escobar (2015).

Another remarkable aspect resides in **the evaluation method of proximity to amenities and opportunities,** and is strictly related to the walking area definition method. The availability of precise geolocalised data on services location has made possible to locate them on the street network and measure the exact distance from individuals' homes. In this way their relevance for the subjects has been weighted according both to their frequency of use and also to the distance from the residence.

A further element finally is innovative in this method: the **inclusion of the level of greenness** of the environment crossed by pedestrians, considered as a spatial property able to improve walking behaviours, since acting on the subjective perception of the quality of space and of its comfort and pleasantness, among the most relevant micro-scale properties (Ewing & Handy, 2009; Alfonzo, 2005).

We took this method as a model for the definition of walkability index to be applied in our case studies: the Metropolitan cities of Milan and Lyon. Due to differences in data availability and provision structure we partially changed the method applied in the Luxembourgish case, as can be seen from the next paragraphs.

8.3 The walkability detection in the Milan and Lyon metropolitan cities

The method proposed in the CURHA project needed to be adapted to our case studies, in order to face the differences in data availability and consequently in their analysis.
The first objective was to adopt the smallest scale possible for data analysis, the closest to the individual one. The reason to work at the smallest territorial level available is aimed in representing as best as possible the real phenomena on the territory and their variation, as explained in Leslie et al (2007, p.115) "Since there is a considerable amount of environmental variation within cities, ideally the smallest available spatial units should be selected to minimize within-unit variability and to maximise the variation between units".
In the Luxembourgish case the availability of individual level data (geolocalisation of residences and amenities) was an important point of strength, but it represents a rare case in research. In the Italian and French contexts, due to privacy issues, this data were not available, at least those about the residences location of individuals.
In the Italian case so we worked on the Census Tracts, whose centroids we adopted as an approximation of the residences and amenities' location as already done for the urbanity index computation (see Chapter 7). In the French case we used again the *données carroyées* for population location approximation (see Chapter 7), while the SIRENE database was adopted as a source for amenities location, making possible their precise georeference on the territory[79].

8.3.1 Residences location and building of walking areas.

In order to better locate the residence of the individuals inside the tract, we considered just the real residential net surface of the tract itself, crossing, in a GIS environment, them with the land use data from DUSAF, that allowed to highlight which portion of tract was actually dedicated to residential use. This was particularly useful in less urbanized contexts, where the inhabited census tracts can be quite wide and being constituted by broader not built up spaces. In Fig. 59 can be seen an example of such a situation, in *Parco Forlanini- Ortica* NIL area. The grey lines represents the limits of census tracts of that area, covering sometimes very broad natural spaces. Crossing the land use information, refining so the residential spaces boarders, helped in making more precise the residences location definition.

[79] In this case the database could be used since there was no need of a magnitude (in terms of employees number) measure of the activities.

Fig. 59 – example of residential areas location approximation through crossing of Istat Census Tracts and DUSAF land use database (Parco Forlanini-Ortica area).

Source: our elaboration on Istat and DUSAF data.

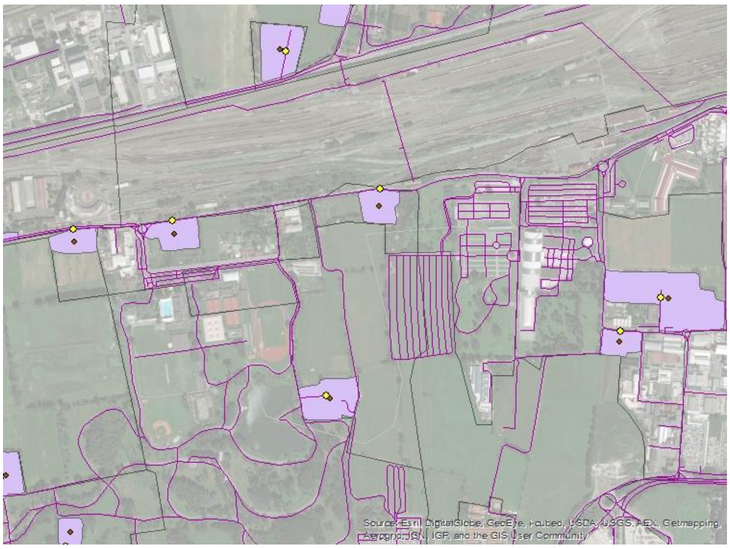
After having refined the residential blocks surfaces, we transformed them into points (their centroids) and located those on the closest street segment (Fig. 60), in order to build from that location the walking area buffer on the street network (Fig. 61). The Buffer has been defined, using a Network Analysis tool in ArcGis software, as a 25m zone area for each side of the road, covering all the street segments that could be walked in 15 minutes, considering a speed of 4.5km/h[80]. This was aimed at creating a surface inside which then detect and measure the presence of all the dimensions composing the index: number of residents, variety of land uses, connectivity (number of street nodes), number of opportunities/amenities, greenness.

In the Lyon case, the lack of availability of a database source for land use at the detail level of the DUSAF was compensated in this phase by the nature of données carroyées database, whose grid is built only on inhabited portion of land, covering, at a good level of detail, the all residential zones. For this reason the

[80] Average walking speed defined by Victor et al. on the base of a detailed literature review (Victor, Klein, & Joliveau, 2015).

carreaux's centroids have been adopted as approximation of residences location in the French context and of walking area drawing.

Fig. 60 – residential areas centroids location (yellow points) on the closest street segment (purple lines) (Parco Forlanini-Ortica area).



Source: our elaboration on Istat, DUSAF and OSM data.

Fig. 61 – walking area building example (Parco Forlanini-Ortica area).

Source: our elaboration on Istat, DUSAF and OSM data.

8.3.2 Walkability Index components operationalisation and measure

As already stated the need to adapt the analysis to local data availability pushed us to change somehow the operationalisation and analysis of walkability dimensions.

In Tab. 29 are reported the dimensions and their operationalisation for the three cases considered (the Luxembourgish adopted as a model and the Milan and Lyon ones).

Tab. 29 – walkability dimensions operationalisation and data sources in Luxembourg, Milan and Lyon cases.

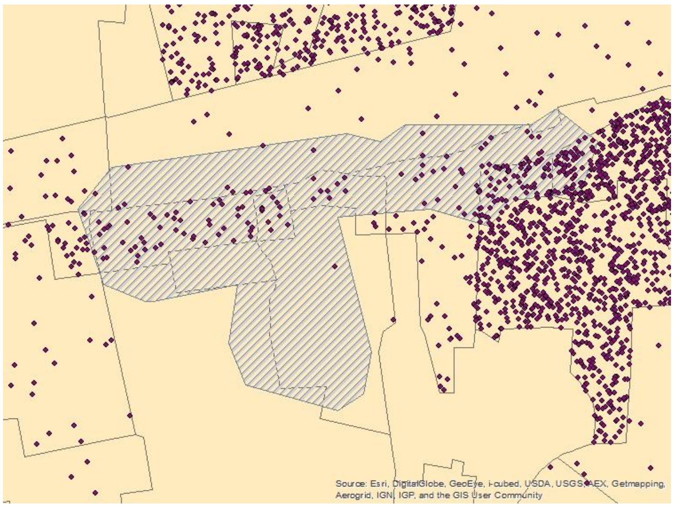
CURHA Project	*Source*	**Milan MA case**	**Grand Lyon case**
Connectivity	Street network (nodes and segments)	It has been considered just according to the number of street nodes Source: *OSM*	It has been considered just according to the number of street nodes Source: *OSM*
Proximity to amenities	OSM data	Available at census tract level (number of establishments for different ATECO). Sources: *National Census and OSM data.*	Available at the precise address location Sources: *Sirene dataset and OSM data*
Residential Density	National Social Security Survey	Data at individual level not available. Census tracts as proxy Source*: National Census*	Data at the *carreaux* level developed by INSEE (200mX200m squares) Source: *National Census*
Land Use Mix		Dataset available for the whole Lombardy region Source: *DUSAF*	Data based on the CORINE land cover Source: *CORINE Land Cover project*
Slope	DEM	Not considered due to the structure of the territory (flat plain)	Not considered
Greenness	SAVI Index LandSat imagery	SAVI Index Source: *LandSat imagery*	SAVI Index Source: *LandSat imagery*

8.3.2.1 Population density

Working always on the census tract level, being impossible to obtain precise data on people residence location, in order to compute the number of people present in the walking areas we translated the variable *resident population* in each block into points, distributed randomly into the block boundaries (Fig. 62). In this way the measure consisted in an approximation of the real distribution, and also for this reason the buffer width extension was defined in 25m for each street side: in order to catch a satisfying portion of points.

In the French case a similar approach has been adopted, working always on the carreaux level.

Fig. 62 – Population density detection in walking area example.



Source: our elaboration on Istat, DUSAF and OSM data.

8.3.2.2 *Proximity to amenities*

In an analogous way was operationalised the *amenities distribution*: this time the variable considered were the economic activities units (establishments) recorded for each census tract, translated into random points (Fig. 63). The services considered are distinguished into three classes, according to the weight they have in people life. Of course the importance of the various services is in this case highly arbitrary, since it differs according to people characteristics like age, gender, social status, health status, etc…but here we consider as a criterion the frequency an average individual could use them, distinguishing between daily use amenities (weight=3), weekly use (weight=2), monthly or more (weight=1). The weighting of amenities is a relevant issue in all the walkability and, more generally, accessibility measures, since it produces sensible different results according to different criteria adopted. We already discussed briefly such a point in chapter 6 (6.1.1.2).

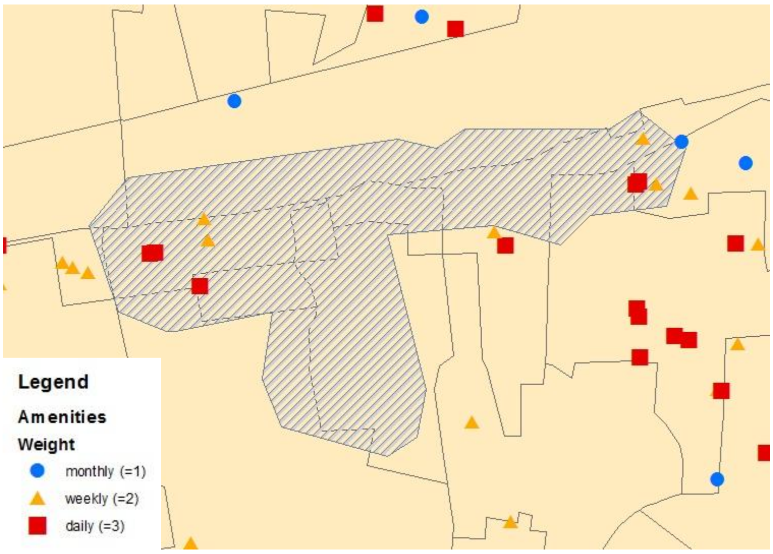
Due to the lack of precise localization data we did not evaluate them according to the distance from residencies location. In order to maintain the comparability with the Italian case, also in the French one only the presence inside the walking area has been considered and not the distance.

Tab. 30 – Amenities considered and their weight in the index computation.

Category	**Amenities**	**Frequency**	**weight**
Public transport	Bus stops, train stations	daily	3
Schools	kindergarden and primary schools	daily	3

Category	Amenities	Frequency	weight
Markets (daily)	supermarkets, grocery stores, bakery and pastry, tobacconist	daily	3
Medical services (daily)	pharmacy	daily	3
Markets (weekly)	butchery and charcuterie	weekly	2
Hostelry	restaurant, cafè, brasserie	weekly	2
Banking	bank, post office	weekly	2
Sport facilities	gym, swimming pool	weekly	2
Green spaces	urban parks	weekly	2
Medical services (monthly)	General Practitioner, specialist medicine, dentist, Hospital	monthly	1
Cultural Places	library, theater, concert hall	monthly	1

Fig. 63 – Amenities mapping examples into walking areas.



Source: our elaboration on Istat and OSM data.

8.3.2.3 Connectivity

Connectivity as been defined here as the number of street nodes existing in the walking areas: an higher amount of street crossings is usually linked to a wider set of routes and a wider set of opportunities (to reach places, amenities, etc...), that can be reached without being forced to walk long roads segments (Jacobs, 1966;

Frank et al. 2008). It is related to walkability and also to some of its components like residential density and retail density (Duncan et al. 2011).

8.3.2.4 Land use mix

The variety of land uses in the walking areas is operationalised similarly in the three cases. In the Italian case study the data source is the regional DUSAF dataset (Fig. 64), produced by ERSAF (Ente regionale per i Servizi all'Agricoltura e alle Foreste[81]), and consisting in a classification of the land uses harmonized with the Corine one, but more detailed, since integrated by other data sources, in order to reach a 4th and 5th level of accuracy (instead of the 3 available in the Corine database)[82]. The various parcels of land, each characterized by a different use class, have been transformed into rasters in order to measure the amount of cells of each kind of land use that were included in the walking areas.

A Shannon Entropy index is then computed in each walkability area, in order to measure the variety of uses present in them:

$$\frac{-\Sigma_k \left(p_k * \ln p_k\right)}{\ln T_k}$$

Where p_k stands for the proportion of land use k and T_k the total land uses possible (in our case 6). Its range goes from 0 (when only 1 kind of land uses is present) to 1 (when there is an equal partition between all the 6 kind of land uses).

The same approach has been adopted in the French case, but the database used is the Corine one, due to lack of more detailed sources.

[81] Regional body for Agricultural and Forestry services

[82] See ERSAF website for further information: http://www.ersaf.lombardia.it/servizi/Menu/dinamica.aspx?idSezione=16908&idArea=16914&idCat=17254&ID=21332&TipoElemento=categoria (26/11/2017)

Fig. 64 – Land Use Mix mapping example in MMC area.

Source: our elaboration on Istat, DUSAF and OSM data.

8.3.2.5 Greenness

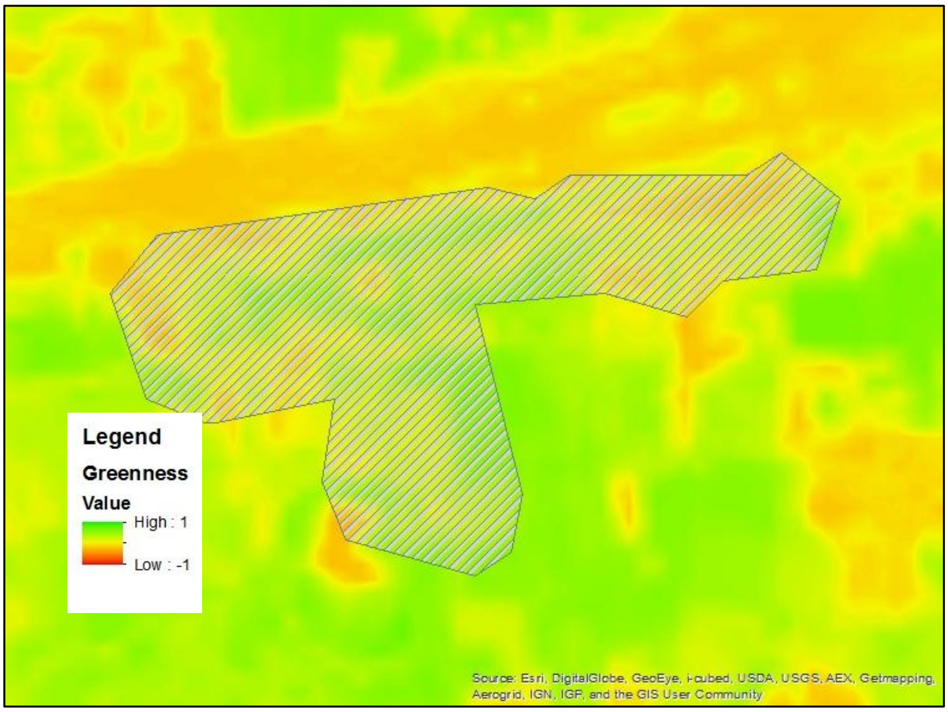
The last element considered is the level of greenness characterizing each walking area, that has been operationalised thanks to the analysis of Landsat Imagery. Landsat is a project[83] run by American USGS, started in the 1970s and consists in a satellite system providing data and images of the earth surface into different radio wavelength, covering all the globe. The image resolution is very detailed, consisting in cells of 30x30m (in the last missions outputs), and after a proper combination of the various data layers provided (distinguished according to the wavelength displayed) many relevant information can be derived from it.

The tool adopted to measure the level of greenness is the NDVI (Normalized Difference Vegetation Index), an index useful to exploit the wavelengths reflected by the vegetation in order to measure its presence and density in the territory (DeFries and al., 1994).

The computation of the index on the Landsat data produces a value ranging from -1 to 1, according to the degree of greenness present in the space (Fig. 65).

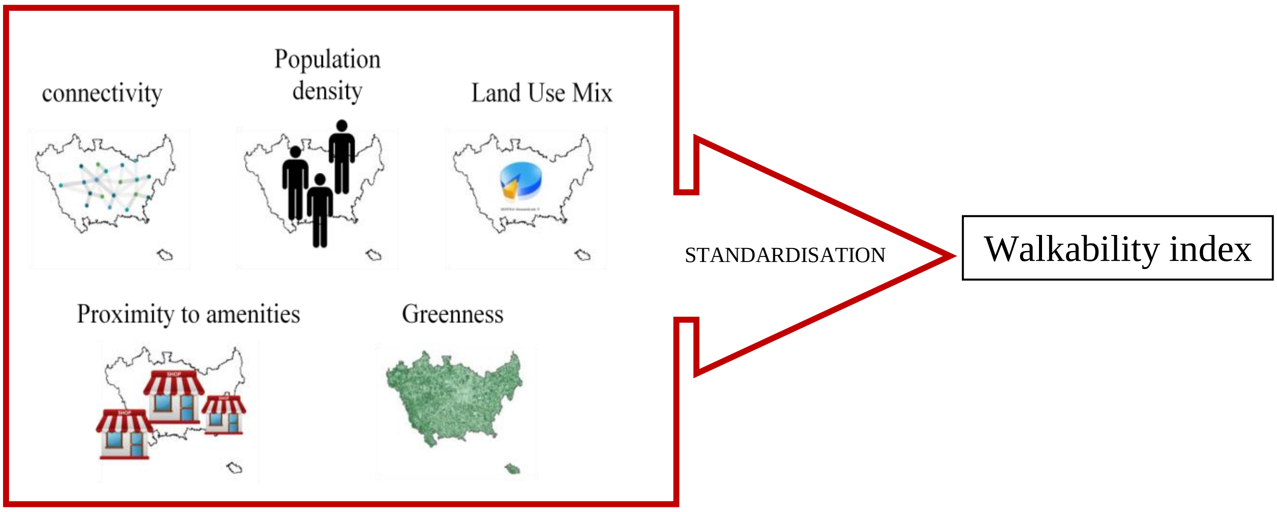
[83] actually is a combination of 8 temporally distributed missions, each providing new and more accurate information and images (the last one has been launched in 2013). https://landsat.usgs.gov/

Fig. 65 – Greenness (NDVI) mapping example in MMC.



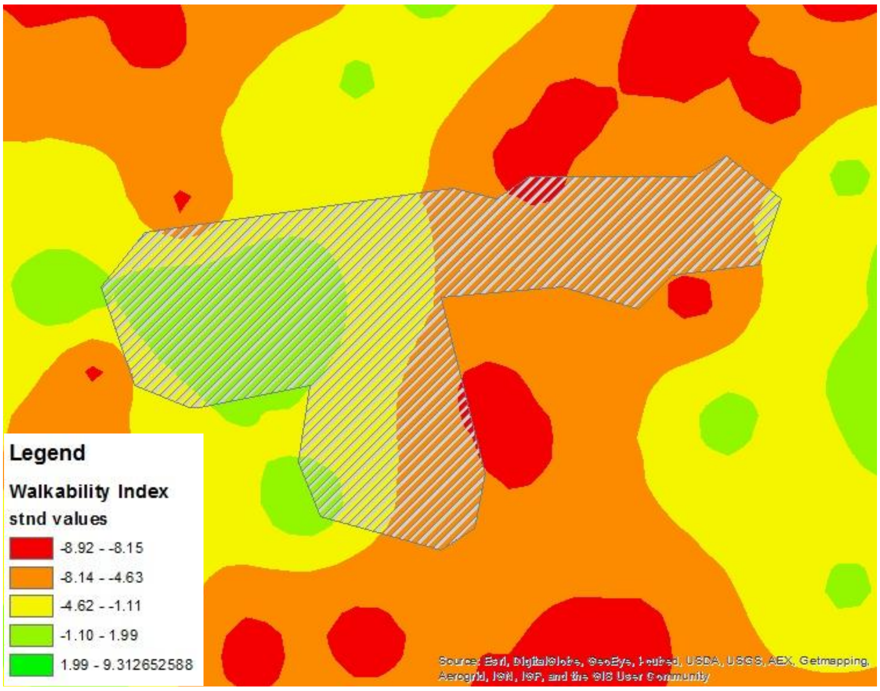
Source: our elaboration on Istat, Landsat and OSM data.

In the end all the dimensions'outputs have been standardized in order to allow their combination, and merged into an additive index:



Once computed for each walking area the walkability index, an IDW interpolation[84] model has been run on them (on their centroids more precisely), in order to transform the walkability values into a continuous surface, distributing on the whole study field territory. In this way we could avoid the limits given by the administrative or statistical territorial units, and also overcoming those given by our walking areas contexts (from which data have been collected and computed).

Fig. 66 – Final walkability index mapping example in MMC.



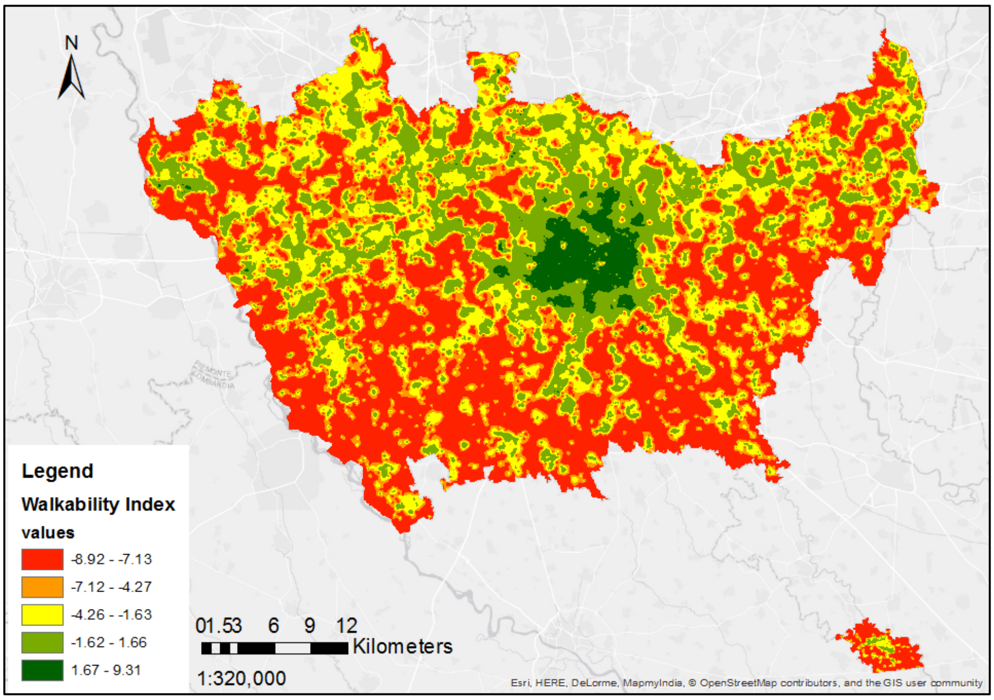
Source our elaboration on Istat, DUSAF, Landsat and OSM data.

8.3. A comparison between contexts: walkability in MMC and Lyon Metropolis

The application of the described procedure on the two study contexts produced two raster surfaces representing the walkability level distribution in their territories.

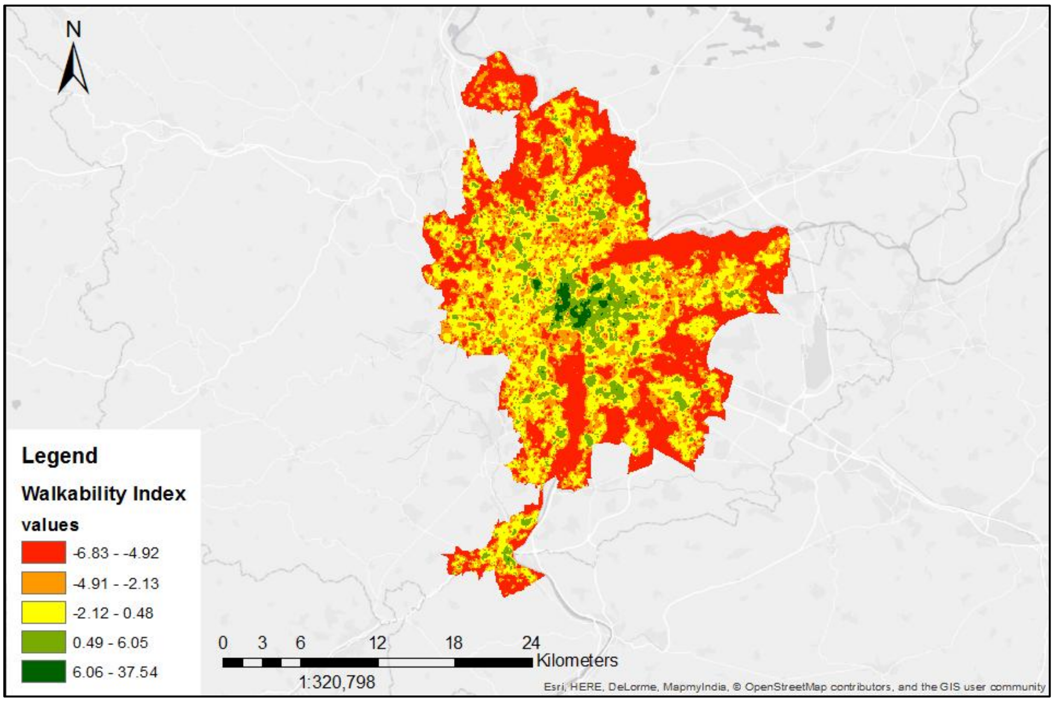
[84] Inverse Distance Weighted, is one of the possible interpolation techniques applicable in GIS softwares. It allows to build, starting from located and punctual data, a continuous raster data surface. This method assumes that the variable being mapped decreases in influence with distance from its sampled location. For further explanation see the ESRI ARCGIS website: http://desktop.arcgis.com/en/arcmap/10.3/tools/spatial-analyst-toolbox/how-idw-works.htm.

Fig. 67 – Walkability index in the MMC territory year 2011.



Source: our elaboration on Istat, DUSAF, Landsat and OSM data.

Fig. 68 – Walkability index in the Lyon Metropolis territory year 2011.



Source: our elaboration on INSEE, SIRENE, Corine, OpenData Grand Lyon and OSM data.

The two indexes show a different range: the Milanese one is much shorter, but the variance is higher. The differences in index values could be due also to the different level of detail and precision in the operationalisation of some dimensions: the analysis of amenities location is for example just approximated for Milan, while very precise for the Lyon case study. On the other hand the land use mix measure is supposed to be more precise in the Milanese case, since the database adopted is much more detailed than the Corine one used for Lyon. In general anyway Lyon records higher values of walkability than Milan and is more concentrated.

Tab. 31 – MMC and LM walkability indexes statistics.

	max	*min*	*mean*	*std. dev.*
Lyon	37.54	-6.83	-3.29	3.09
Milan	10.71	-8.7	-4.81	3.52

From the comparison of the spatial correlation between walkability dimensions (Tab. 32 and Tab. 33) we can see how some elements are more or less relevant, also depending on the context considered.
Overall, the most important components seem to be those related to the physical or morphological and functional characteristics of the space: *Connectivity* and *Land Use Mix* show the highest values (Milan case), first of them in both study cases. *Greenness* comes just after them those, while *population and amenities densities* are the lowest impacting dimensions.
In MMC population density is less relevant in walkability computation: this could be due to the less compact territory characterising it if compared to Lyon. Is not by chance in fact that the density between the two areas is quite different, with Lyon Metropolis reaching the value of 2.452 ab/km^2 vs 1.929 ab/km^2 of Milan in 2011. In this sense a higher homogeneity among metropolitan contexts in terms of population distribution can produce a lower impact of this dimension on the index computation.
Amenities are as well more impacting in Lyon, maybe due to the data operationalisation procedure as already explained above, producing a more precise differentiation between areas.
Connectivity do not differ very much between contexts, while on the contrary it happens for Land Use Mix degree, more impacting in Milan. Again we could explain that according to the differences in data availability and dimensions operationalisation in the two cases.
Greenness is highly relevant in both cases, more in the Milanese one.

Tab. 32 – Milan Metropolitan City walkability index and components correlation matrix.

	Population	*Amenities*	*Connectivity*	*LandUse*	*Greenness*	***WI***
Population	1	0.892	0.661	0.375	0.143	**0.856**
Amenities	0.892	1	0.587	0.264	0.061	**0.951**
Connectivity	0.661	0.587	1	0.884	0.762	**0.966**
LandUse	0.375	0.264	0.884	1	0.878	**0.498**
Greenness	0.143	0.061	0.762	0.878	1	**0.586**
WI	**0.586**	**0.498**	**0.966**	**0.951**	**0.856**	**1**

Tab. 33 – Lyon Metropolis walkability index and components correlation matrix.

	Population	Amenities	Connectivity	LandUse	Greenness	**WI**
Population	1	0.788	0.820	0.158	0.179	**0.826**
Amenities	0.788	1	0.828	0.156	0.096	**0.655**
Connectivity	0.820	0.828	1	0.325	0.342	**0.699**
LandUse	0.158	0.156	0.325	1	0.547	**0.630**
Greenness	0.179	0.096	0.342	0.547	1	**0.760**
WI	**0.699**	**0.655**	**0.826**	**0.630**	**0.760**	**1**

In order to make the index more readable we classified it adopting as thresholds the standard deviations from the mean value. In this way we could distinguish between 5 classes (Tab. 34): Not walkable (values between -2 and -1 standard deviations), Low (values between -1 and 0 s.d.), Medium-Low (values between 0 and 1 s.d.), Medium-High (values between 1 and 2 s.d.), High (values over 2 s.d.).

Tab. 34 – Surface extension of Walkability Index classes in MMC and LM.

		Milan Metropolitan City		Lyon Metropolis	
Std deviations	**WI class**	**Area km^2**	**% on the whole MMC**	**Area km^2**	**% on the whole MMC**
-2 to -1	*Not walkable*	366	24%	108	20%
-1 to 0	*Low*	439	28%	147	28%
0 to 1	*M.-Low*	449	29%	196	37%
1 to 2	*M.-High*	262	17%	61	12%
2 to 3	*High*	32	2%	14	3%
Total		1 548	100%	526	100%

The results show a similar structure between the two case studies, with Lyon being characterized by a slightly higher amount of spaces with a level of walkability higher than the mean (4 percentage points).

Since this is a relative measure (based on the specific distribution of each context) a better comparison need to be run. If we look at the values corresponding at the various thresholds considered we see that Lyon has higher values of walkability for each of them (Tab. 35). If we apply the same walkability index values thresholds to both cases (adopting the ones defined for Milan) the surface extension of the territory belonging to the various classes in Lyon would be wider: 197 km^2 instead of 196km^2 for *M-Low class* , 120 km^2 instead of 61 km^2 *M.-High class*, 17 km^2 instead of 14 km^2 *High class*.

Tab. 35 – Walkability index classes thresholds values in MMC and LM.

			MilanMC	**Lyon M**
Std deviations	threshold	**WI class**	Index Values	Index Values
-2 to -1	-2	*No walkable*	-8.92	-6.83
-1 to 0	-1	*Low*	-8.39	-6.38
0 to 1	0	*M.-Low*	-4.81	-3.29
1 to 2	1	*M.-High*	-1.23	-0.2
2 to 3	2	*High*	2.35	2.89

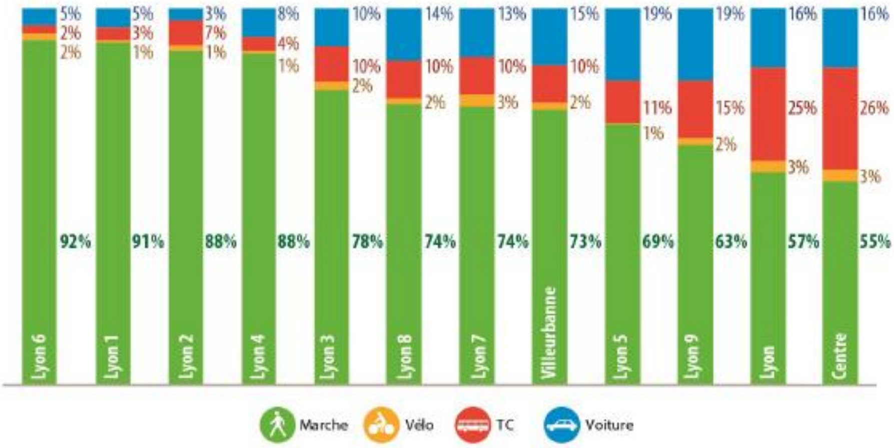
A similar result can be found also when analyzing the population distribution inside the various areas according to their walkability class belonging (Tab. 36): areas with a medium-high/high level of walkability include almost the half of the overall population in both contexts, with Milan showing a slightly better condition (4 percentage points more) than Lyon (59% vs 45%). Again, if we consider as thresholds the ones defined for Milan, we see that the situation is inverted: Lyon records 44% of residents (545 157 inhabitants) in medium-high WI areas, and 20% in High WI ones (255 661 inhabitants), overpassing Milan.

Tab. 36 – Population distribution among the different walkability classes in MMC and LM case studies.

					Population distribution			
			MilanMC	**Lyon M**	**MilanMC**		**Lyon M**	
Std deviations	threshold	WI class	Index Values	Index Values	population	%	population	%
-2 to -1	-2	*Not walkable*	-8.92	-6.83	7 418	0.2%	1 518	0.1%
-1 to 0	-1	*Low*	-8.39	-6.38	56 994	1.9%	100 875	8.1%
0 to 1	0	*M.-Low*	-4.81	-3.29	1 182 389	39.0%	574 415	45.9%
1 to 2	1	*M.-High*	-1.23	-0.2	1 225 545	40.4%	357 822	28.6%
2 and >	2	*High*	2.35	2.89	559 658	18.4%	215 715	17.2%
					3 032 004		1 250 345	

In terms of territorial distribution of walkability a general prevailing direct relation is found between centrality of places and their level of walkability. This is an expected result, already highlighted by previous research (Naess et al., 2004; Haugen, 2011). As stressed by Lyon Agence d'Urbanisme (2016), looking at the mobility behaviours statistics allow to confirm such a result (Graph 14): the 80% of the overall LM mobility is concentrated in Lyon and Villeurbanne municipalities, and only 16% of them are done by car (In Villeurbanne walking amounts to 73% of the all internal movements). This is due greatly to the higher density of opportunities located in these areas and the easiness of reaching them, to their accessibility.

Graph 14 – Modal share of the travels internal to the municipality or arrondissement of belonging, Lyon and Villeurbanne (2015)



Source: *Marce e déplacements de proximité*, Observatoire parternarial Déplacements, Agence d'Urbanisme de Lyon, n.12, December 2016, p.5

A visual comparison between two specific cases in both study areas can confirm such a result (see next paragraphs). We will focuses on 2 different kind of contexts in each study area, in order to highlight the existence of various situations when centrality and walkability are analysed together:

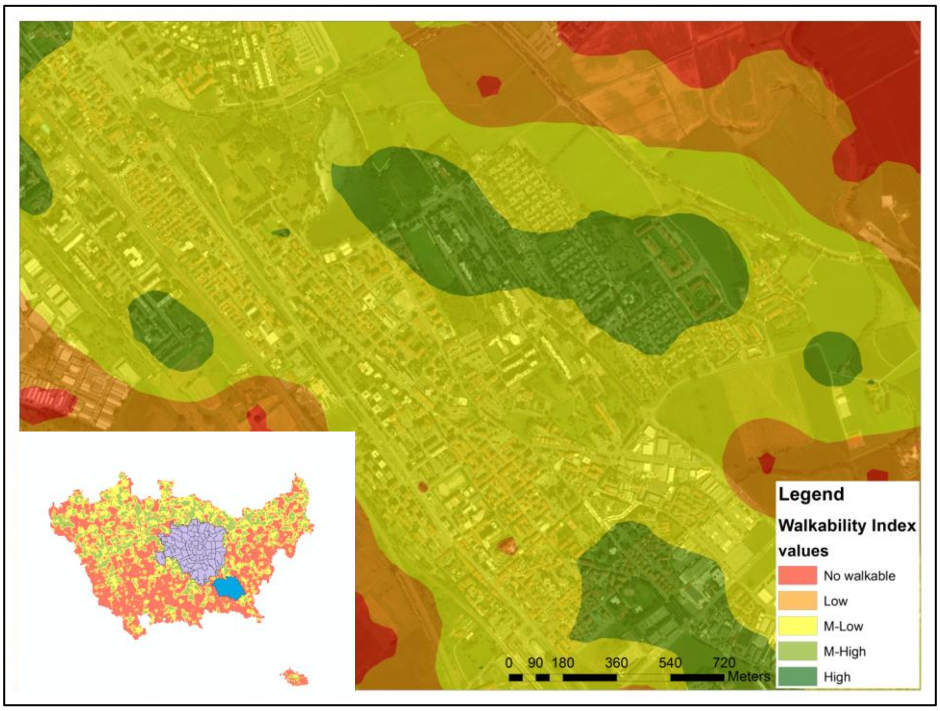
- A low walkability area in a peripheral zone
- A high walkability area in a central zone

Our analysis will be mainly visual, but useful to stress some examples of potential scenarios that populate the metropolitan realm.

8.3.3 Milan Metropolitan City

For MMC we focused first on a peripheral municipality, San Giuliano Milanese (Fig. 69), strictly integrated into the Milan hinterland, and also part of the group of centers constituting the PIM Milano, the association of Milanese area municipalities cooperating in planning and services development. As can be seen from the image in the area there are just few spots of medium-high level of walkability, corresponding to greener spaces and a wider variety of land uses, while the overall territory is covered by Medium-low level areas, since more strictly residential.

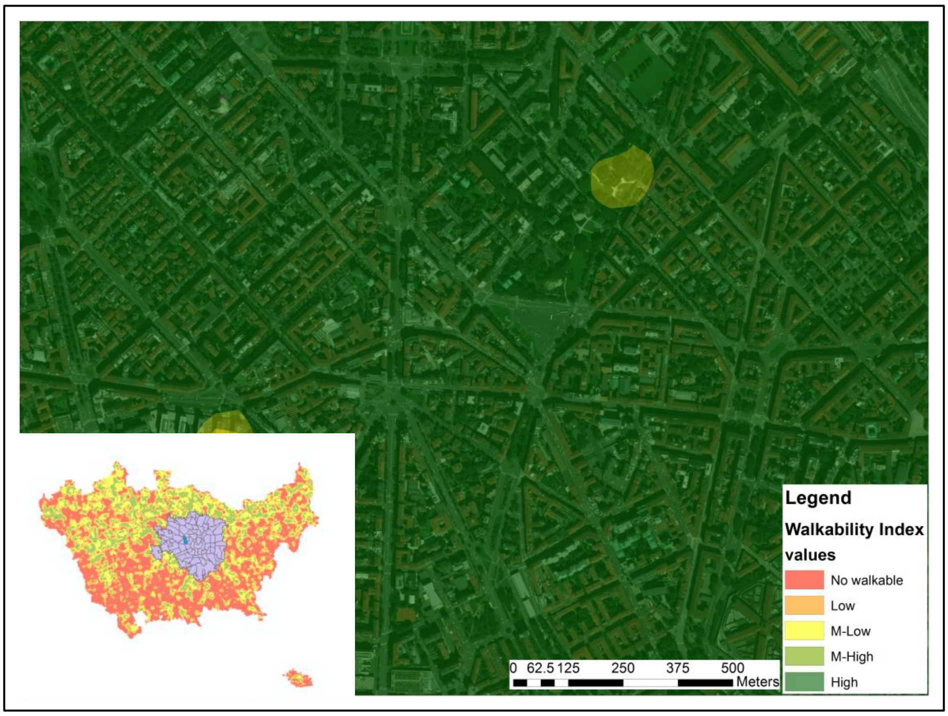
Fig. 69 –San Giuliano Milanese area zoom (MMC): low walkability in peripheral area example.



Source: our elaboration on Istat, DUSAF, Landsat and OSM data.

On the contrary a focus on the central zone of De Angeli (NIL n. 58), in the city center of Milan show a different situation, where an homogeneous surface of high walkability is present (Fig. 70), due to the high levels of all the dimensions composing the index (not the highest for greenness and Land Use Mix actually, but still in the highest classes of the distribution, anyway compensated by the very high concentration of amenities, population and connectivity).

Fig. 70 – De Angeli area zoom (MMC): high walkability in central area example.



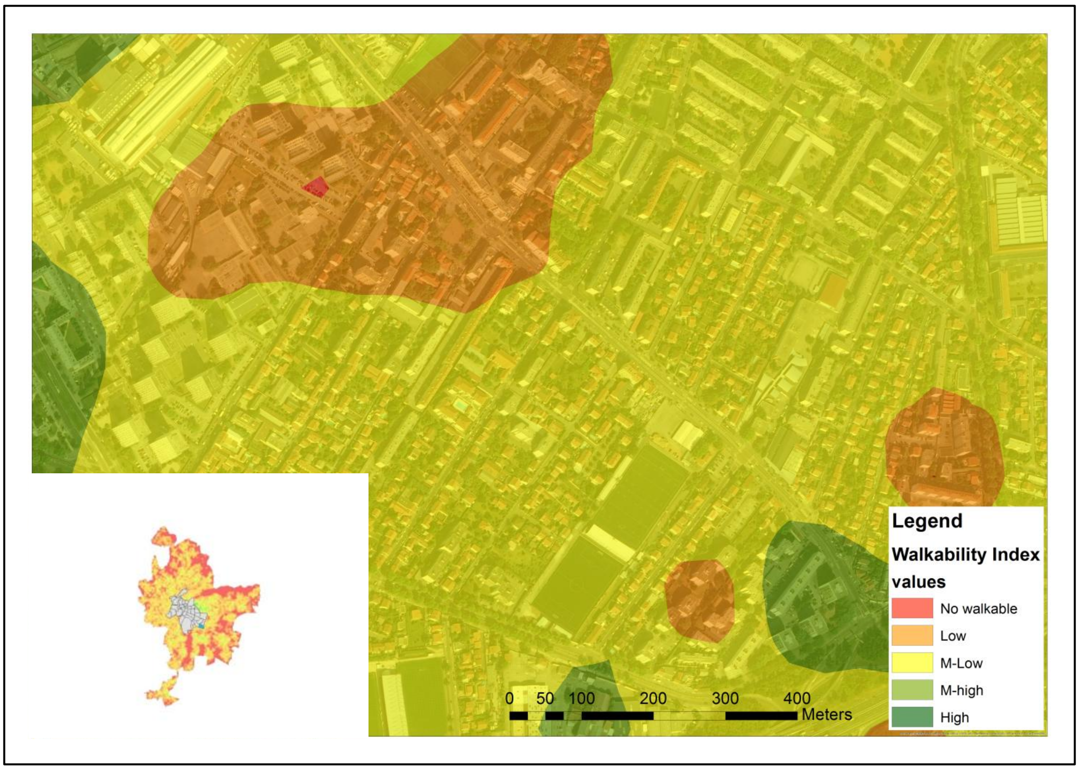
Source: our elaboration on Istat, DUSAF, Landsat and OSM data.

8.3.4 Lyon Metropolis

The same tendency can be found also for the Lyon case study: two areas are here showed, *La Plaine* - *Santy* (Lyon-8eme arrondissement) and the central area of *Voltaire-Part Dieu* (Lyon - 3eme arrondissement).

In the first case we can see an area with a low density of population, followed by a even lower presence of amenities and Land Use Mix. The only dimension with a medium-high degree of concentration is the Greenness, not able alone to compensate for the lack of the other components. For this reason the level of walkability is mainly low or medium-low, without relevant spots of high walkable zones (Fig. 71).

Fig. 71 – La Plaine-Santy area zoom (LM): Low walkability in peripheral area example.



Source: our elaboration on INSEE, SIRENE, Corine, Landsat and OSM data.

In the Voltaire-PartDieu area, on the contrary an high land use mix and amenities concentration create an environment more suitable for pedestrians[85]. Also Connectivity and population density are higher than the average in the rest of the Lyon Metropolis territory, while greenness records a partially lower degree. In fact walkability levels are very high, showing the existence of only a portion of the area (east part) with a medium-high degree. Spots of medium-low walkability are also recorded (Fig. 72).

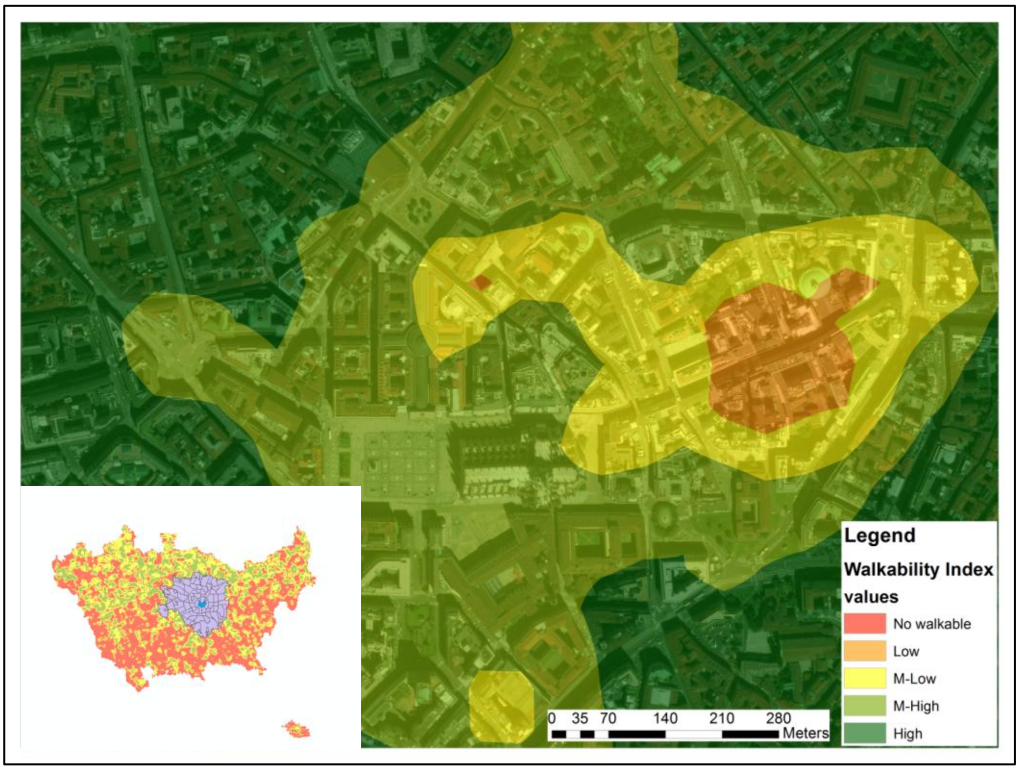
[85] Since data are referred to 2011 or 2012, the nowadays existing commercial area of Part Dieu has not been detected by the measure, and its impact could be today quite different in terms of walkability of the zone.

Fig. 72 – Voltaire-Part Dieu area zoom (LM): high walkability in central area example.

Source: our elaboration on INSEE, SIRENE, Corine, Landsat and OSM data.

Not all the contexts anyway follow the same general tendency: in some cases in fact even if in central urban areas, low levels of walkability can be detected. This is the case of a portion (North-East) of San Babila-Duomo zone for example in Milan, area of high level services, one of the most affluent zones of the city, where important firms have their offices. A low level of resident population density and greenness is accompanied by a lower, if compared with the close surrounding areas, degree of connectivity and Land Use Mix. This is due to the potential mono-functional nature of that area, principally served by tourist activities or business offices, and lacking daily life services and residences.
It creates a situation similar (in terms of walkability levels) to the already showed San Giuliano one, but due to completely different reasons. In both cases anyway a lower level of urbanity, if adopting our theoretical view, is found (Fig. 73).

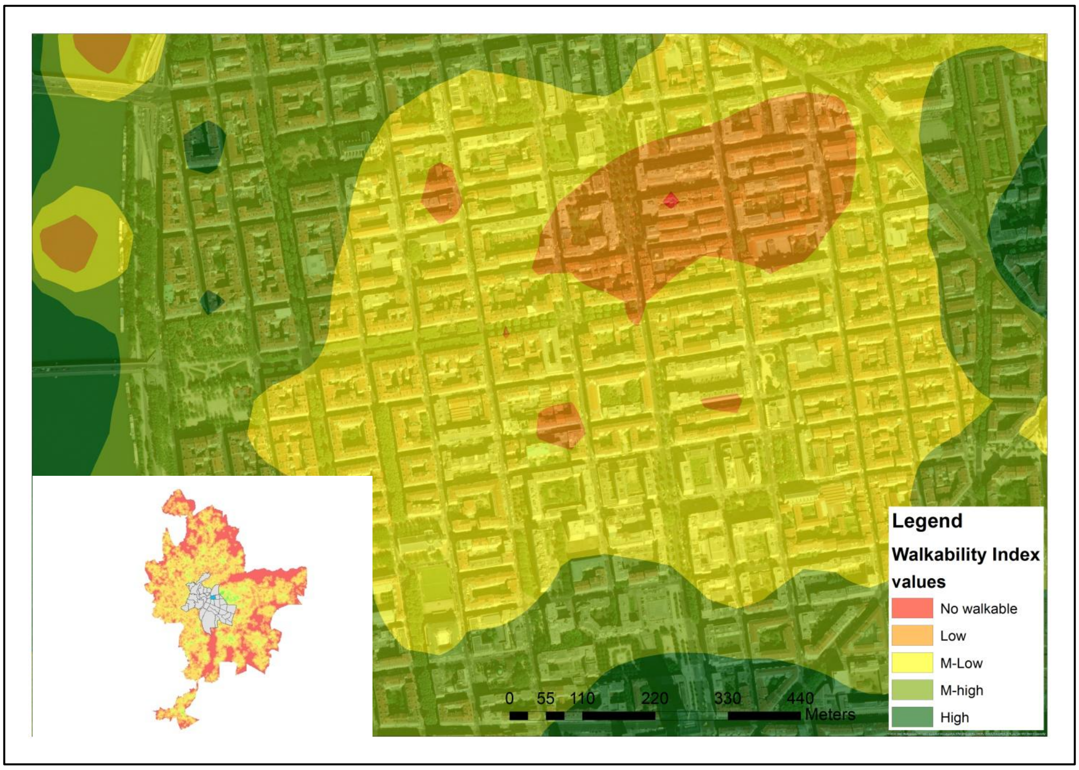
Fig. 73 – San Babila-Duomo area zoom (MMC): low walkability example in central urban zone.



Source: our elaboration on Istat, DUSAF, Landsat and OSM data.

The zone at the crossroads of *Saxe-Roosvelt* (Lyon - 6eme arrondissement)/*Parc Duquesne*/*Brotteaux* represents a similar case than San Babila in Milan: located in the center of Lyon city, it is characterized by a prevalent residential monofunctional zone, with a spot of low density of population, connectivity and amenities in the north-east part of the area, where wider built up blocks are concentrated. The area is surrounded by high values of walkability, and represents a kind of low walkable enclave in a apparently highly pedestrian friendly environment (Fig. 74).

Fig. 74 - Saxe-Roosvelt/Parc Duquesne/Brotteaux (LM): low walkability example in central urban zone.



Source: our elaboration on INSEE, SIRENE, Corine, Landsat and OSM data.

8.3.5 Walkability and socio-demographic characteristics of the territory

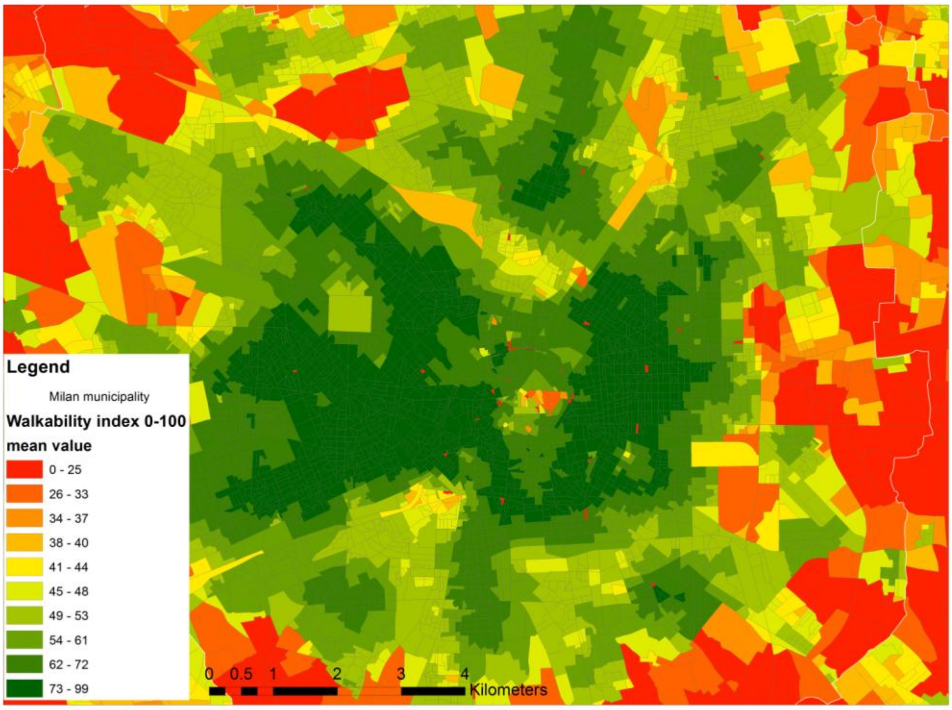
Walkability is recognized as a potential tool for quality of life measure (frank et al., 2007; 2009; Rogers et al. 2011) since it allows to describe environmental characteristics able to enhance active behaviour and so improve individual health condition, social relationships, and to reduce environmental pollution, through the reduction of motor vehicles use. We already analysed these aspects in Chapter 3, in which we also focused on the potential role of walkability in lowering social issue linked to mobility strategies: environments suitable for soft mobility (that is also strictly correlated with transit mobility) can at least partially free people from the costs of private vehicles-based travels, providing more opportunities reachable without the use of private means of transport.

It can act as a factor reducing social vulnerability in particular in contexts already marked by social weaknesses elements. In this sense an analysis of correlation between socio-demographic characteristics and walkability could highlight virtuous or negative situations in the two contexts.

Since our walkability index has not been computed on an administrative territorial unit our purpose is to attribute it to the smallest territorial unit possible in order to be able to correlate it with the sociodemo indicators available at that scale. In the case of Milan we worked on the Census tract level, in the Lyon case on the IRIS level (Fig. 75 and Fig. 76).

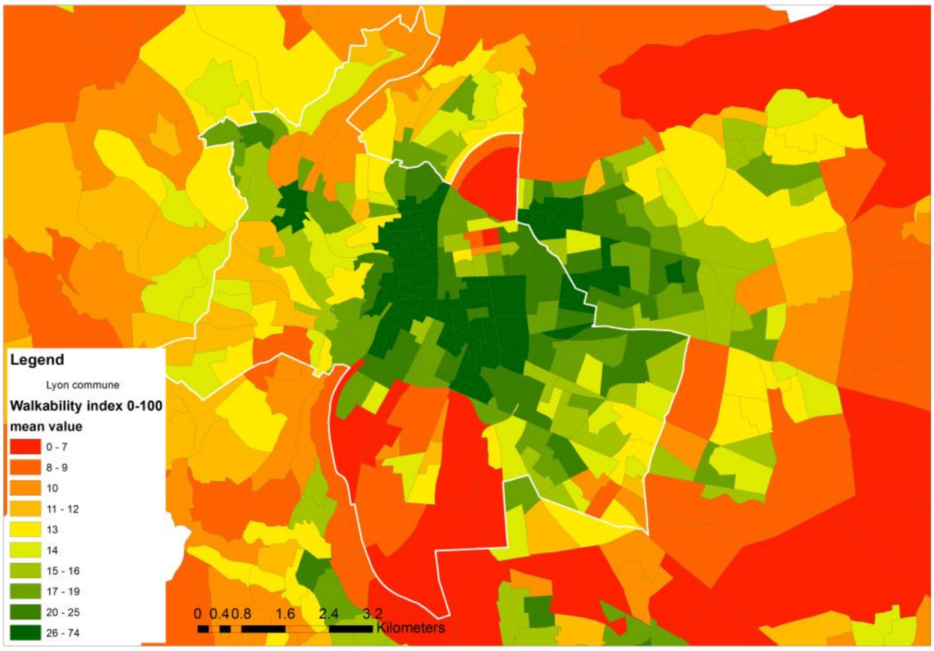
In both cases we computed for each territorial unit of analysis the average value of the walkability index, that we transformed into a scale from 0 to 100 in order to make differences in values more immediately understandable.

Fig. 75 – Walkability index (average value on a 0 to 100 scale) distribution among the census tracts. Focus on the center of Milan city.



Source: our elaboration on Istat, DUSAF, Landsat and OSM data.

Fig. 76 - Walkability index (average value on a 0 to 100 scale) distribution among the IRIS. Focus on Lyon city.



Source: our elaboration on INSEE, SIRENE, Corine, Landsat and OSM data.

The indicators available among socio-demographic variables have been chosen in order to be comparable in the two cases, even if in the Lyon case more properties could be considered due to higher richness in data availability.

	indicator	property
1	Dependence Index	Vulnerability of the resident population
2	High education	High status population
3	Low Education	low status population
4	Unemployed	Vulnerability of the resident population
5	Commuters	Check for availability of opportunities
6	Foreigners	Vulnerability of the resident population

We computed a simple correlation (p value) between the Walkability Index and the indicators selected, in order to find the direction of proportionality existing (Tab. 37).

Tab. 37 – Correlation values between walkability index and the socio-demographic indicators selected. Milan Metropolitan City and Lyon Metropolis comparison.

	correlation with walkability index (p value)	
	milan	*lyon*
Dependence index	0.027**	-0.492**
High education	0.553**	0.412**
Low education	-0.442**	-0.382**
unemployed	-0.004	0.174**
commuters	-0.561**	-0.528**
foreigners	0.035**	0.096

Note: ** correlation significant for 0.01 (two tails)

The two contexts show a similar relationship structure between walkability and sociodemographic characteristics of the population, at least for some of them.
In general seems that places with a higher level of walkability shows also a higher percentage of highly educated people, proposing a direct proportionality between this variable, approximating social status, and walkability of the neighbourhood. The relation is stronger in the MMC area, and the datum is confirmed also from the analysis of low education population percentage, showing, as expected an opposite relation.
The dependence index shows a significant negative relation with walkability in Lyon, while almost not existent in Milan, expressing that areas with a higher presence of young children and elders are also characterized by a low degree of

walkability. This could be due to the higher presence of young families with children, that are usually located not in central areas (but suburban or periurban), usually less walkable. Data confirm such a deduction, looking at other socio-demographic indicators. If we consider the number of family components in families and of children in particular (in the Milan case) and the number of families with children in the French case we see that the correlation is negative for all the indicators (Tab. 38).

Tab. 38 - Correlation values between walkability index and families with more than 2 components and number of children (MMC) and number of families with children (Lyon Metropolis)

	Milan		Lyon
	Families with more than 2 components	**Number of children (age < 18yo)**	**Number of families with children**
Walkability Index	-0.309**	-0.063**	-0.415**

Note: ** correlation significant for 0.01 (two tails)

The rate of unemployed is positively, even if not strongly, correlated with walkability in Lyon, while not significantly in Milan, highlighting in this sense a positive factor contrasting potential vulnerability of this particular kind of population. Mobility access through alternative means then the private motor vehicle is in fact improved by living in a walkable environment, where access to amenities and public or non-motorised means of transport is higher.

As expected the rate of commuters is negatively correlated with walkability, stressing the relation between walkability and mobility behaviours.

As a last indicator, the presence of foreigners, usually considered as a more vulnerable population, is not significantly related with walkability, not showing a concentration of that peculiar population in walkable or not walkable spaces.

8.3.1.1. A focus on Lyon case

The higher availability of data at the IRIS level (compared to the census tracts in the Milanese case study) made possible to analyse better some social dimensions and their correlation with walkability.

About the social status we see that a strong relation between high status-families and walkability is recorded by dataTab. 39). If we look at the occupational position of people (adopted here as a proxy of their social status), we can see that in general the status is correlated with the walkability of the residential area: even if not very high the *p value* records a positive relation for intellectual profession occupied individual, while it decreases going down into the hierarchical scale[86].

[86] French occupational position classification is actually wider, and consist in 8 classes: (1) Agriculteur exploitant, (2) Artisan, Commerçant, Chef dxentreprise, (3) Cadre ou exerce une Profession intellectuelle supérieure, (4) Profession intermédiaire, (5) Employé, (6) Ouvrier, (7) Retraité, (8) Autre sans activité professionnelle. Due to the closeness in characteristics we merged

Seems that a higher concentration of high status residents can be accompanied by a more walkable environment (for the concentration of both high walkable and status individuals in the more central zones).
A confirmation is given by the analysis of a similar indicator, focusing on the while family condition (

Tab. 40). The variable adopted is the "professional position of the reference person in the household", indicating the status of the oldest man of active person in the household[87]. It is clearly a proxy of the general status of the family. From data we see that the highest level of walkability are correlated with households whose reference person is employed in intellectual professions or has a head position, where negative relation is between walkability and lower household statuses. An exemption is represented by Employees households-Reference-Person, showing a *p value* very close to the intellectual profession one. In this case the variability of household composition can work changing the relation existing at the individual level, increasing its positivity.

Tab. 39 - Correlation values between walkability index and people occupational position (Lyon Metropolis)

Indicator	p value
Intellectual profession or head	0.326**
Wide intermediate occupational position	0.007
employees	-0.183**
workers	-0.261**

Tab. 40 - Correlation values between walkability index and household's reference peron's occupational position (Lyon Metropolis)

Indicator	p value
Intellectual professions HRP	0.278**
Intermediate professions HRP	0.046
Employees HRP	0.233**
Workers HRP	-0.245**

togheter classes 1, 2 and 4 into a wide intermediate working position, while keeping all the others separated.

[87] La personne de référence du ménage est déterminée à partir de la structure familiale du ménage et des caractéristiques des individus qui le composent. Il s'agit le plus souvent de la personne de référence de la famille quand il y en a une, ou de l'homme le plus âgé, en donnant priorité à l'actif le plus âgé (INSEE definitions online: https://www.insee.fr/fr/metadonnees/definition/c1192) 26/11/2017

A confirmation of the goodness of walkability measure so computed is given by the analysis of relation between the index and the principal kind of transport mean used to reach the workplace: walking and public transport have the highest correlations, exactly the opposite of car (Tab. 41). Two-wheels means show an ambiguous pattern, since they include most probably motorbikes, but anyway are strongly related with walkability. The datum is confirmed by the information about the presence of cars in the household: the higher the presence families without a car the higher (and positive) the correlation with walkability (p= 0.424**), while the opposite is found for families with two cars or more (p= -0.589**).

Tab. 41 - Correlation values between walkability index and people means of transport to workplace (Lyon Metropolis)

Indicator	p value
none	0.071
walking	0.657**
2 wheels	0.542**
car	-0.732**
Public Transport	0.634**

8.3.6 Do disadvantaged zones in terms of walkability and social vulnerability concentration exist?

As already stated, the presence of a low level of walkability if combined with a socially vulnerable population can produce further deprivation and vulnerability in local areas. In order to check for the existence of this kind of situations in the two study contexts we will analyse the co-presence of low walkability and social vulnerability concentrations in the MMC and LM through the adoption of a peculiar ArcGis statistical tool. The application of the Moran I statistics[88] for autocorrelation analysis of the walkability index among the Census Tracts and IRIS allowed to highlight spatial concentration of zones with high level of walkability. The same model has been applied on a vulnerability index built running a factor analysis on two (three for the French case) indicators we considered as potential proxies for social vulnerability: Rate of unemployed and rate of low educated people, and families with worker as reference person (this last variable only for Lyon case). The choice has been forced to the data

[88] The tool used is the Cluster and Outlier Analysis, with a fixed distance computation criterion, see for further details the ESRI website: http://desktop.arcgis.com/en/arcmap/10.3/tools/spatial-statistics-toolbox/h-how-cluster-and-outlier-analysis-anselin-local-m.htm (25/11/2017)

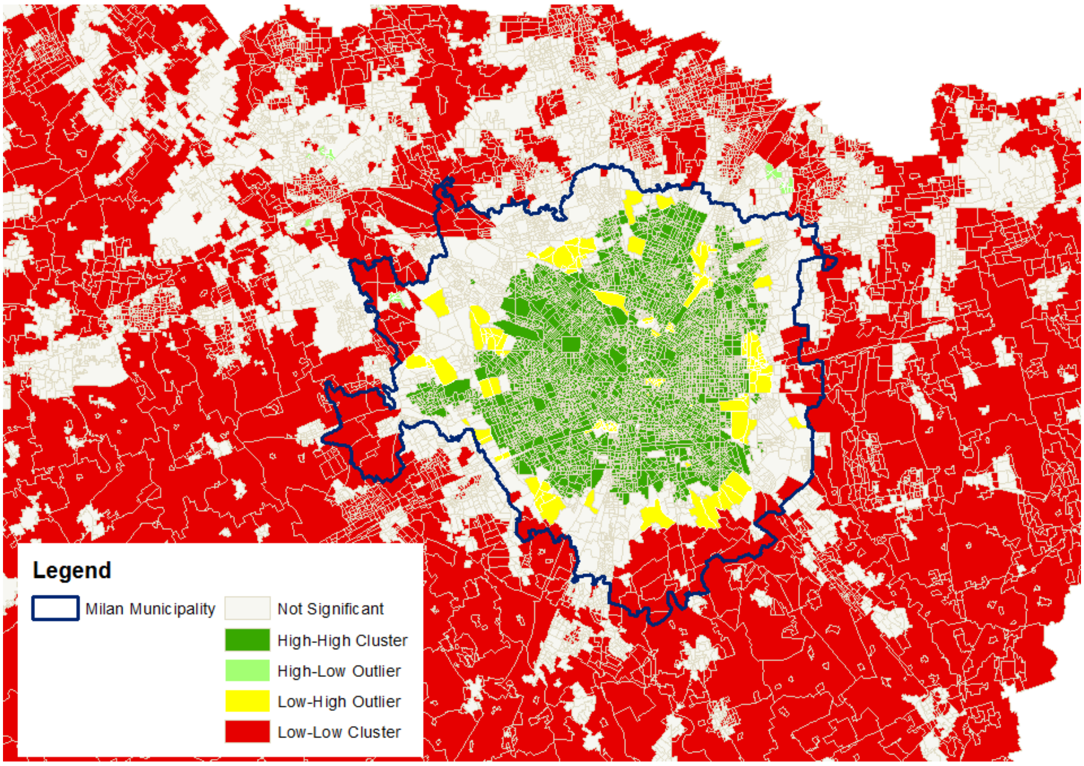
availability, and is clearly just a proxy of the potential social deprivation status, inspired by an analogous index computed in Daconto (2017).
The vulnerability index computed in the Lyon case has a 76% of variance explained, even if the KMO and Bartlett statistics are not actually satisfying, and a lower 58% of variance explained in the Milanese case (KMO and Bartlett statistics as well are not completely satisfying[89]).

8.3.6.1 Milan Metropolitan City disadvantaged zones

In terms of walkability the only significant high values clusters of census tracts are found in the internal area of Milan municipality, while all the other contexts present a low walkability clustering tendency (Fig. 77). This is due to the strength in terms of walkability of the city of Milan, and the divide existent between its territory and the other areas of the MMC, making it emerges as a compact spot of high values.
Different is the picture given by the clustering of the vulnerability index, that records concentration of high vulnerability contexts generally at the periphery of Milan, and in the outer areas (Fig. 78). If we select all the tracts classified both as parts of a low walkability and a high vulnerability cluster we highlight those contexts recording a probable worse living condition (Fig. 79).

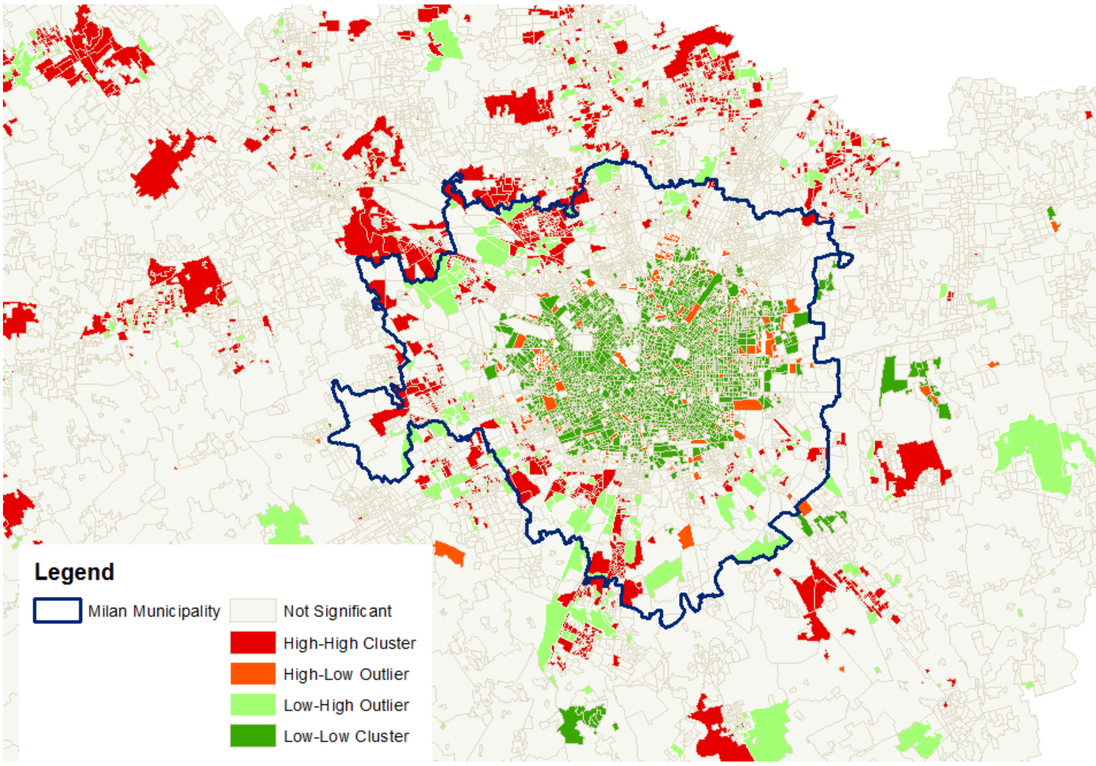
[89] Milan: KMO=0.500, Bartlett sig.=0.000; Lyon: KMO=0.583, Bartlett sig.=0.000. KMO should be >0.6 or >0.7. The combination with other possible indicators were considered but the KMO values did not improve.

Fig. 77 – Walkability index clustering output after the computation of the Moran I statistics on census tracts in MMC.



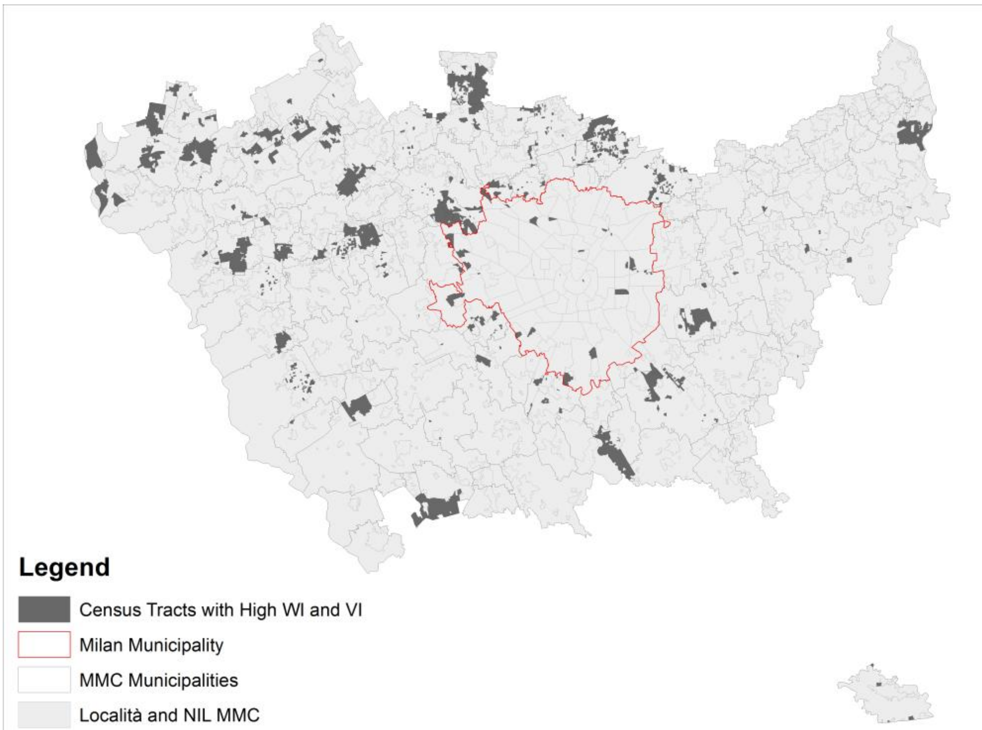
Source: Our elaboration on Istat, DUSAF, Landsat and OSM data.

Fig. 78 - Vulnerability index clustering output after the computation of the Moran I statistics on census tracts.



Source: Our elaboration on Istat, DUSAF, Landsat and OSM data.

Fig. 79 – Census tracts classified as *disadvantaged* (codified both into a high walkability cluster or as a high walkability outlier and into a high vulnerability cluster or as a high vulnerability outlier).



Source: Our elaboration on Istat, DUSAF, Landsat and OSM data.

Among the Milan MC municipalities (134) 14 have at least the 30% of surface covered by areas that we could classify as *disadvantaged* (included in a cluster or being an outlier with low walkability and high vulnerability). Some of them records even half or more of the surface in this condition: Cesate,Vanzaghello, Zelo Surrigone, Pero.

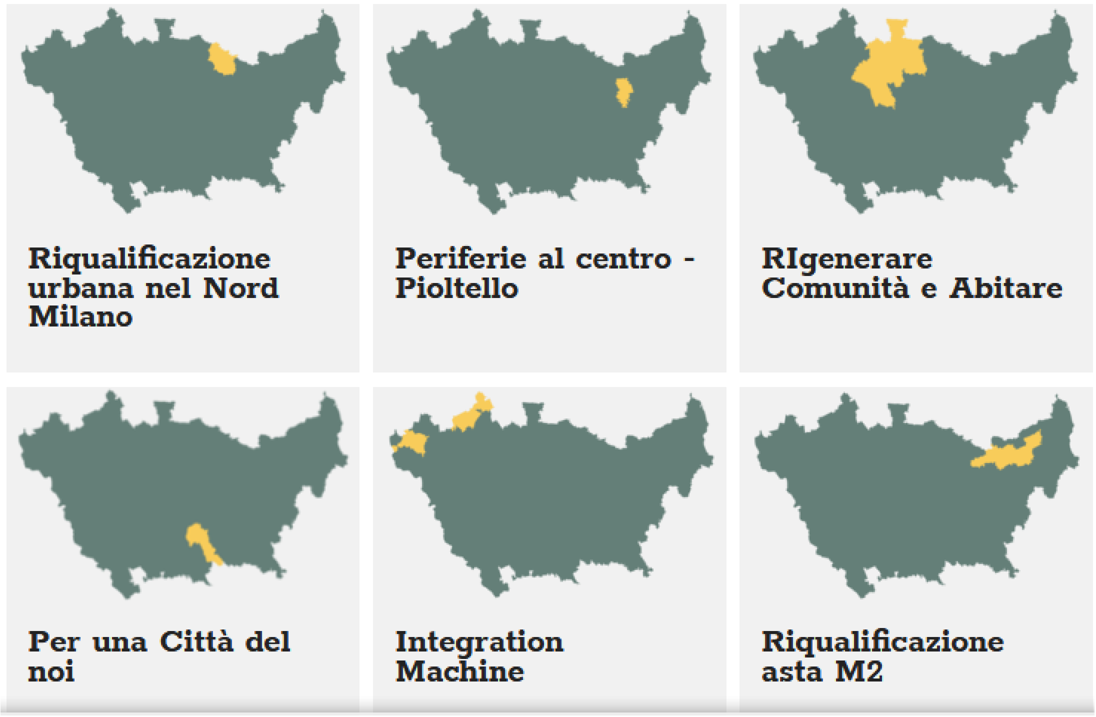
The population living in disadvantaged census tracts amounts in 2011 to 121 688 people, the 4% of the overall MMC inhabitants, and the 16% of the population living in low walkable areas and the 31% of those living in vulnerable zones (Tab. 42).

Tab. 42 – Percentage of disadvantaged population in the low WI, high VI tracts and in the overall MMC.

	Population disadvantaged tracts	**Population low WI tracts**	**Population high VI tracts**	**MMC Population**
n.	121 688	748 869 (25% of the MMC)	392 088 (13% of the MMC)	3 038 420
% of dis. pop.	100%	16.2%	31.0%	4.0%

Among the *disadvantaged* municipalities some have been included into a recently developed plan for urban regeneration managed and coordinated by the Milan Metropolitan City and co-financed by the Central State, called "*Welfare metropolitano e rigenerazione urbana. Superare le emergenze e costruire nuovi spazi di coesione e di accoglienza*"[90]. The plan identifies different zones needing specific policies implementation addressed to face issues of weak populations and to regenerate abandoned public structures in order to create new public services provision spaces. The overall objective is to build new residential strategies inscribed into a system of services narrowed on social cohesion promotion, managed by a network of municipalities taking part to the plan itself. The plan is articulated into 6 different sub-projects, addressed to different sensitive zones: North Milan (*Riqualificazione Urbana del NM*), Martesana-Adda area (*Periferie al Centro*), North-West (*RIgenerare Comunità e Abitare*), South-West (*Per una Città del noi*), Alto Milanese (*Integration Machine*), Martesana-Adda area (*Riqualificazione asta M2*).

Fig. 80 – *Welfare Metropolitano* project's plans.



Source: Città Metropolitana di Milano website
(http://www.cittametropolitana.mi.it/welfare_metropolitano/welfare_metropolitano.html 26/11/2017)

[90] Metropolitan welfare and Urban regeneration. Overtake the emergences and build new spaces of cohesion and inclusion (our translation).

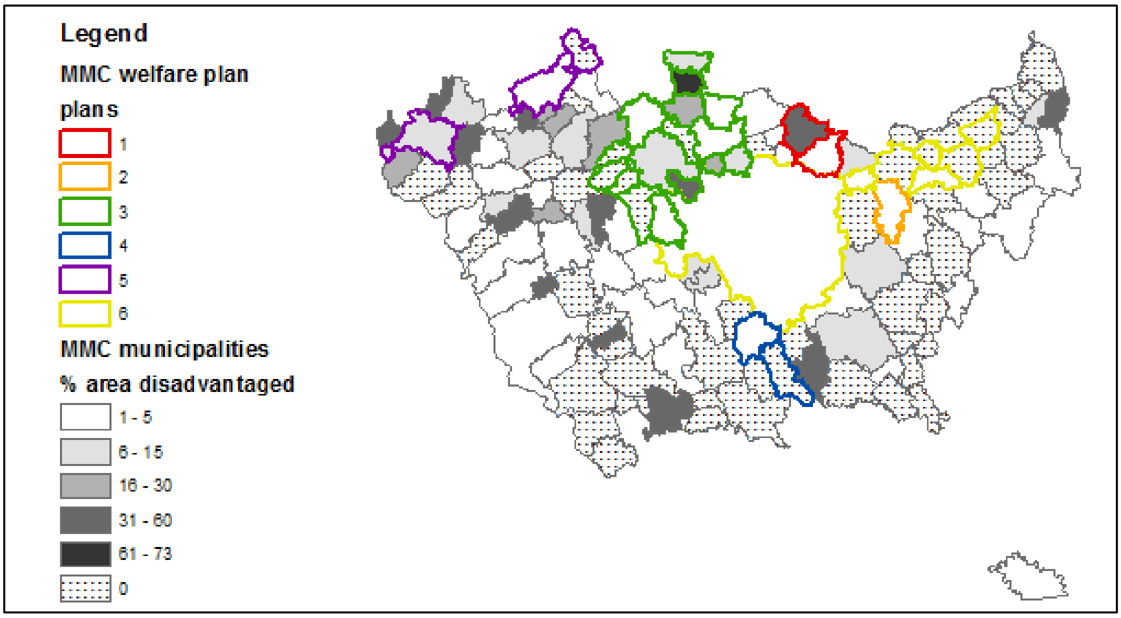
Among the MMC municipalities 3 of the ones recording a share of at least 30% of disadvantaged areas in their territory, are included into the metropolitan plan. If for two of them the population residing in these areas is wide (more than 1/3 of municipality inhabitants), for Pero it amounts just to 3% (Tab. 43).

Tab. 43 – MMC municipalities with more than 30% of the territory classified as disadvantaged engaged into the Metropolitan Welfare project.

municipality	**% disadvantaged areas**	**% population living in disadvantaged areas**	**Plan**
Cesate	73%	35%	RIgenerare Comunità e Abitare
Pero	50%	3%	RIgenerare Comunità e Abitare
Cinisello Balsamo	32%	37%	Riqualificazione Urbana nel Nord Milano

Note: Cesate (pop. 2011=13.858), Pero (pop. 2011=10.291), Cinisello Balsamo (pop. 2011=71.128).

Fig. 81 – MMC municipalities rate of disadvantaged areas concentration and welfare plans territorial coverage.



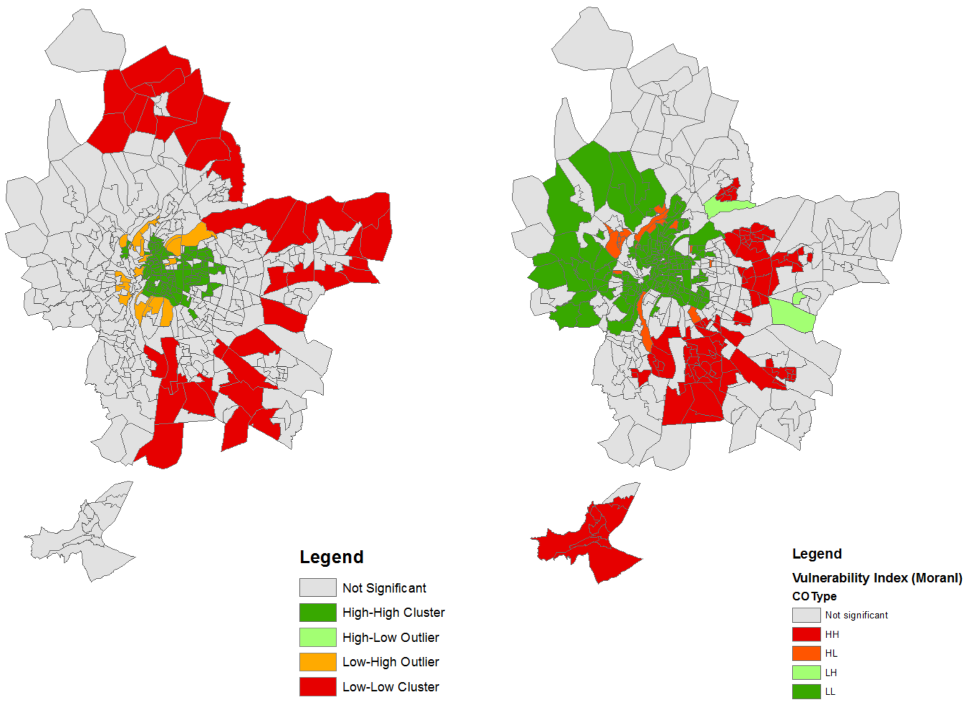
Notes: MMC welfare plans 1. Riqualificazione Urbana del NM; 2. Periferie al Centro; 3. RIgenerare Comunità e Abitare; 4. Per una Città del noi; 5. Integration Machine; 6. Riqualificazione asta M2

8.3.6.2 Lyon Metropolis disadvantaged zones

The computation of the Moran I statistics on the Lyon Metropolis area confirmed, as well as happened for Milan, the existence of a high walkability cluster in the center of the metropolis (Fig.82), while lower values are found in the outer zones.

In particular significant clusters concentrate in the eastern iris, while low walkability zones surrounded by high walkability ones are located in a radial pattern in the north, West and south part of the high walkable metropolitan center. What is more interesting here is the picture described by our vulnerability proxy, stressing the presence of high vulnerability areas in the south, and east parts of the Metropolis (zones of residential expansion). Some IRIS with a high level of vulnerability are also found in the more central zones, constituting outliers in the area.

Fig.82 - Walkability index (left) and Vulnerability index (right) clustering outputs after the computation of the Moran I statistics on LM IRIS.

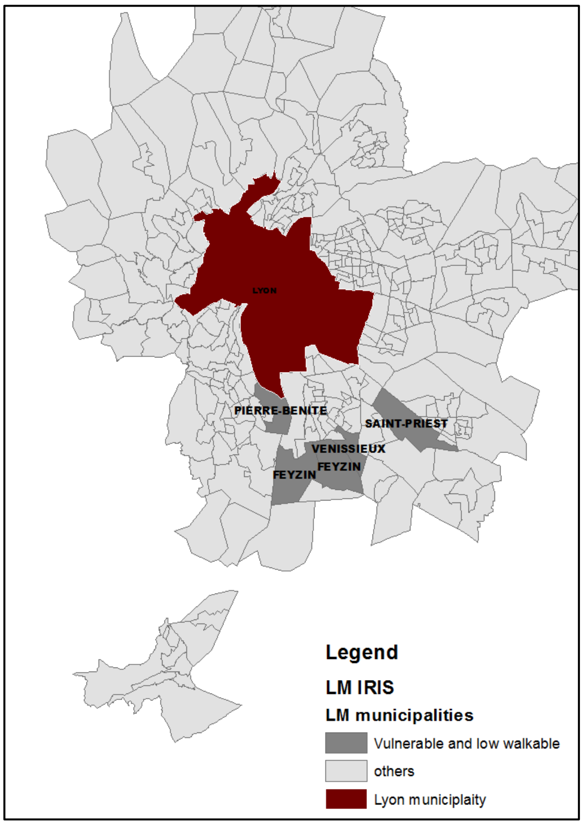


Source: our elaboration on INSEE, SIRENE, Corine, Landsat and OSM data.

At a first sight seems not to be a strong overlap between low walkability and high vulnerability, but some iris in the south portion of Lyon Metropolis record a high level of disadvantage: these are included generally in municipalities with an overall high level of walkability (and, as a consequence, an high proportion of pedestrian internal mobility as shown by Lyon Agence d'Urbanisme, Graph 15) , but presenting a part of their surface less walkable or not walkable (

Fig. 84). The list includes: Pierre Benite (in particular a productive area of its territory), Saint-fons (the *Clochette-Sud* area), Feyzin (*Les Razes* and *Geraniums* areas), Venissiuex (the *Henri-Wallon* area) and Saint Priest (the *Cite-Berliet-Gare* area) (Fig. 83).

Fig. 83 – LM IRIS classified as disadvantaged areas.



Source: our elaboration on INSEE, SIRENE, Corine, Landsat and OSM data.

The population living in these contexts seems to be smaller than in the Milan case, both in absolute and in percentage value (Tab. 44), as well as for the all other proportions (only the percentage of population living in vulnerable areas records a value almost double than MMC one, 24% vs 13%).

Tab. 44 - Percentage of disadvantaged population in the low WI, high VI IRIS and in the overall LM.

	Population disadvantaged IRIS	**Population low WI IRIS**	**Population high VI IRIS**	**LM Population**
n.	15 028	117 569 (9% of the LM)	307 983 (24% of the LM)	1 306 972
% of dis. pop.	100%	12.8%	4.9%	1.1%

In general the portion of the inhabitanst of these municipalities living in disadvantaged areas is lower than the 10%, excepted for Saint-Fons (13.5%) and, much higher, Feyzin, where more than the 77% of the population lives in a disadvantaged IRIS (

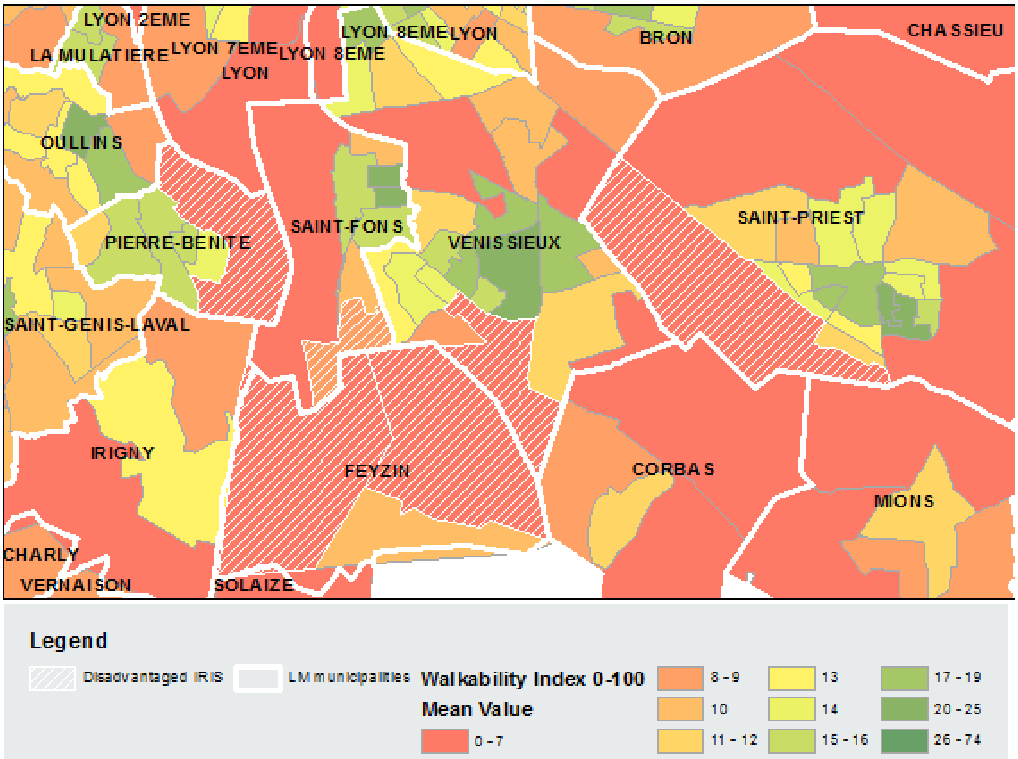
Tab. 45).

Tab. 45 - Percentage of disadvantaged population in the municipalities hosting disadvantaged areas.

Municipality	Population in disadvantaged IRIS	Municipality Population	% Population disadvantaged
Pierre Benite	90	1 011	8.9%
Saint-fons	2 292	17 032	13.5%
Feyzin	7 205	9 333	77.2%
Venissiuex	2 391	60 159	4.0%
Saint Priest	3 050	42 535	7.2%
Total	**15 028**	**130 070**	**11.6%**

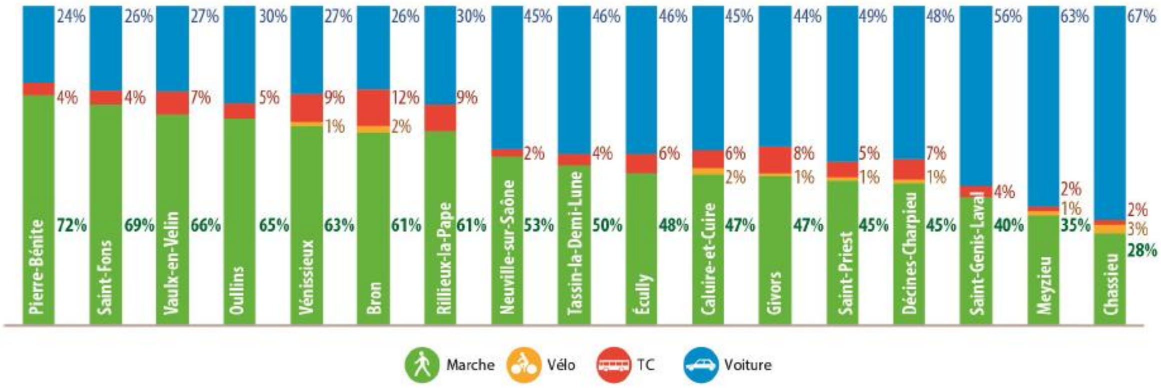
Source: our elaboration on INSEE data

Fig. 84 – Walkability index distribution in the municipalities hosting disadvantaged areas (IRIS), south part of LM.



Source: our elaboration on INSEE, SIRENE, Corine, Landsat and OSM data.

Graph 15 - Mobility modal share, travels inside the municipality of residence (municipalities of the Lyon SCOT, Lyon excluded).



Source: *Marce e déplacements de proximité*, Observatoire parternarial Déplacements, Agence d'Urbanisme de Lyon, n.12, December 2016, p.7.

The condition of these areas is also worsened considering that they include an high proportion of children (0 to 14 years), whose mobility opportunities are limited by the age to walking and public transport. The computation of a MoranI statistics highlights such an issue: Feyzin (Les Rozes and Geraniums areas), Venissiuex (the Henri-Wallon area, to which Cobras-St.Priest is added in this case) and Saint Priest (the Cite-Berliet-Gare area) are included among the clusters of IRIS with high presence of children and a low level of walkability.
The same cannot be said for elders, since the highest concentrations are located in the north-west part of the Lyon Metropole. The areas with highest concentration of elders and lowest of walkability are not fortunately in these cases also included among the disadvantaged zones: Lyon 4eme Arrondissement (Plage-Ypres and St.Exupery-Popy) and Meyzieu (Les Marais and Les Gaulnes).

Some of these areas we classified as disadvantaged are actually included in the local Contrat de Ville (2015-2020), the Chart thorugh which the Lyonnaise Politique de Ville (policy implementation of the city) is officially presented and explained, and in which all the objectives of the local authority policies are enlisted.
With the *Contrats Urbains de Cohésion Sociale* (CUCS), partnerships between central State, Local Authority and associations and private actors have been put into practice from 2007, in order to manage the improvement of lagging zones of the city, adapting policies to the local specific issues (*Contrat de Ville*). Of course the *Contrat de Ville* is not limited to the disadvantaged areas, but priority is given to them. For this reason CUCS (until their transformation into QPV, *Quartiers prioritaires de la Politique de la Ville*[91]) were classified according to the priority

91 Two criteria are adopted for the definition of the Quartiers Prioritaires (QPV) : 1) the presence of more than 1 000 inhabitants; 2) A median income equal or lower than the threshold of 11 900 €/year/for Consumption Unit (Unité de Consommation) for the Lyon Metropolis.

degree they have (priority 1,2 or 3), based on the degree of vulnerability characterising them (in terms of unemployment rate, housing issues, safety,...).
Nowadays in the areas we defined as disadvantaged are included some neighbourhoods enlisted among the QPV (national level defined) and QVA (Quartiers de Veille Active, local level defined)[92] (Fig. 85 and Fig. 86):

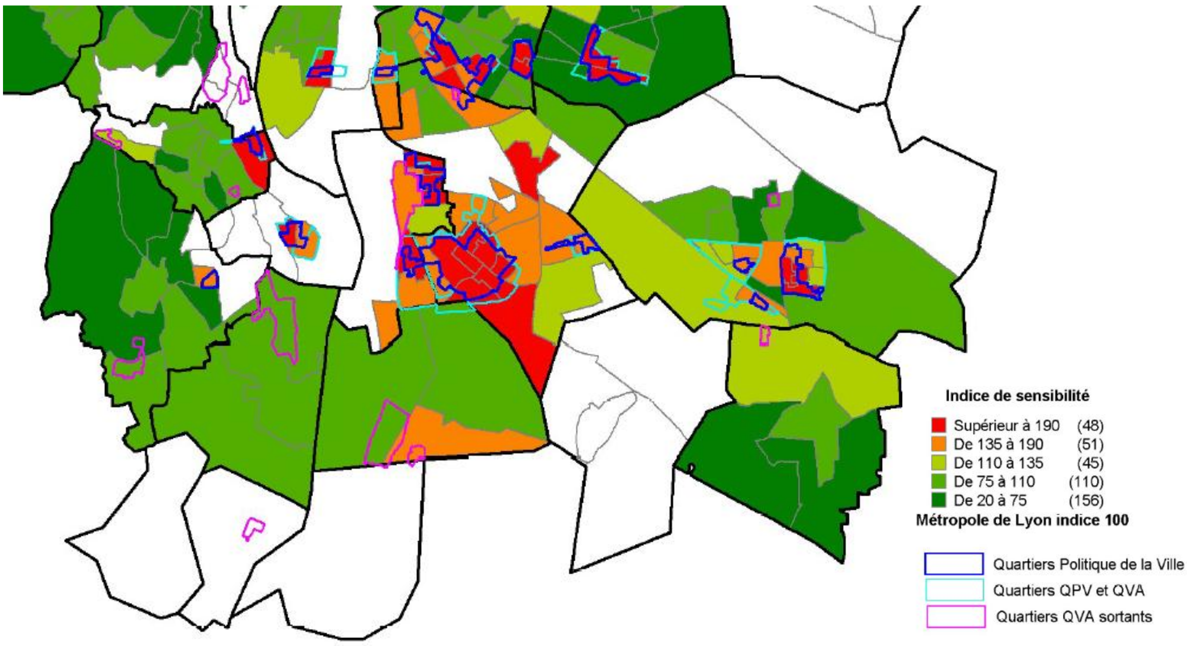
- **QPV**

in Venissiuex municipality, in particular the northern portion of Henri-Wallon area. Some other neighbourhoods around the Venissiuex center are included among the QVA zones, confirmed in the last *Contrat de la Ville*.

- **QVA**

Saint-fons, the Clochette-Sud area, is defined as a QVA zone. In Saint-Priest municipality, the QVA-defined *Garibaldi* neighbourhood is only partially included among our disadvantaged area.
In Feyzin a portion of the Les Razes area has been included into a QVA zone until 2014 (it was classified as a level 2 priority CUCS in 2013), but it is nowadays excluded from priority zones.

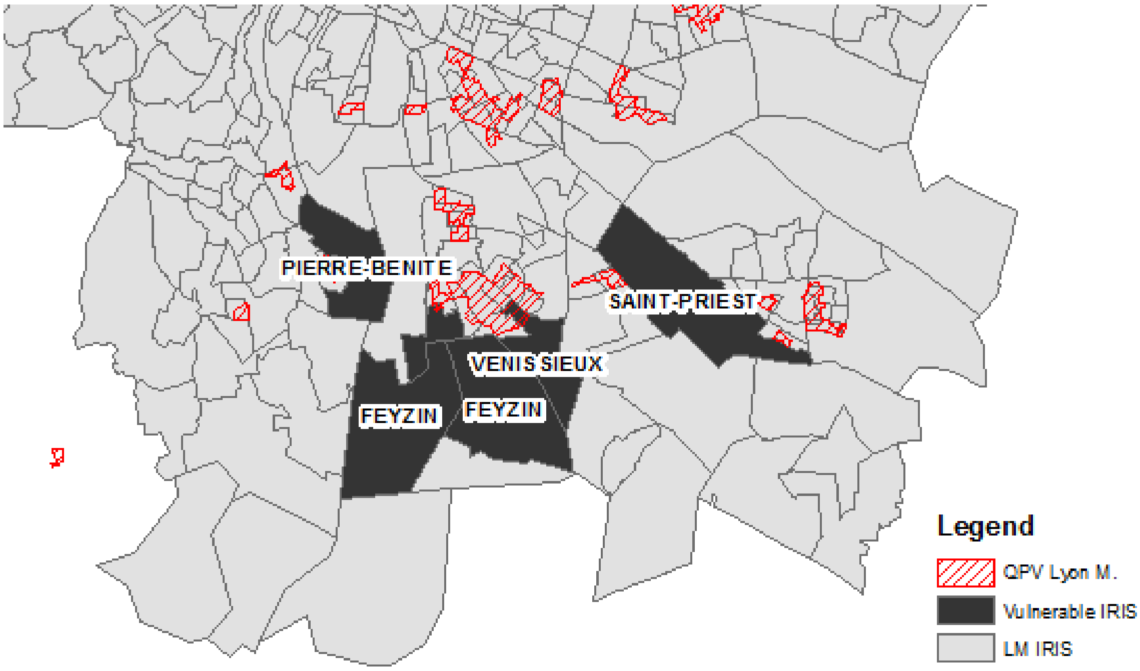
Fig. 85 – *Indice de Sensibilité*[93] 2015 in the Lyon Metropolis (south zone zoom, IRIS territorial subdivision).



Source: *Portrait des Quartiers de la Politique de la Ville*, Observatoire parternarial Cohésion Social et Territoriale, Agence d'Urbanisme de Lyon, Cahier n.1, December 2016, p.5.

[92] QVA are areas defined as socially sensible, but not by the Central State institutions (on the base of the *average income* indicator). They have a lower level of priority compared to the QPV.
[93] It consists in a social weakness index composed of 4 indicators regarding income, youngers educational level, unemployment and family economic precariousness (for further details see Agence d'Urbanisme de Lyon, *Portrait des Quartiers de la Politique de la Ville*, Cahier n.1, December 2016; and Lyon Metropolis' *Contrat de Ville*).

Fig. 86 – Mapping of disadvantaged IRIS and areas included in the QPV in the LM.



Source: our elaboration on INSEE, SIRENE, Corine, Landsat, OSM and Grand Lyon OpenData data.

8.4 Walkability and urbanity in Milan municipality

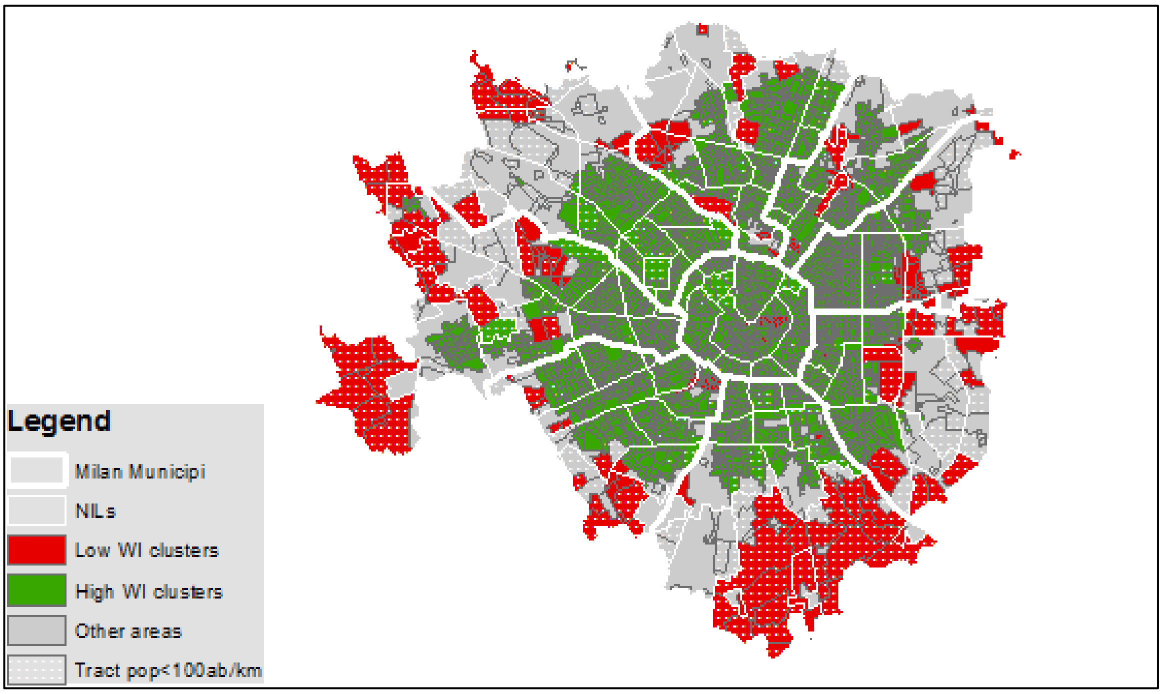
If we would interpret the level of walkability as a measure of the urbanity of spaces, looking inside the boundaries of the main urban center of the MMC, Milan, the pattern already highlighted above for the overall Metropolitan City is confirmed: central zones (census tracts in our analysis here) are those showing the highest levels of walkability, constituting clusters of high values (Fig. 87 and Fig. 88). Anyway, as already showed before, even in these contexts can be found spaces with a low level of walkability. In order to make the image more understandable we adopted as an interpretative and analytical territorial framework the NIL subdivision of the Milan municipality. NILs (*Nuclei di Identità Locale*[94]) can be conceived as neighbourhoods, defined by the municipal authority on the base of historical and geographical characteristics, composing the municipality territory. They don't overlap always with administrative limits, like the *Municipi* (decentralization administrative contexts comparable to French *arrondissements*), and represent an useful grid through which look at the results.

The neighbourhoods whose surface is covered for more than a half by high walkability clusters are 47 on 88[95], more than the half of the total composing the city. What is interesting from such a ranking is that among these neighbourhoods, the first 10 includes not only central but also semi-central areas: Vigentina, Parco Sempione, Portello, Bande Nere, Dergano, Ghisolfa, Pagano, De Angeli - Monte Rosa, Umbria – Molise, Tre Torri, are all semi-central zones classified as high value clusters, while areas like Duomo or Brera come after them (even if with very high values, 92% of area highly walkable Duomo and 98% Brera).

[94] Nuclei of Local Identity

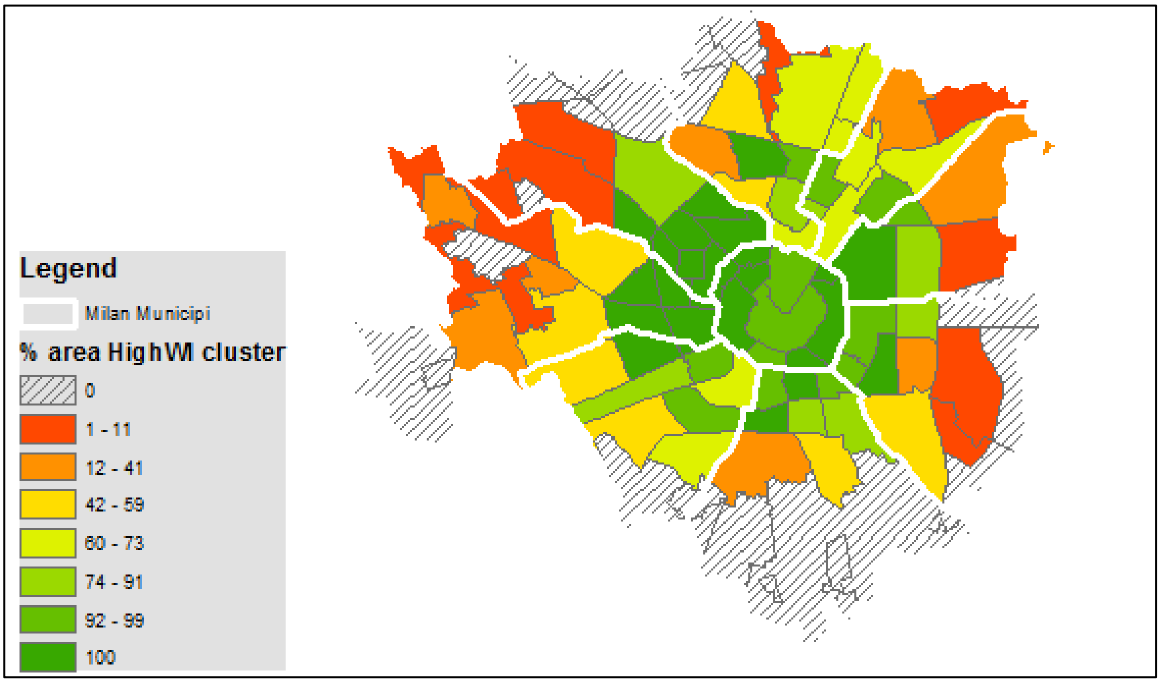
[95] For the complete list see Annex 7.

Fig. 87 – High and low Walkability index clusters among census tracts in the municipality of Milan.



Source: Our elaboration on Istat, DUSAF, Landsat and OSM data.

Fig. 88 – High walkability clusters' concentration rate in Milan municipality NILs



Source: Our elaboration on Istat, DUSAF, Landsat and OSM data.

As we wanted to stress in our previous theoretical chapters, not all the contexts included into an urban environment could be considered as sharing the same degree of urbanity: the monofunctionality of the spaces can be found in both central and peripheral (or periurban/suburban) zones, and it is this aspect to determine, in our view, the real degree and nature of urbanity of places. *De*

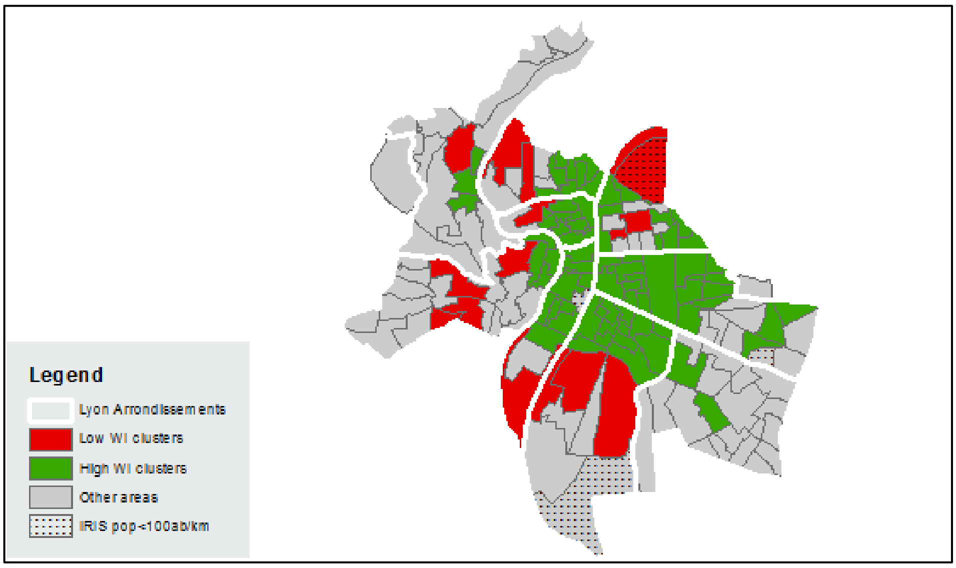
Angeli-Monte rosa, an area we already highlighted as characterized by high values of walkability, even if not central as well as the *Brera* or *Duomo* ones, presents a level of concentration and variety of the dimensions considered composing walkability (and as a consequence, urbanity) higher than those.
On the contrary some areas located in peripheral zones records a high degree of walkability/urbanity: *San Cristoforo* (in the south portion of the city) for example has the same proportion of area covered by high walkability index clusters (92%) than Duomo.

8.4.1 Walkability and urbanity in Lyon Municipality

In applying a similar analysis to the Lyon territory we adopted as an interpretative territorial level the *quartiers* subdivision, fairly comparable to the Milanese NILs[96]. As well as in the Milan case we computed the average WI value for each of them, in order to offer a more understandable image of the Lyon city's territory.
The structure of the Lyon municipality is more compact but less regular compared to the Milan one, with central areas strongly walkable and almost completely covered by high walkability clusters of IRIS, but, at the same time, interrupted often by not significant, in clustering terms, or lower walkability zones. The neighbourhood of Saxe-Roosvelt and Brotteaux records for example a lower % of walkable areas, even if located in the center of the city (as already stressed in the paragraphs above).
In general it could be said that the West part of the city shows the smaller degree of walkable zones if compared to the eastern portion of it, even if both share a similar condition if compared with the more central areas. Urbanity in this case proceeds mainly on a West-East direction, from the nucleus of the city to the external parts of it (Fig. 89 and Fig. 90). The Eastern part is also the one more plain and where the recent residential urban development took place: the 3rd and 8th Arrondissements are among those gaining more population, overpassed only by the 7th (Agence d'Urbanisme, 2012).

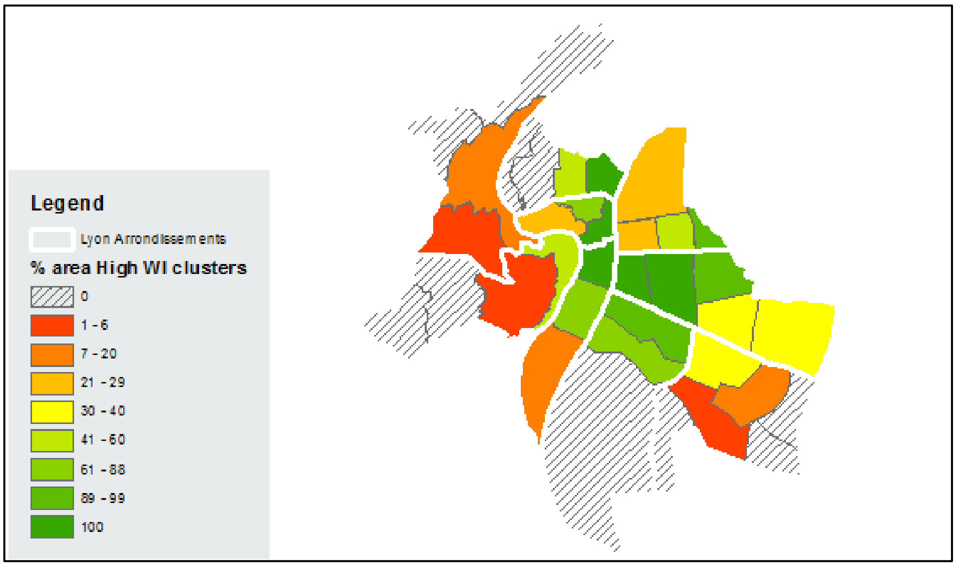
[96] Milan NILs have an average surface extension of 2km^2 while Lyon *Quartiers* have an average surface of 1.33km^2.

Fig. 89 - High and low Walkability index clusters among IRIS in the municipality of Lyon.



Source: our elaboration on INSEE, SIRENE, Corine, Landsat, OSM and Grand Lyon OpenData data.

Fig. 90 - High walkability clusters' concentration rate in Lyon municipality *Quartiers*



Source: our elaboration on INSEE, SIRENE, Corine, Landsat, OSM and Grand Lyon OpenData data.

8.4. A comparison between urbanity morphological index and Walkability index

As anticipated in the previous chapters, our work aimed to adopt two different methods for urbanity measure, based on two similar, but operationally different, methods: the one described in Chapter 6 was based in fact on the concept of pedestrian accessibility (very close to the one of walkability introduced in chapter 3 and reviewed in methodological terms here), and was implemented through the generation of a morphological index.
The one described in this chapter is based on the concept of walkability, and operationally computed through the application of a network-based method, restituting in the end a synthetic measure of the property researched.
In this section we would like to study the relation between the two, in order to test their closeness or differences. Of course comparing a categorical variable with a cardinal one is not directly feasible, for this reason we just checked for the average value of the WI (in its 0-100 range and z-scores versions) into the three classes of territory in which we divided the Lombardy region territory at the beginning. We focused the analysis on the MMC, since the WI was computed only on this territory. What emerges is a positive relation between the urbanity index and the walkability index (Tab. 46): the contexts classified as Highly urban in our zoning show an average WI value of 0.11 z points (49.5 points on 0-100 scale), locating them into the medium-high walkability class (range -1.23 to 2.35, see Tab. 35). A lower degree of walkability is recorded in territories classified as middle urban, -2.37 (35.9 on 0-100), defining them as medium-low walkable, and even lower in low urbanity spaces, -6.80 (11.6 on 0-100).

Tab. 46 – Average Walkability Index values (0-100 ragne and z-scores versions) and classification of the three classes defined by the morphological urbanity index.

Urbanity	**Average WI100**	**Average WI**	**Walkability class**
High	49.5	0.11	M.-High
Middle	35.9	-2.37	M.-Low
Low	11.6	-6.80	Low

If adopted on the overall metropolitan zoning, the same analysis returns a more homogeneous image of the territory (Tab. 47): the walkability among the metropolitan zones differs but locates almost all the zones into the Middle-Low walkability class. Anyway an higher level of walkability is usually found in higher urbanity zones, while less relevant is the position in the metropolitan hierarchy. Sub-poles and Lower-S.P. Nuclei records a similar value (37.58 or -2.1 and 37.00 or -2.2 respectively), as well as for Suburban, Lower Suburban, Periurban and Transition Centers' Nuclei, but with a lower degree of walkability. Residual and Rural contexts follow with low values of walkability.

Tab. 47 - Average Walkability Index values (0-100 ragne and z-scores versions) and classification of the metropolitan zoning classes of Lombardy region territory.

Metropolitan Zoning class	**Average WI100**	**Avergae WI**	**Walkability class**
Core Nucleus	52.78	0.7	M.-High
Periphery	27.52	-3.9	M.-Low
Subpoles Nuclei	37.58	-2.1	M.-Low
Suburban	35.01	-2.5	M.-Low
Lower S.P.Nuclei	37.00	-2.2	M.-Low
lower Suburban	34.44	-2.6	M.-Low
Residual 2 & 3	11.85	-6.8	Low
TCN	34.92	-2.6	M.-Low
Periurban	35.23	-2.5	M.-Low
Residual 1	10.10	-7.1	Low
Rural	30.24	-3.4	M.-Low
Residual	8.19	-7.4	Low

As a conclusive evaluation we can assert that using walkability for urbanity detection is much more efficient, because more precise and detailed in the representation of the property of interest: this is quite self-evident if the nature of the two measures are considered, one categorical and morphologically based, the other numeric and continuous in space.

The main negative aspect linked to the adoption of the walkability measure here presented is that, since not represented through an administrative territorial unit fix in time and comparable like census tracts, its potential in terms of territorial delimitation of different areas, useful for policies suggestions and advice, is low. For this reason we needed to attribute walkability values to the census tracts, in order to be able to represent them in a harmonized territorial framework, useful for further analysis implementation.

Of course the computation method of the property is still original and valid, being done on a different and *ad hoc* defined territorial unit (the walking areas), and represents the added value of the approach described. Only the final representation is reported to a pre-given territorial classification, not affecting the index computation.

Anyway the precision of the walkability index method can improve accessibility-related issues contrasting policies, producing a more detailed representation and evaluation of the spatial characteristic of the phenomena. It strictly depends on the scale of policy intervention and evaluation assessment.

What emerges from our analysis is also the importance of a detailed data collection for urban phenomena analysis and eventual policies planning: more detailed the data, stronger and efficient are the results and methods of the research itself. Lombardy region DUSAF database on land use classification, on the one hand, INSEE detailed data on economic activities location on the other, are virtuous examples in this sense. Satellite imagery technologies on the one side, and open source databases like Open Street Map on the other offer new possibilities in this direction, but much more could be done by public institutions in making available data sources for research. Open Data philosophy is spreading worldwide, but the pace is quite different among national, and even intra-national contexts. For territorial Sociology this is a crucial issue.

Conclusions

We saw in this chapter how walkability has been operationalised in recent research. Its nature of both objective and subjective property of space, being produced by the relation between individuals (characterized by different habits, culture, conditions, physical features,…) and space (differentiated by structure and morphology), makes its measurement a difficult issue. Here we focused on the objective elements defined as the most relevant in walkability detection, and the most accessible in terms of operationalisation and empirical analysis: density, variety and size of the elements constituting its structural dimensions. Even if conceptualized in quite different ways we managed to produce an evaluation of these properties' distribution in the MMC and LM territories, applying a method developed in a recent work on the Luxembourgish territory, we adopted as a model, stressing the similarities and differences between and among the two contexts taken as comparative cases.

Milan and Lyon walkability characteristics

We saw how the two case studies show different level of walkability, and in particular that in the Lyon case its values reached higher rates than in Milan. The higher concentration of the Lyon Metropolis territory (in terms of population and as a consequence, activities and amenities) is also at the base of the lower variance of walkability values distribution, in a context in which the dimensions impacting the most in the index computation are population and amenities density. For sure a part of the variation in the WI between the two case studies is also due to the differences in the operationalisation of the properties at the base of the index itself, caused by differences in data availability and provision, but the structure of the territory is as well a relevant element to be considered.

The analysis of the walkability in the two contexts has been run considering relative distribution of WI values: we saw that if in the Lyon case the walkability reaches higher values, the internal distribution of the index is much more concentrated, and, for example, a smaller portion of the territory is covered by medium-high or high level of it (15% vs 19%), conceived in our proposal as higher than 1 standard deviations on, and a smaller amount of metropolis population (45% vs 59%). But if we adopt the same value thresholds for the two contexts (in particular the MMC thresholds) and compare the z-scores of the two areas we see that in Lyon a higher % of the surface is covered by medium-high/high levels of walkability (26% vs 19%) and the same for population (64% vs 59%). So in relative terms, in Milan walkability is more distributed, but in absolute terms its values are lower than in the Lyon context. In general anyway at least 50% of the overall population lives in zones classified according to our method as medium or highly walkable.

Different kinds of low urbanity

The analysis, run at a high level of territorial detail, on the base of an original and not administrative-driven territorial unit (the walking area), allowed to highlight the existence of different kinds of low walkability (and so urbanity) contexts in the two case studies. Beside the expected low walkable areas in the peripheral zones of the metropolitan cities (and in particular at the peripheries of the main centers), usually examples of monofunctional, since mainly residential, areas, we found spots of low walkability also in the central zones. These are examples of monofunctional areas of a different kind, where residential function is marginal, and, on the contrary economic activities (but of specific and high rank type) are prevalent. These are the two extremes of the metropolitan cities: the *bedroom community* and the *business/touristic districts*, both lacking parts of the dimensions composing what we defined as urbanity. We could stress also empirically our approach, where the variety of local functions is at the base of our conceptulisation of the urbanity of spaces.

Walkability socio-demographic connotation

The index was also tested in terms of “validity” measuring the correlation with other properties of the territory hypothetically peculiar of walkable spaces: we saw that the rate of commuters decrease when walkability increase, in both case studies, and in Lyon the number of cars owned by families is lower as higher the walkability of the contexts.

The analysis showed also the existence of a direct positive proportionality between walkability and social status (detected through the educational level of individuals, plus the reference person status in Lyon case), stressing how walkable environments are hypothetically more concentrated in high status zones.

These areas are then usually located in the central areas of the urban centers, as highlighted by the maps presented, and confirmed by the negative correlation existing between number of families components and families with children and walkability. These kind of families are usually more represented in suburban or periurban contexts, due to housing costs and residential preferences.

Walkability and social disadvantage

Due to this partial overlap between low walkability and low social status, we wanted to better analyse the relation between them, computing a vulnerability index, that, due to the lack of comparable data at a detailed territorial level on the two metropolitan cities contexts, was limited to few components. This anyway helped in finding a, fortunately, low overlap between high clusters of vulnerability and low walkability in both cases: only the 4% and 1% of the overall Milan Metropolitan City and Lyon Metropolis population respectively live in areas classified by our method both highly socially vulnerable and lowly walkable. Milan MC seems so to record a higher rate of disadvantaged population, as emerges also from the analysis of the disadvantaged population concentration in the sub-populations of low WI and VI areas.

In Lyon these disadvantaged contexts are confirmed as low walking environments by mobility studies (Agence d'Urbanisme) and some of them have been included, or are still today, into social policies programmes (*Quatiers Prioritaires* as classified by the *Contrat de Ville*) oriented in improving living conditions of these neighbourhoods.
In the Milanese case we found that some of the municipalities hosting important portions of disadvantaged areas are included as well in some plans of the Metropolitan welfare programme of the MMC, co-financed by the Central State through the *Bando Periferie* (Peripheries Call), a funding scheme aimed at territorial and social policies planning implementation for areas in need.
Since the administrative structure of the MMC is still not fully mature (see chapter 4) the actions produced or promoted at this territorial level are few, but probably in the next years things will change.

Conclusions

This work wanted to focus on an old issue, rooted in the origins and tradition of the Urban Studies, but recently risen again among the most discussed arguments in the field: the Urban Question. Moving from strongly theoretical discourses we worked in order to relocate on the empirical ground the discussion, introducing a proposal for the empirical detection of the *urbanity*, the condition typical of those environments in which Urbanism and an urban life-style can be *generated* thanks to the presence of environmental characteristics able to offer the conditions for their emersion. We adopted for this reason as an interpretative key, to be used as an empirical tool for the detection of this property, the concept of accessibility and, more precisely, of pedestrian accessibility and walkability. Beside this meso/micro scale a macro one has been considered as well, constituting the framework in which the local dimension of urbanity is inserted and is then shaded: the metropolitan scale. We proposed here the application of a particular definition of Metropolitan Areas, developed in a previous work by Boffi e Palvarini (2011), in order to distinguish between the various zones in terms of both urbanity and metropolitanity degree. On the base of a contribution on the same issue by Colleoni and Caiello (2013) we wanted to update the analysis on the Lombardy region territory with the data from the last Census available (2011), and to compare our results with the Lyon Metropolis context, in order to stress similarities and differences in the metropolitan development of the two areas.
Unfortunately our comparison project was accomplished only in part, due to gaps in data availability and to issues linked to the harmonization of the method between the two cases (see chapter 7). The production of a metropolitan zoning for the Lyon context was in this sense impossible, and we limited our analysis to the computation and definition of the metropolitan areas present in the French territory, according to the same method applied on the Italian case study.
On the other hand, the comparison between the two contexts was possible on the micro/meso level through the definition and application of a walkability index, we computed in order to propose a further and more precise measure of urbanity than the one based on the pedestrian accessibility already proposed in the Italian case. In the following paragraphs some observations on the results of our analysis are provided.

Metropolitan zoning in Milan: What emerges from the comparison between years?

As already highlighted in Chapter 6, three main conclusions can be derived from the analysis of the metropolitan degree of Lombardy region between 2001 and 2011, all based on a general process. A general phenomenon of densification of the metropolitan realm has occurred, and not an expansion of its boundaries: this emerges from the observation of the increase of the metropolitan index values inside the limits of the Metropolitan Area of Milan. Such a result aligns to and confirms the *regionalization trend* in metropolitan development stressed by some prominent authors in the field of Urban Studies. Edward Soja is for sure of the most representative of this position, he defended in several occasions (Soja, 2000; 2009; 2011;2015), analyzing the form of this process:

> Briefly described, regional urbanization is characterized by a densification if not urbanization of traditional suburbia and usually a flattening out of the density gradient from the peak level in the central city. In many large metropolitan areas, the outflow of domestic populations from the urban core has been matched by the influx of even larger numbers of transnational migrants. As a result, the once recognizable boundaries between urban and suburban ways of life are blurred in a new and more heterogeneous mixture of race, class, and culture;

Soureli, K., & Youn, E. (2009). Urban Restructuring and the Crisis: A Symposium with Neil Brenner, John Friedmann, Margit Mayer, Allen J. Scott, and Edward W. Soja. *Critical Planning*, *16*(1), 35-59.

Soja highlights the *flattering of the density gradient* moving from the main centers towards the suburbs and periurban contexts, a process driven not, as proposed in the late ‘70s, by a reduction of urbanity in the high rank urban centers, but, on the contrary, by an increase in this property of the former lower rank settlements.
Our analysis seems to adhere to this image, since compatible with the main results enlisted:

1. As we already said an increase in complexity of the metropolitan territory is found, due the process of densification of its internal areas. This process in fact produces further territorial contexts in which the degree of metropolitanity get closer to the highest values of the central zones, generating intermediate areas characterised by this condition. This is mainly due to the population increase in the interstices of the metropolitan nodes, a tendency highlighted also in the PIM Report 2016, and, along with the population, also other, low level, services and activities expands, following the population distribution.
The flattering trend is not homogeneous of course, and this is at the base of the complexification of the internal zones of the metropolitan areas.

2. The analysis of both urbanity and metropolitanity allows to give a more detailed representation of this complexity, and to underline the shades existing among high urbanity contexts.

3. We showed that high urbanity spaces increased in terms of area and regional surface covered, and that, if metropolitan classification in the time interval between 2001 and 2011 lost its capacity in distinguishing population in terms of socio-demographic characteristics, the same did not happen for urbanity.

A similar scenario of densification is also stressed by the recently concluded PRIN (Progetto di Rilevante Interesse Nazionale) *Postmetropoli* managed by the DAStU research team of the Politecnico di Milano in which the regionalization process in

Milan urban area is attributed to a threefold phenomenon composed by: (1) a densification trend in between the main urban centers, (2) a reshape of the mobility flows (less dependent from the big cities and increased in between the other settlements in a networked pattern), (3) a change in the governance structures, due to the growing relevance and transcalar nature of the current metropolitan phenomenon (Balducci et al., 2016).

What is clear in such a situation is that the current forms of management and administration of the metropolitan (or post-metropolitan) phenomenon are still not adequate to face the challenges faced by the territories. Further work is needed in order to offer the best bases on which build new administrative tools.

What emerges from the comparison between Italian and French metropolitan development?

In the comparison between the metropolitan areas defined through the application of our method on the two cases of Italy and France emerged the higher concentration in space of Italian metropolitan realms, characterized by a higher density of the population. As we already highghlighted in chapter 7 this is probably due to the specific geographical nature of the Italian territory, where few contexts present the preconditions for a wide expansion of the urbanized environment. The only context showing a similar potential is the Padana plain, where in fact the two most extended areas are present: the Milan and Vento Metropolitan Areas.

In France two main agglomerations, result of the closeness of relevant metropolitan centers, are present: Paris-Rouen one and Lyon-Marseille (including St.Etienne, Grenoble and Aix-en-Provence).

Walkability and urbanity

The main purpose of this work was to offer an empirical approach and method for the detection of urbanity of spaces. The method proposed and adopted are two: one based on the pedestrian accessibility, and resulting in a morphological index, the second built on a network-based computation of the walkability of spaces, producing a continuous property in the space. In the first case, the impossibility to compute a continuous property limited the effectiveness of the method. We needed also to modify the criterion at the base of our conceptualization of periurban spaces we adopted as a reference for the urbanity levels distinction.

On the other hand the computation of the walkability index allowed to obtain a more precise measure of the pedestrian accessibility of spaces, and their suitability for walking. The adoption of a network-based method produced an index more effective, not only for its final numeric nature, but also because computed in order to adhere as much as possible to the reality of the phenomenon described. It faces limits as well, being computed considering only the objective dimensions of walkability, while subjective aspects are recognized relevant as well as objective in the literature. For this reason for example the weights attributed to the amenities considered for the index computation are arbitrary, even if reasonable, as well as their selection.

More information should be included as well for the objective dimension, on the availability and condition of sidewalks for example, or traffic condition of the streets. But models are necessary simplifications of the reality, and they can’t reproduce it, due to its extreme complexity (and it is not even their aim). Anyway further developments in data provision would help to perfect the method.

Data availability and their level of detail in fact constituted an issue as well, we worked on to solve. Unfortunately some differences between the two case studies in the structure of data adopted remained, influencing for sure the final results. A further development in data provision and the empowerment of open data “philosophy” could surely help in improving the harmonization of data structure available in different contexts, at least we hope so.

Regarding the comparison between the two methods, as already said, the walkability index allowed to obtain a more precise measure, due to its nature, result of its computation procedure. Anyway a quite good general overlap between the two has been found, stressing the similarity of both methods in intercepting the property we wanted to measure.

Due to its structure the walkability index was able to better highlight those elements that in our conceptualization are constitutive of an urban contexts, able to generate the *urbanity*: the diversity, variety and easiness in access of the spaces. All the limits we highlighted in the paragraphs above remain, but further research can only reduce them. From our analysis we could stress how Lyon presents overall a higher level of walkability if we consider the range of its walkability index, but more concentrated in space. On the other hand Milan Metropolitan City territory presents an overall lower degree of walkability, but more distributed among the different contexts. Anyway if the same values thresholds are adopted in the classification of the index a higher percentage of the entire Lyon Metropolis territory’s surface is covered by medium-high or high levels of walkability than in the MMC, and the same happens for the resident population.

A low walkability of the residential spaces can be considered as a further obstacle if associated to an already existing vulnerability condition. We studied, with the data available, the potential overlap between social vulnerable and low walkable contexts, highlighting the existence in both case studies of some contexts living this condition. Fortunately they represent just a small portion of the relative whole populations, and sometimes have been already included in social policies action plans, but not all of them. Mobility constitutes in fact, as we already highlighted in chapters 3 and 8, an element able to reduce social vulnerability, but its availability differs according to the various kind of mobility considered, since they require a different level and types of resources to be performed. Providing walkable environments allow to reduce the risks of increasing social vulnerability, creating the better conditions for people to live a diverse urban space full of opportunities.

Limits

Beside the already mentioned limits faced in walkability and urbanity computation due to data availability and structure, we also had to confront with issues in metropolitanity and urbanity computation in the French context, that made for us impossible to reproduce the metropolitan zoning for the Lyon case and run the comparison. As we explained in chapter 7, the lack of precise data, at the level of detail needed on employees size of the various service activities considered in the urbanity morphological index prevented us from completing the computation and so the comparison.

Another element to be stressed is the fact that all the measures are relative to a specific contexts (the Italian case or the French one) and in this sense also the metropolitan subareas definitions for example. The criteria are based mainly on statistical methods but all considering the relative distribution of data.

Again: the method is applicable to western countries contexts, where the urban development is more similar from country to country, while should be rethought in order to be applied to much different urban contexts. This is partially an effect of the methodological criteria adopted: the metropolitan area definition, based on the metropolitan functions' distribution analysis approach, has been developed looking at the American and European's urban studies traditions. Data required for its application are more easily available in these countries (on mobility flows, economic activities location and relevance, residential functions), and, as demonstrated by our own comparative case for example, the Lyon Metropolis, even in these contexts comparability is often an issue. This is also an effect of the administrative similarities, due to historical closeness of the territorial contexts, and to the more general homogeneity (or at least commonalities) in economic production systems, one of the most relevant engines of urbanization process (Brenner, etc…)
Anyway as highlighted in particular in post-colinal studies, among the many by Robinson, opening the analysis to extra western countries could be an opportunity to find and stress elements important for a general interpretation of metropolitan phenomenon, not included otherwise into the analysis due to the too much similar contexts considered (Robinson, 2011). Moreover, the closeness and similarities between western countries and inside each sub-class of this broad cathegory, are

also a matter of degree: many and strong are the cultural and structural differences between cities in the United States and the European ones. We already highlighted such an issue in the previous chapters, describing both the urbanization process producing the metropolitan cities (chapter 4), but also between southern Italy's cities and English ones. A plentiful amount of properties can impact on the comparison procedure, the consideration of their relevance and importance depends both on research objectives but even on a previous analysis of the phenomena co-determinants (ivi).
This is evident also when original territorial units are considered in the research and comparative studies, like in our case, where an original definition of metropolitan area is introduced. As stressed by Robinson in fact, even if powerful for comparing different contexts, the elaboration of a functional definition of the city (and we would extend her reasoning to any originally defined territorial unit) must be "carefully justified" and constructed. The existence of globalizing trends in urbanization process, distributing similar elements and trends in design, policy, culture and governance[97]can justify a similar approach, but the specific implementation of it remains a sensitive aspect.

From a mere empirical and operative point of view, also very challenging is the data availability issue regarding the walkability and accessibility (micro-scale) scope. The opportunities opened by the new open data *philosophy*, spreaded thanks to the efforts in this sense made by national governments (pioneering in this sense were the USA in 2009), made today possible analyses only thinkable few years ago, providing administrative data once difficult to be reached.

On a parallel journey, the rising of open source and free online databases improved the scientific analysis potential. Just as an example, the OpenStreetMap project, among the most relevant, has become for territorial analysis a worth source of data, updated, harmonized, detailed and distributed worldwide, even if not exhaustive.

All these sources are of course not evenly distributed in all the potential contexts, depending on local resources, technological development, government structures, socio-political conditions, etc… and such an aspect limits the implementation of the same methods to some specific contexts. Anyway in this sense the process of advancement in open data distribution and use will continue in the next years, increasing the analysis potential and the possibilities of scientific research in different contexts.

Beside the openness of data source, another relevant issue in order to allow better analyses and also to improve comparative studies is the widening of micro data availability. Since, at least in territorial analysis (but the same argument could be

[97] see for example Marcuse and van Kempen, 2000; Smith, 2001; Sassen, 2002; King, 2004; McFarlane, 2006; Huyssen, A. 2008

addressed to many different research fields), one of the main problems is usually the existence of different territorial levels of data provision, obstacle for the comparison between contexts. Regarding territorial studies in this sense the adoption of spatial analysis represents a solution to the ecological fallacy and unit of analysis diversities, but it can be employed only in presence of disaggregated data, to be processed then with the spatial instruments and methods. National Statistical Institutes (for example the Italian ISTAT) have some difficulties in providing this kind of data, due to, not least, privacy issues always increasing when reducing the level of aggregation of the information. But attempts towards a easier and broader access to micro data, on the ackwoledge of their relevance for scientific research, are growing (see for example the ARCHIMEDE[98] project in Italy). It is still an ogoing but hopeful process.

Further developments

The research here presented has as an important limit the lack of a study of the subjective dimensions linked to urbanity and metropolitanity measure: do the quantitative objective data produced a representation of the territory that corresponds to the population perception?

As we highlighted many times, the individual perception of urban space characteristics has a relevant role in shaping people behaviours, in particular in terms of mobility and more precisely walkability. Running a survey on people beliefs and representations of the space, to be compared with actual behaviours, would provide useful further information able to better interpret the objective data and complete our understanding of walkability, and relation between population and residential space, of the contexts studied. In particular, regarding the walkability measure, a better selection and then weighting of the amenities located in the walking areas could be run, producing a more precise datum.

A survey on the sense of territorial belonging was at the beginning planned to be run in order to compare highly urban and metropolitan residential areas with low urban and metropolitan ones, to study the relation between place of residence, mobility habits and sense of belonging. A CATI survey was hypothesized but a similar project was too ambitious for the resources we could rely on and so quitted.

A time-geographical analysis of people daily geographies would provide data on people's *actual* and *perceived* action spaces, to be combined with the potential one (even if limited to the domain covered through walking activity) we already computed in this research. This would allow to face the question: is there any relation between "objective" spatial conditions, subjective perceptions and behaviours? Why do given specific "objective" spatial conditions, perceptions and

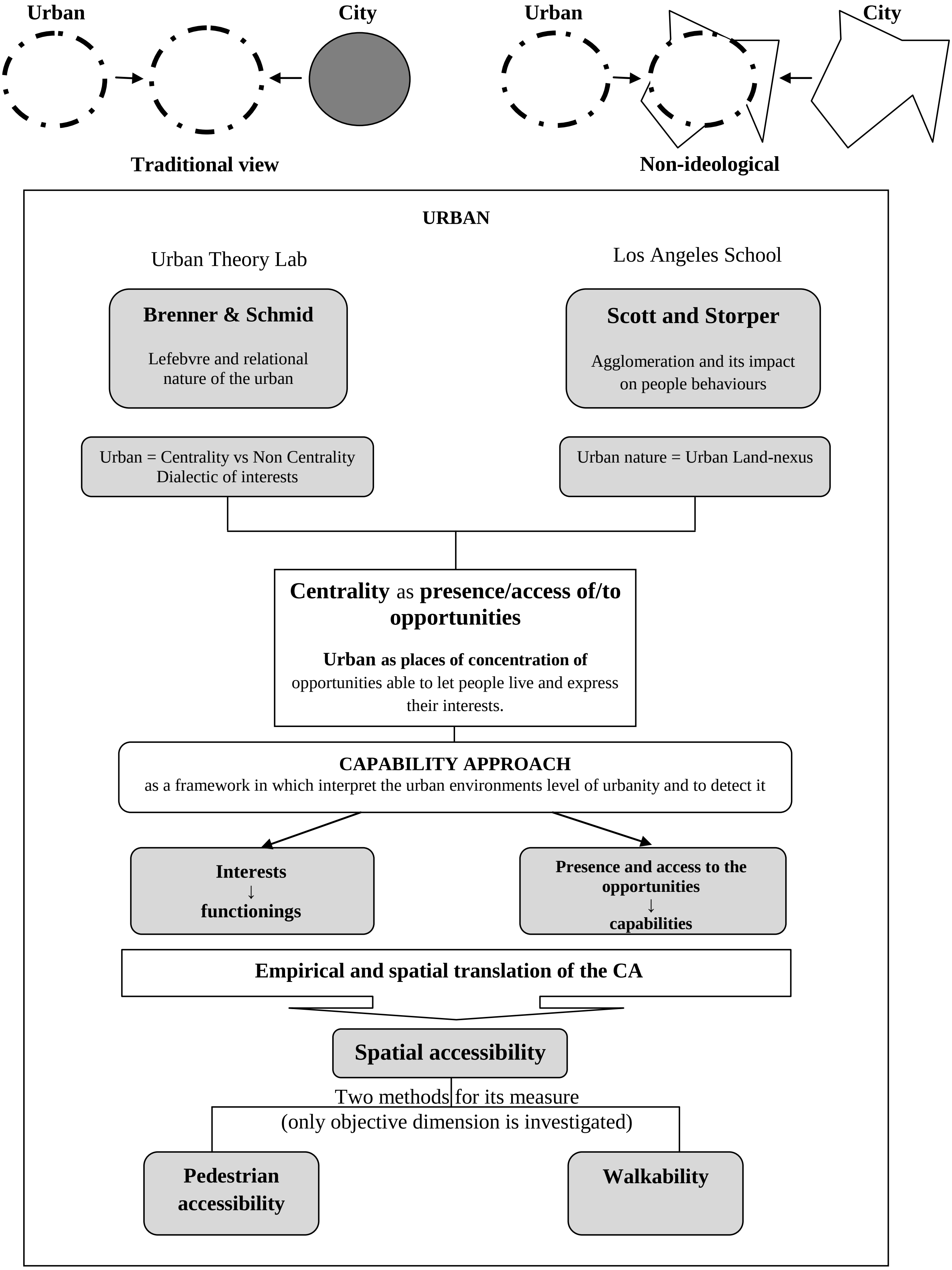
[98] ARCHivio Integrato di Microdati Economici e DEmografici (integrated economic and demographic microdata archive).

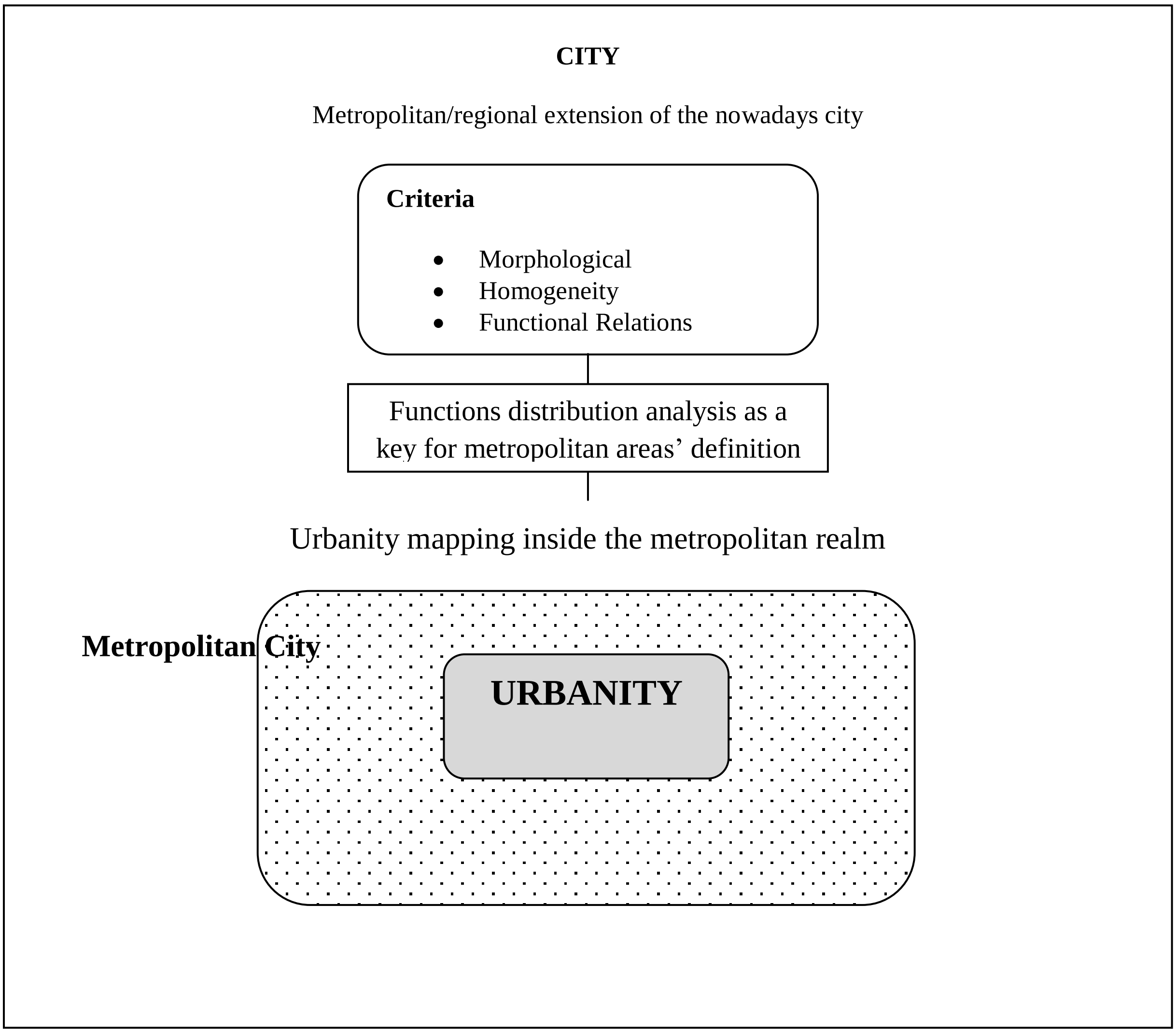
behaviours vary according to a particular pattern? What are the main elements impacting on the relation?
The addition of the time dimension would even enrich the image, integrating the analysis with an element strictly intertwined with the spatial one in mobility behaviours. The combination of interviews, with secondary data analysis and gps data for people mobility detection (today easier in access thanks to mobile technology evolution) would offer a wide toolset for the implementation of such a study.

In this sense it would be interesting to address the differentiation of Action Spaces structures according to various kinds of populations, in order to better highlight the specific response in terms of spatial characteristics urban spaces offer to different people (and as a consequence different life styles populations) residing in them. In our study we focused on an ideal type of adult (18-65), without physical hindrances, but the differences would be big considering children (and also among them according to the various age cohorts), elders (we saw that in the CURHA project taken as a model), disabled, or other vulnerable (in terms in particular of mobility) populations.

Accessibility remains a phenomenon produced by the interaction between space and people: forgetting one of the two elements will not produce a complete picture. And this is the main objective of Territorial Sociology: analyzing and deconstruct the link existent between space and people.

Thesis conceptual diagram




CITY
Metropolitan/regional extension of the nowadays city
Criteria
Morphological
Homogeneity
Functional Relations
Functions distribution analysis as a key for metropolitan areas' definition
Urbanity mapping inside the metropolitan realm
Metropolitan City
URBANITY

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- Città Metropolitana di Milano:
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- Commissariat général à l’égalité des territoires:
http://www.cget.gouv.fr/

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- DTA:
http://www.rhone.gouv.fr/Politiques-publiques/Amenagement-du-territoire-urbanisme-construction-logement/Urbanisme/Documents-d-urbanisme/DTA.

- ERSAF Lombardia
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http://resources.arcgis.com/en/home/

- Grand Lyon Metropole (Contrat de Ville)
https://www.grandlyon.com/metropole/politique-de-la-ville.html

- INSEE
https://www.insee.fr/fr/metadonnees/definitions

- ISTAT - file geografici:
https://www.istat.it/it/archivio/104317

- ISTAT – Progetto UrBes:
http://www.istat.it/it/archivio/153995

- ISTAT – data warehouse:
http://dati.istat.it/

- Landsat Project:
https://landsat.usgs.gov/

- Landscan Projecy:
http://web.ornl.gov/sci/landscan/

- Level of Service:
http://www.levelofservice.com/

- NASA – Earth at Night:

https://www.nasa.gov/topics/earth/earthday/gall_earth_night.html

- New Urbanism association:
http://www.newurbanism.org/

- New York City institutional website:
http://www1.nyc.gov/site/planning/plans/city-wide.page

- Observatoire Partenarial Lyonnais en Economie:
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- Open Street Map:
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- Piano Intercomunale Milanese:
http://www.pim.mi.it/

- SCOT Lyon:
https://www.scot-agglolyon.fr

- Smart Growth network:
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- U.S. Bureau of Census
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- Walkscore:
https://www.walkscore.com/

- Walkshed:
http://walkshed.org/

ANNEX 1

Activities (ATECO 2007 code and its description) included among the local services accessibility basins for the urbanity morphological index computation.

<u>47.2 COMMERCIO AL DETTAGLIO DI PRODOTTI ALIMENTARI , BEVANDE E TABACCO IN ESERCIZI SPECIALIZZATI</u>

47.21 Commercio al dettaglio di frutta e verdura in esercizi specializzati
47.21.0 Commercio al dettaglio di frutta e verdura
47.21.01 Commercio al dettaglio di frutta e verdura fresca
47.21.02 Commercio al dettaglio di frutta e verdura preparata e conservata
47.22 Commercio al dettaglio di carni e di prodotti a base di carne in esercizi specializzati
47.22.0 Commercio al dettaglio di carni e di prodotti a base di carne
47.22.00 Commercio al dettaglio di carni e di prodotti a base di carne
47.23 Commercio al dettaglio di pesci, crostacei e molluschi in esercizi specializzati
47.23.0 Commercio al dettaglio di pesci, crostacei e molluschi
47.23.00 Commercio al dettaglio di pesci, crostacei e molluschi
47.24 Commercio al dettaglio di pane, torte, dolciumi e confetteria in esercizi specializzati
47.24.1 Commercio al dettaglio di pane
47.24.10 Commercio al dettaglio di pane
47.24.2 Commercio al dettaglio di torte, dolciumi, confetteria
47.24.20 Commercio al dettaglio di torte, dolciumi, confetteria
47.25 Commercio al dettaglio di bevande in esercizi specializzati
47.25.0 Commercio al dettaglio di bevande
47.25.00 Commercio al dettaglio di bevande
47.26 Commercio al dettaglio di prodotti del tabacco in esercizi specializzati
47.26.0 Commercio al dettaglio di generi di monopolio (tabaccherie)
47.26.00 Commercio al dettaglio di generi di monopolio (tabaccherie)
47.29 Commercio al dettaglio di altri prodotti alimentari in esercizi specializzati
47.29.1 Commercio al dettaglio di latte e di prodotti lattiero-caseari
47.29.10 Commercio al dettaglio di latte e di prodotti lattiero-caseari
47.29.2 Commercio al dettaglio di caffè torrefatto
47.29.20 Commercio al dettaglio di caffè torrefatto
47.29.3 Commercio al dettaglio di prodotti macrobiotici e dietetici
47.29.30 Commercio al dettaglio di prodotti macrobiotici e dietetici
47.29.9 Commercio al dettaglio di altri prodotti alimentari in esercizi specializzati n.c.a.
47.29.90 Commercio al dettaglio di altri prodotti alimentari in esercizi specializzati n.c.a.

<u>47.4 COMMERCIO AL DETTAGLIO DI APPARECCHIATURE INFORMATICHE E PER LE TELECOMUNICAZIONI (ICT) IN ESERCIZI SPECIALIZZATI</u>

47.41 Commercio al dettaglio di computer, unità periferiche, software e attrezzature per ufficio in esercizi specializzati
47.41.0 Commercio al dettaglio di computer, unità periferiche, software e attrezzature per ufficio in esercizi specializzati
47.41.00 Commercio al dettaglio di computer, unità periferiche, software e attrezzature per ufficio in esercizi specializzati

47.42 Commercio al dettaglio di apparecchiature per le telecomunicazioni e la
telefonia in esercizi specializzati
47.42.0 Commercio al dettaglio di apparecchiature per le telecomunicazioni e la telefonia in
esercizi specializzati
47.42.00 Commercio al dettaglio di apparecchiature per le telecomunicazioni e la telefonia in esercizi
specializzati
47.43 Commercio al dettaglio di apparecchiature audio e video in esercizi
specializzati
47.43.0 Commercio al dettaglio di apparecchi audio e video in esercizi specializzati
47.43.00 Commercio al dettaglio di apparecchi audio e video in esercizi specializzati

47.5 COMMERCIO AL DETTAGLIO DI ALTRI PRODOTTI PER USO DOMESTICO IN ESERCIZI SPECIALIZZATI

47.51 Commercio al dettaglio di prodotti tessili in esercizi specializzati
47.51.1 Commercio al dettaglio di tessuti per l'abbigliamento, l'arredamento e di biancheria
per la casa
47.51.10 Commercio al dettaglio di tessuti per l'abbigliamento, l'arredamento e di biancheria per la casa
47.51.2 Commercio al dettaglio di filati per maglieria e merceria
47.51.20 Commercio al dettaglio di filati per maglieria e merceria
47.52 Commercio al dettaglio di ferramenta, vernici, vetro piano e materiali da
costruzione in esercizi specializzati
47.52.1 Commercio al dettaglio di ferramenta, vernici, vetro piano e materiale elettrico e
termoidraulico
47.52.10 Commercio al dettaglio di ferramenta, vernici, vetro piano e materiale elettrico e termoidraulico
47.52.2 Commercio al dettaglio di articoli igienico-sanitari
47.52.20 Commercio al dettaglio di articoli igienico-sanitari
47.52.3 Commercio al dettaglio di materiali da costruzione, ceramiche e piastrelle
47.52.30 Commercio al dettaglio di materiali da costruzione, ceramiche e piastrelle
47.52.4 Commercio al dettaglio di macchine, attrezzature e prodotti per l'agricoltura;
macchine e attrezzature per il giardinaggio
47.52.40 Commercio al dettaglio di macchine, attrezzature e prodotti per l'agricoltura; macchine e
attrezzature per il giardinaggio
47.53 Commercio al dettaglio di tappeti, scendiletto e rivestimenti per pavimenti e
pareti (moquette, linoleum) in esercizi specializzati
47.53.1 Commercio al dettaglio di tappeti, tende e tendine
47.53.11 Commercio al dettaglio di tende e tendine
47.53.12 Commercio al dettaglio di tappeti
47.53.2 Commercio al dettaglio di carta da parati e rivestimenti per pavimenti (moquette e
linoleum)
47.53.20 Commercio al dettaglio di carta da parati e rivestimenti per pavimenti (moquette e linoleum)
47.54 Commercio al dettaglio di elettrodomestici in esercizi specializzati
47.54.0 Commercio al dettaglio di elettrodomestici in esercizi specializzati
47.54.00 Commercio al dettaglio di elettrodomestici in esercizi specializzati
47.59 Commercio al dettaglio di mobili, di articoli per l'illuminazione e altri
articoli per la casa in esercizi specializzati
47.59.1 Commercio al dettaglio di mobili per la casa
47.59.10 Commercio al dettaglio di mobili per la casa
47.59.2 Commercio al dettaglio di utensili per la casa, di cristallerie e vasellame
47.59.20 Commercio al dettaglio di utensili per la casa, di cristallerie e vasellame
47.59.3 Commercio al dettaglio di articoli per l'illuminazione
47.59.30 Commercio al dettaglio di articoli per l'illuminazione
47.59.4 Commercio al dettaglio di macchine per cucire e per maglieria per uso domestico
47.59.40 Commercio al dettaglio di macchine per cucire e per maglieria per uso domestico
47.59.5 Commercio al dettaglio di sistemi di sicurezza
47.59.50 Commercio al dettaglio di sistemi di sicurezza
47.59.6 Commercio al dettaglio di strumenti musicali e spartiti

47.59.60 Commercio al dettaglio di strumenti musicali e spartiti
47.59.9 Commercio al dettaglio di altri articoli diversi per uso domestico n.c.a.
47.59.91 Commercio al dettaglio di articoli in legno, sughero, vimini e articoli in plastica per uso domestico
47.59.99 Commercio al dettaglio di altri articoli per uso domestico n.c.a.

56.3 BAR E ALTRI ESERCIZI SIMILI SENZA CUCINA

56.30 Bar e altri esercizi simili senza cucina
56.30.0 Bar e altri esercizi simili senza cucina
56.30.00 Bar e altri esercizi simili senza cucina

85.1 ISTRUZIONE PRESCOLASTICA

85.10 Istruzione prescolastica
85.10.0 Istruzione di grado preparatorio: scuole dell'infanzia, scuole speciali collegate a quelle primarie
85.10.00 Istruzione di grado preparatorio: scuole dell'infanzia, scuole speciali collegate a quelle primarie

85.2 ISTRUZIONE PRIMARIA

85.20 Istruzione primaria
85.20.0 Istruzione primaria: scuole elementari
85.20.00 Istruzione primaria: scuole elementari

ANNEX 2

Cases included into the sample on which the thresholds definition for urbanity levels has been based.

The criteria, as explained in chapter 6, at the base of their selection are:

- location in the urban fringes of the metropolitan area of Milan (cfr. next section for its definition)
- low density of the built environment and low height of the residential buildings (assessed visually through satellite images)
- high discontinuity in the built environment around the settlements, at least 200m of distance from the closest settlement.
- non contiguous areas of belonging, in order to diversify as much as possible the sample.
- low demographic size (considered following the INSEE classification between 2.000 and 10.000 inhabitants)
- a high increase in the resident population compared to the previous census (higher than the regional average increase rate between 2001 and 2011)

C1_Arconate (MI)
Located in the Province of Milan, it is included in the Metropolitan Homogeneous Area (MHA) of *Alto Milanese* (7).

C2_Busnago (MI until 2004; now MB),
Located in the province of Milan until 2004, it is now part of the Monza-Brianza province. It is also included in *Adda Martesana* MHA (10).

C3_Arzago d'Adda (BG),
located outside of the Metropolitan City boundaries, in the Bergamo province, at the border of the Metropolitan Area.

C4_Cura Carpignano (PV),
located in the southern part of the region, close to Pavia, provincial capital, it is as well external to the Metropolitan City, but included in the Metropolitan Area.

Tab. 48 – Municipalities samples' Population trend and percentage variation between inter-census intervals (1951-2011).

	Population							**Inter-census population variation**					
	1951	**1961**	**1971**	**1981**	**1991**	**2001**	**2011**	**1951-1961**	**1961-1971**	**1971-1981**	**1981-1991**	**1991-2001**	**2001-2011**
Arconate	2,756	3,286	4,006	4,402	4,474	5,440	6,524	19%	22%	10%	2%	22%	20%
Arzago d'adda	1,500	1,428	1,392	1,446	1,828	2,285	2,760	-5%	-3%	4%	26%	25%	21%
Busnago	2,060	2,183	2,497	3,153	3,789	4,576	6,413	6%	14%	26%	20%	21%	40%
Cura Carpignano	1,530	1,234	1,006	1,125	1,267	2,145	4,371	-19%	-18%	12%	13%	69%	104%
regional average								**17%**	**28%**	**14%**	**11%**	**11%**	**14%**

Source: our elaboration on Istat data.

Fig. 91 – Busnago (C2) satellite image

Source: Google Maps

Fig. 92 - Busnago (C2) street view

Source: Google Maps

Fig. 93 – Arconate (C1) satellite image

Fig. 94 - Arconate (C1) street view

Source: Google Maps

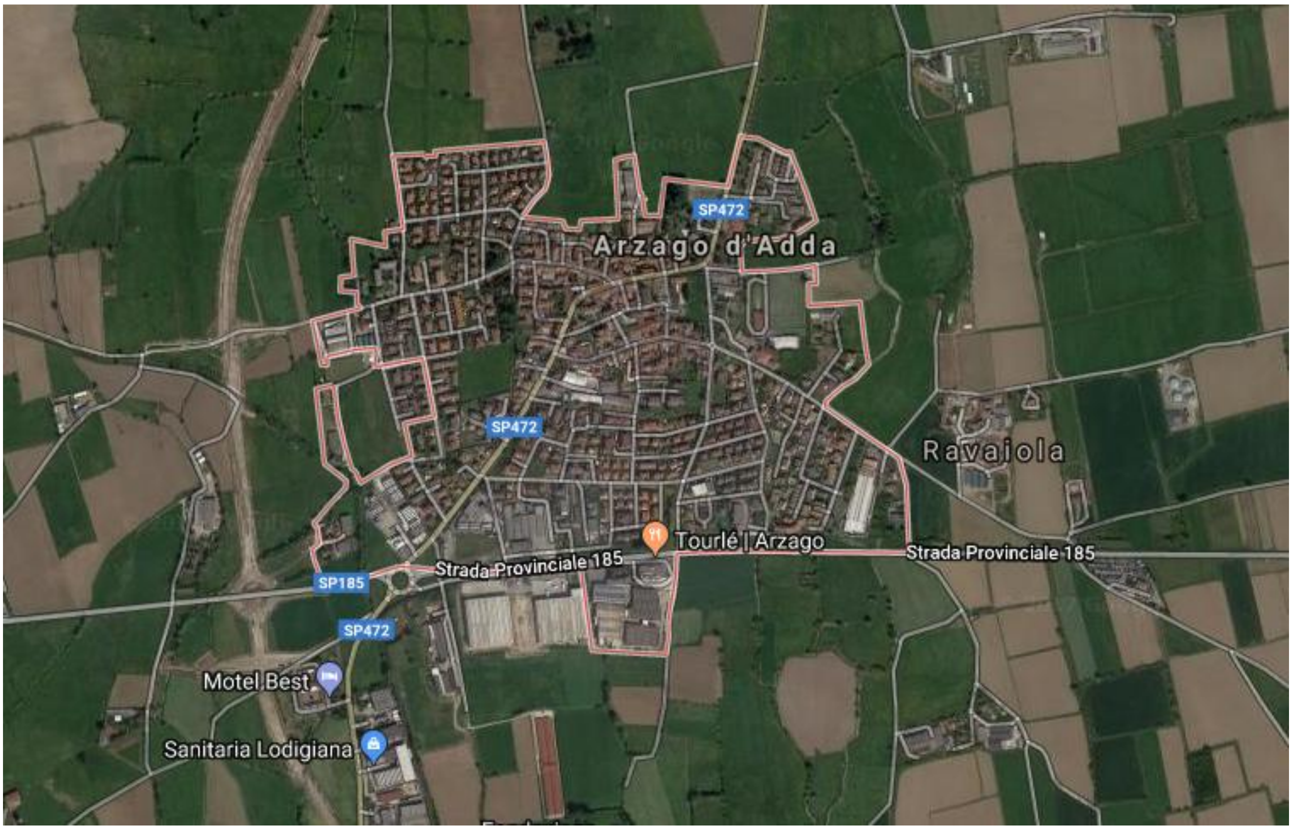
Fig. 95 – Cura Carpignano (C4) satellite image

Source: Google Maps

Fig. 96 - Cura Carpignano (C4) street view

Source: Google Maps

Fig. 97 – Arzago d'Adda (C3) Satellite image



Source: Google Maps

Fig. 98 - Arzago d'Adda (C3) street view

Source: Google Maps

ANNEX 3

Services and amenities considered in proximity to amenities dimension in walkability computation.

Sources and list of selected NACE classes are specified for the Italian (ATECO) and French (NAV) case.

typology	code	service	frequency	ATECO Italy 2007	NAV France
Public transport	1.1	Bus stops	**Daily**	Not available for MMC	Grand Lyon Opendata
	1.2	Train Stations	**Daily**	Open data Lombardia	Grand Lyon Opendata
market (daily)	2.1	supermarket	**Daily**	47.11.2	47.11B-C-D
	2.2	grocery store	**Daily**	47.21-47.21.0.2	47.21Z
				47.23	47.23Z
				47.25	47.25Z
				47.29-47.29.9	47.29Z
	2.3	bakery and pastry	**Daily**	47.24-47.24.2	47.24Z
	2.4	tobacconist	**Daily**	47.26	47.26Z
	2.5	kiosk	**Daily**	47.62	47.62Z
market (weekly)	3.1	hairdresser	**Weekly**	96.02	96.02A
	3.2	butcher	**Weekly**	47.2	47.22Z
	3.3	charcuterie	**Weekly**	47.2	47.22Z
hostelry	4.1	restaurant	**Weekly**	56.10.0-56.10.2	56.10A-B-C
	4.2	cafe	**Weekly**	56.3	56.30Z
	4.3	brasserie	**Weekly**	56.10.0-56.10.2	
banking services	5.1	bank	**Weekly**	64.19.10	64.19Z
	5.2	post office	**Weekly**	53.1	53.10Z
medical (weekly)	6.1	general practitioner	**Weekly**	86.21	86.21Z
	6.2	pharmacy	**Weekly**	47.73.1	47.73Z
sport facilities	7	gym and swimmingpool	**Weekly**	93.1	93.11Z
green spaces	8	urban parks	**Weekly**	OSM data	OSM data
medical services	6.3	hospital	**Monthly**	86.1	86.10Z
	6.4	dentist	**Monthly**	86.23	86.23Z
	6.5	specialist	**Monthly**	86.22	86.22A-B-C
culture	9.1	library	**Monthly**	91.01-2	91.01Z
	9.2	cinema	**Monthly**	59.14*	59.14Z
	9.3	theater	**Monthly**	90.04	90.04Z

*Note: it includes also museums

ANNEX 4

List of the Lyon Municipality IRIS included into a Low or High Walkability index cluster

1) List of Lyon Municipality IRIS included into a Low Walkability Cluster

DCOMIRIS	*IRIS of the Lyon municipality*	Average WI
693850404	Alberic Pont	8
693840403	Bony Bonnet	11
693850302	Champvert Mairie	11
693860101	Cite Internationale	7
693810402	Giraud-Saint-Vincent	14
693860302	Kleber	8
693850202	La Sarra	13
693870701	L'artillerie-La Gare	6
693870602	Le Fleuve	6
693860102	Le Parc	6
693850403	Les Castors-Les Granges	8
693840501	Lyon Plage-Ypres	10
693860501	Mairie	9
693820501	Montrochet-Marche-Gare	6
693810401	Normale-Chartreux	12
693890203	Rochecardon-Gare De Vaise	10
693840401	Saint-Exupery-Popy	13
693860402	Saxe-Bossuet	12
693860303	Vitton	6
693870601	Yves Farges	9

2) List of Lyon Municipality IRIS included into a High Walkability Cluster

DCOMIRIS	*IRIS of the Lyon municipality*	Average WI
693820302	Ampere-Ainay	36
693810303	Annonciade-Saint-Benoit	31
693830404	Baraban-Ferrandiere	34
693860701	Bellecombe-Thiers	24
693820202	Bellecour-A Gourjus	47
693820204	Bellecour-Sala	31
693830104	Bonnel-Servient	29

DCOMIRIS	*IRIS of the Lyon municipality*	Average WI
693840102	Boucle Louis Thevenet	24
693810202	Capucins-Griffon	71
693820402	Carnot-Charite	25
693840103	Cdt Arnaud-Dumont D'urville	24
693870103	Centre Berthelot	17
693810304	Chardonnet	74
693880102	Colbert	21
693840204	Cuire Canuts	17
693830302	Danton-Bir Akeim	31
693830602	Dauphine-Montluc	21
693870401	Domer	35
693850201	Fourviere-Antiquaille	20
693820401	Gailleton-A. Comte	23
693840202	Grande Rue-Bertone	21
693810301	Grande-Cote-Bon-Pasteur	43
693810201	Griffon-Royale	36
693840101	Herbouville-Gros Caillou	26
693840201	Hopital-Saint-Denis	17
693820201	Hotel Dieu	30
693860603	J. Recamier	20
693820103	Jacobins	51
693870402	Jean-Mace	30
693870501	Jules Brunard	27
693860601	Jules Ferry	21
693830102	Jussieu	21
693820101	La Bourse-Grenette	37
693890202	La Gare D'eau	19
693870503	Lamothe	22
693880701	Le Bocage	23
693870202	Le Prado	23
693860103	Les Belges	17
693860304	Les Brotteaux	19
693860702	Les Charmettes-Lafayette	20
693830103	Les Halles	26
693860104	L'helvetie	18
693810102	Louis-Pradel	60
693870203	Mairie	22
693890303	Mairie	29
693810501	Mairie-Martiniere	60
693830205	Mairie-Saint-Sacrement	26
693840303	Mairie-Tabareau	17
693880104	Marius Berliet Nord	14
693880105	Marius Berliet Sud	20
693820102	Merciere-Grolee	38
693860401	Moliere	19

DCOMIRIS	*IRIS of the Lyon municipality*	Average WI
693830201	Moncey	30
693830703	Monchat-Bonnand	19
693830105	Mutualite-Liberte	30
693830301	Part Dieu	29
693870101	Pasteur	29
693830502	Paul Bert-Maisons Neuves	25
693840203	Place Croix Rousse-Austerlitz	30
693830403	Pompidou	17
693830101	Prefecture	25
693860201	Puvis De Chavannes	18
693830901	Richard Vitton-Docteur Long	19
693830402	Richerand-Petites Soeurs	22
693830601	Rouget-De-L-Isle-Felix Faure	26
693870403	Route De Vienne	16
693830204	Saint-Amour	38
693830405	Saint-Anne De Baraban	30
693850103	Saint-Georges	34
693850102	Saint-Jean	26
693870302	Saint-Louis	29
693870201	Saint-Michel	35
693850101	Saint-Paul	20
693890301	Salengro	33
693830203	Saxe-Vileroy	28
693870502	Stalingrad	37
693810101	Terreaux-Bat-D-Argent	48
693830802	Trarieux-Lacassagne	21
693810302	Trois-Gaules	47
693870102	Universites	17
693820301	Vaubecour-Mairie	35
693820503	Verdun-Suchet	21
693870301	Victor Bach	36
693830401	Villette Gare	21
693830501	Villette-Paul Bert	18
693830202	Voltaire	21

ANNEX 5

List of the Lyon Municipality Quartiers and share of areas classified *high*, *low* or *not significant* walkability cluster.

		% of areas clusters		
Arrondissement	Lyon Quartiers	High WI	Low WI	not significant
1	Ouest Pentes	29%	27%	44%
1	Haut Et Coeur Des Pentes	83%	17%	0
1	Bas Des Pentes / Presqu'ile	100%	0	0
2	Perrache - Confluence	13%	60%	28%
2	Bellecour - Cordeliers	100%	0	0
2	Bellecour - Carnot	87%	0	13%
3	Mutualite - Prefecture - Moncey	100%	0	0
3	Voltaire - Part Dieu	100%	0	0
3	Villette - Paul Bert	99%	0	1%
3	Sans Souci - Dauphine	38%	0	62%
3	Montchat	36%	0	64%
4	Croix-Rousse Centre	59%	0	41%
4	Croix-Rousse Saone	0	55%	45%
4	Croix-Rousse Ouest	0	63%	37%
4	Croix-Rousse Est Et Rhone	100%	0	0
5	Quartiers Anciens	60%	18%	22%
5	Colline Des Funiculaires	5%	33%	62%
5	Champvert - Point Du Jour - Jeunet	0%	31%	69%
5	Menival - Battieres - La Plaine	0%	0	100%
6	Coeur De Quartier Bellecombe Village	99%	0	1%
6	Coeur De Quartier Brotteaux	49%	16%	34%
6	Coeur De Quartier Saxe-Roosevelt	26%	25%	49%
6	Coeur De Quartier Parc-Duquesne	23%	66%	11%
7	Guillotiere	99%	0	1%
7	Gerland	0	37%	63%
7	Jean Mace	88%	11%	1%
8	Laennec - Mermoz	0	0	100%
8	Grand Trou - Moulin A Vent - Petite Guille	0	0	100%
8	Bachut - Transvaal	19%	0	81%
8	Monplaisir	40%	0	60%
8	Etats-Unis	6%	0	94%
8	La Plaine - Santy	0	0	100%
9	Saint Rambert - Ile Barbe	0	0	100%
9	Champvert - Gorge De Loup	1%	0	99%

9	Vaise - Rochecardon - Industrie	20%	17%	63%
9	La Duchere	0	5%	95%

ANNEX 6

List of Milan Metropolitan City municipalities and their share of disadvantaged areas on the overall municipal territory.

Municipality	PROCOM	% of disadvantaged areas
Cesate	15076	73.4
Vanzaghello	15249	58.0
Zelo Surrigone	15246	50.1
Pero	15170	49.7
Vaprio d'Adda	15230	44.1
Buscate	15038	42.7
Sedriano	15204	41.1
Nosate	15155	39.9
Marcallo con Casone	15134	36.4
Villa Cortese	15248	35.0
Vernate	15236	32.6
Cassinetta di Lugagnano	15061	32.5
Cinisello Balsamo	15077	31.6
Locate di Triulzi	15125	30.4
Baranzate	15250	25.5
Santo Stefano Ticino	15200	25.4
Turbigo	15226	23.1
Nerviano	15154	22.3
San Giorgio su Legnano	15194	21.6
Canegrate	15046	20.5
Garbagnate Milanese	15105	17.0
Cologno Monzese	15081	13.9
Solaro	15213	12.2
Peschiera Borromeo	15171	11.9
Castano Primo	15062	10.3
Corsico	15093	10.0
Rho	15182	9.8
Busto Garolfo	15041	9.2
Parabiago	15168	8.5
San Giuliano Milanese	15195	8.4
Vittuone	15243	7.8
Pozzo d'Adda	15177	7.1
Cesano Boscone	15074	6.9
Mesero	15144	6.6
Magnago	15131	5.4
Novate Milanese	15157	5.3
Rozzano	15189	4.9
Buccinasco	15036	4.7
Ossona	15164	4.3
Bareggio	15012	4.3
Paderno Dugnano	15166	4.0
Senago	15206	3.6
Inveruno	15113	3.5
Lainate	15116	3.4

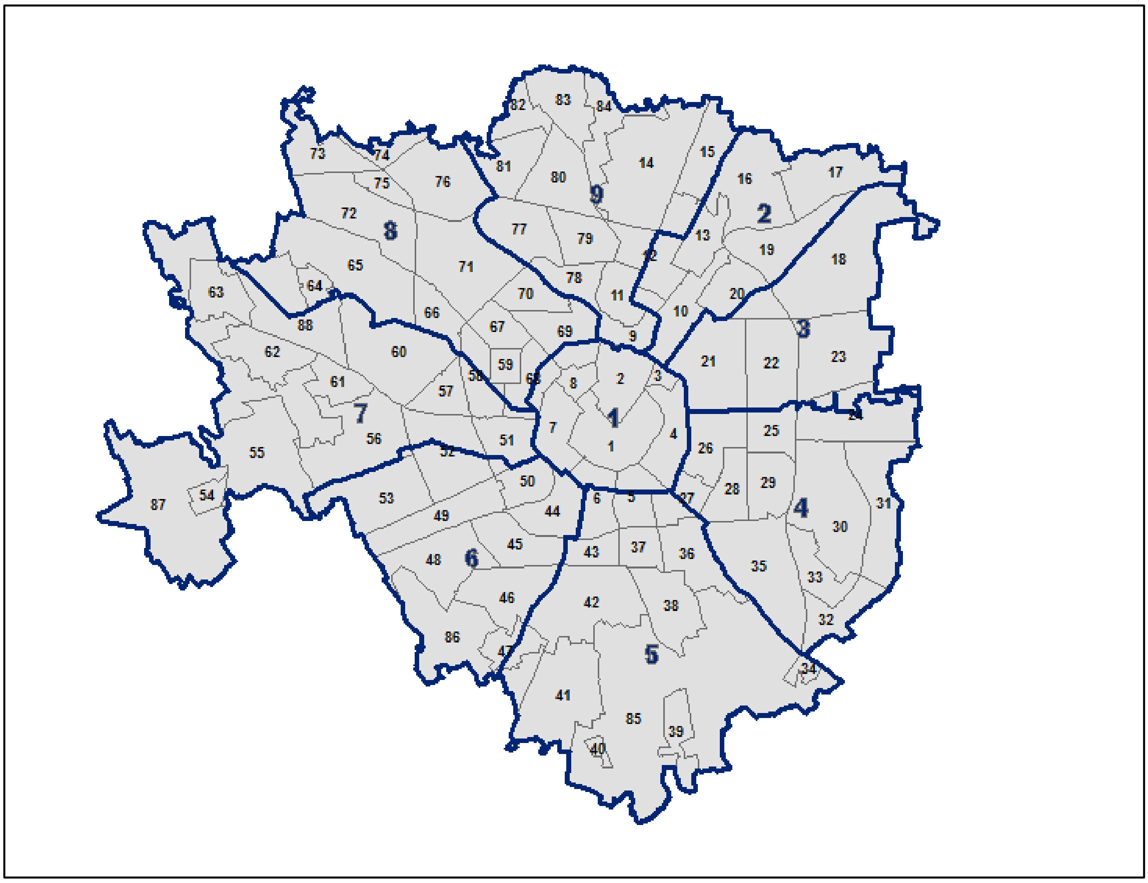
Municipality	PROCOM	% of disadvantaged areas
Dairago	15099	3.4
Sesto San Giovanni	15209	3.3
San Donato Milanese	15192	3.1
Milano	15146	2.6
Cusano Milanino	15098	2.4
Bresso	15032	2.1
Corbetta	15085	2.0
Liscate	15122	1.8
Settimo Milanese	15211	1.7
Bollate	15027	1.5
Abbiategrasso	15002	1.5
San Colombano al Lambro	15191	1.5
Arconate	15007	1.5
Bernate Ticino	15019	1.4
Cassina de' Pecchi	15060	1.3
Magenta	15130	1.2
Legnano	15118	1.0
Truccazzano	15224	0.6
Ozzero	15165	0.6
Rodano	15185	0.6
Vimodrone	15242	0.5
Melzo	15142	0.4
Robecco sul Naviglio	15184	0.3
Cerro Maggiore	15072	0.3
Noviglio	15158	0.2
Cisliano	15078	0.1
Paullo	15169	0.1
Trezzano sul Naviglio	15220	0.1
Cassano d'Adda	15059	0.1
Cusago	15097	0.1
Gaggiano	15103	0.0
Melegnano	15140	0.0
Albairate	15005	0.0
Arese	15009	0.0
Arluno	15010	0.0
Assago	15011	0.0
Basiano	15014	0.0
Basiglio	15015	0.0
Bellinzago Lombardo	15016	0.0
Besate	15022	0.0
Binasco	15024	0.0
Boffalora sopra Ticino	15026	0.0
Bubbiano	15035	0.0
Bussero	15040	0.0
Calvignasco	15042	0.0
Cambiago	15044	0.0
Carpiano	15050	0.0
Carugate	15051	0.0
Casarile	15055	0.0
Casorezzo	15058	0.0
Cernusco sul Naviglio	15070	0.0
Cerro al Lambro	15071	0.0
Colturano	15082	0.0

Municipality	PROCOM	% of disadvantaged areas
Cormano	15086	0.0
Cornaredo	15087	0.0
Cuggiono	15096	0.0
Dresano	15101	0.0
Gessate	15106	0.0
Gorgonzola	15108	0.0
Grezzago	15110	0.0
Gudo Visconti	15112	0.0
Inzago	15114	0.0
Lacchiarella	15115	0.0
Masate	15136	0.0
Mediglia	15139	0.0
Morimondo	15150	0.0
Motta Visconti	15151	0.0
Opera	15159	0.0
Pantigliate	15167	0.0
Pessano con Bornago	15172	0.0
Pieve Emanuele	15173	0.0
Pioltello	15175	0.0
Pogliano Milanese	15176	0.0
Pozzuolo Martesana	15178	0.0
Pregnana Milanese	15179	0.0
Rescaldina	15181	0.0
Robecchetto con Induno	15183	0.0
Rosate	15188	0.0
San Vittore Olona	15201	0.0
San Zenone al Lambro	15202	0.0
Segrate	15205	0.0
Settala	15210	0.0
Trezzano Rosa	15219	0.0
Trezzo sull'Adda	15221	0.0
Tribiano	15222	0.0
Vanzago	15229	0.0
Vermezzo	15235	0.0
Vignate	15237	0.0
Vizzolo Predabissi	15244	0.0
Zibido San Giacomo	15247	0.0

ANNEX 7

List of Milan NILs and share of areas classified as *high*, *low* or *not significant* walkability cluster.

Fig. 99 – Milan municipalities NILs and Municipi subdivision



Source: our elaboration on Comune di Milano data.

Municipio	CODE NIL	Name of the NIL	% of areas clusters High WI	Low WI	not significant
1 e 5	5	Vigentina	100%	0	0
1	8	Parco Sempione	100%	0	0
8	67	Portello	100%	0	0
6 e 7	52	Bande Nere	100%	0	0
9	79	Dergano	100%	0	0
8	70	Ghisolfa	100%	0	0
1 e 7	68	Pagano	100%	0	0
7	58	De Angeli - Monte Rosa	100%	0	0
4	28	Umbria - Molise	100%	0	0
8	59	Tre Torri	100%	0	0

1	3	Giardini Porta Venezia	100%	0	0
8	66	QT 8	100%	0	0
5	43	Tibaldi	100%	0	0
6 e 7	51	Washington	100%	0	0
1	4	Guastalla	100%	0	0
7	57	Selinunte	100%	0	0
1 e 8	69	Sarpi	100%	0	0
1	7	Magenta - San Vittore	100%	0	0
3	21	Buenos Aires - Venezia	100%	0	0
4 e 5	27	Porta Romana	99%	1%	0
1 e 5	6	Ticinese	99%	1%	0
4	26	XXII Marzo	99%	1%	0
1	2	Brera	98%	1%	1%
2 e 9	12	Maciachini - Maggiolina	97%	0	3%
6	50	Tortona	95%	5%	0
3 e 2	20	Loreto	94%	3%	2%
6	45	San Cristoforo	92%	0	8%
1	1	Duomo	92%	8%	1%
5	36	Scalo Romana	91%	2%	8%
3	22	Cittá Studi	85%	13%	2%
4	25	Corsica	85%	12%	3%
2 e 9	11	Isola	85%	7%	9%
5	37	Ex OM - Morivione	83%	0	17%
8	71	Villapizzone	81%	3%	16%
6	49	Giambellino	79%	6%	14%
2	10	Centrale	73%	26%	1%
6	46	Barona	73%	6%	21%
6	44	Navigli	71%	18%	11%
2	19	Padova	71%	2%	27%
2 e 9	13	Greco	66%	27%	8%
9	14	Niguarda - Ca' Granda	65%	14%	21%
9	9	Garibaldi Repubblica	65%	8%	27%
9	15	Bicocca	63%	0	37%
4	35	Lodi - Corvetto	59%	22%	18%
6	48	Ronchetto sul Naviglio	57%	10%	32%
6	53	Lorenteggio	57%	14%	29%
6 e 7	56	Forze Armate	53%	14%	33%
7	60	San Siro	50%	42%	9%
9	78	Farini	47%	51%	2%
5	38	Ripamonti	46%	0	54%
9	80	Affori	46%	11%	43%
5	42	Stadera	41%	7%	52%
7	55	Baggio	37%	1%	63%
9	77	Bovisa	32%	52%	16%
2	16	Viale Monza	31%	6%	64%
4	29	Ortomercato	28%	68%	4%
7	61	Quarto Cagnino	22%	0	78%

3	18	Parco Lambro - Cimiano	17%	15%	68%
7	63	Figino	12%	65%	23%
8	65	Gallaratese	11%	0	89%
3	23	Lambrate	10%	49%	40%
4	33	Rogoredo	10%	0	90%
9	84	Parco Nord	9%	34%	57%
2	17	Adriano	6%	9%	85%
7 e 8	88	Parco Bosco in Cittá	6%	56%	38%
8	72	Maggiore - Musocco	3%	14%	83%
4	30	Mecenate	3%	6%	91%
3 e 4	24	Parco Forlanini - Ortica	0	74%	26%
4	31	Parco Monluè - Ponte Lambro	0	27%	73%
4	32	Triulzo Superiore	0	89%	11%
5	34	Chiaravalle	0	30%	70%
5	39	Quintosole	0	95%	5%
5	40	Ronchetto delle Rane	0	41%	59%
5	41	Gratosoglio - Ticinello	0	0	100%
5 e 6	47	Cantalupa	0	0	100%
7	54	Muggiano	0	0	100%
7	62	Quinto Romano	0	38%	62%
8	64	Trenno	0	0	100%
8	73	Cascina Triulza - Expo	0	100%	0
8	74	Sacco	0	26%	74%
8	75	Stephenson	0	29%	71%
8	76	Quarto Oggiaro	0	9%	91%
9	81	Bovisasca	0	8%	92%
9	82	Comasina	0	0	100%
9	83	Bruzzano	0	6%	94%
5	85	Parco delle Abbazie	0	88%	12%
5 e 6	86	Parco dei Navigli	0	58%	42%
7	87	Parco Agricolo Sud	0	93%	7%

ANNEX 8

IRIS of the Lyon Metropolis territory aggregated in order to compute statistics on Socio-demographic indicators

As suggested in INSEE metadata[99] data at the infar-municipal level (IRIS) need to be prepared before data analysis. Due to statistical issue the value of some variables cannot be adopted directly, but an aggregation of IRIS is needed in order to ensure its consistency. LAB_IRIS variable, ranging from 1 to 5, indicates the characteristics of the IRIS and the treatment it needs (see INSEE metadata for further explanations). The IRIS labelled with value 2 or 3 needed to be merged with other in order to offer a better representation of the socio-demographic characteristics of their population (the Census sample was not big enough to guarantee representativeness of the population). For this reason we aggregated between them 101 IRIS in order to obtain 46 new ones, and be able to use more robust data (usually 2 IRIS were merged, sometimes 3, according to geographic closeness/contiguity and population size).

IRIS	DCOM_IRIS	REG	DEP	UU2010	COM	GRD_QUART	LIBCOM	TRIRIS	TYP_IRIS	LIBIRIS	LAB_IRIS	Pop 2011	AreaKm	Aggregation
0302	693830302	82	69	00758	69383	6938303	Lyon 3e Arrondissement	690771	H	Danton-Bir Akeim	1	8597	0.41	1
0301	693830301	82	69	00758	69383	6938303	Lyon 3e Arrondissement	690771	A	Part Dieu	2	3226	0.46	1
0401	693830401	82	69	00758	69383	6938304	Lyon 3e Arrondissement	690781	H	Villette Gare	2	2684	0.21	2
0402	693830402	82	69	00758	69383	6938304	Lyon 3e Arrondissement	690781	H	Richerand-Petites Soeurs	1	3190	0.16	2
1202	692661202	82	69	00758	69266	6926612	Villeurbanne	690461	H	Albert-Thomas	2	1968	0.15	3

[99] “ Bases de données infra-communales – IRIS Mode et conseils d’utilisation des données”: https://www.insee.fr/fr/information/2383389 (26/11/2017).

IRIS	DCOM_IRIS	REG	DEP	UU2010	COM	GRD_QUART	LIBCOM	TRIRIS	TYP_IRIS	LIBIRIS	LAB_IRIS	Pop 2011	AreaKm	Aggregation
1203	692661203	82	69	00758	69266	6926612	Villeurbanne	690461	H	Gratte-Ciel-Ouest	2	2573	0.10	3
0302	693860302	82	69	00758	69386	6938603	Lyon 6e Arrondissement	690951	H	Kleber	1	2668	0.09	4
0303	693860303	82	69	00758	69386	6938603	Lyon 6e Arrondissement	690951	H	Vitton	1	2754	0.09	4
0501	693860501	82	69	00758	69386	6938605	Lyon 6e Arrondissement	690971	H	Mairie	1	1988	0.07	4
0403	692660403	82	69	00758	69266	6926604	Villeurbanne	690421	H	Tonkin-Nord	2	2201	0.12	5
0302	692660302	82	69	00758	69266	6926603	Villeurbanne	690421	H	Espace-Central	1	3145	0.17	5
0501	692660501	82	69	00758	69266	6926605	Villeurbanne	690411	H	Croix-Luizet-Ouest	1	3416	0.16	6
0502	692660502	82	69	00758	69266	6926605	Villeurbanne	690411	H	Croix-Luizet-Est	2	2689	0.15	6
1601	692661601	82	69	00758	69266	6926616	Villeurbanne	690481	H	Cusset-Ouest	2	3267	0.26	7
0703	692660703	82	69	00758	69266	6926607	Villeurbanne	690431	H	Buers-Sud	1	2476	0.23	7
1702	692661702	82	69	00758	69266	6926617	Villeurbanne	690501	H	Reguillon	1	3114	0.18	8
1701	692661701	82	69	00758	69266	6926617	Villeurbanne	690501	H	Jacques Monod	2	2341	0.12	8
1403	692661403	82	69	00758	69266	6926614	Villeurbanne	690481	H	Perraliere	1	2522	0.16	9
1402	692661402	82	69	00758	69266	6926614	Villeurbanne	690481	H	Damidot	2	3024	0.17	9
1503	692661503	82	69	00758	69266	6926615	Villeurbanne	690491	H	Grandcl	2	2561	0.17	10

IRIS	DCOM_IRIS	REG	DEP	UU2010	COM	GRD_QUART	LIBCOM	TRIRIS	TYP_IRIS	LIBIRIS	LAB_IRIS	Pop 2011	AreaKm	Aggregation
1501	692661501	82	69	00758	69266	6926615	Villeurbanne	690491	H	Grandcl	2	3845	0.39	10
1502	692661502	82	69	00758	69266	6926615	Villeurbanne	690491	H	Genas	2	3779	0.44	10
0701	693830701	82	69	00758	69383	6938307	Lyon 3e Arrondissement	690811	H	Genas CFEL	2	3050	0.19	11
1303	692661303	82	69	00758	69266	6926613	Villeurbanne	690471	H	Maisons-Neuves	1	5131	0.29	11
0203	693880203	82	69	00758	69388	6938802	Lyon 8e Arrondissement	691061	H	Montplaisir Nord	2	2042	0.14	12
0204	693880204	82	69	00758	69388	6938802	Lyon 8e Arrondissement	691061	H	Montplaisir Sud	2	2725	0.14	12
0105	693880105	82	69	00758	69388	6938801	Lyon 8e Arrondissement	691061	H	Marius Berliet Sud	2	4116	0.20	13
0104	693880104	82	69	00758	69388	6938801	Lyon 8e Arrondissement	691061	H	Marius Berliet Nord	2	2842	0.13	13
0102	693880102	82	69	00758	69388	6938801	Lyon 8e Arrondissement	691061	H	Colbert	2	3903	0.17	13
0702	693880702	82	69	00758	69388	6938807	Lyon 8e Arrondissement	691111	H	Etats-Unis	2	3134	0.24	14
0801	693880801	82	69	00758	69388	6938808	Lyon 8e Arrondissement	691111	H	Moulin-a-Vent	1	2601	0.21	14
0802	693880802	82	69	00758	69388	6938808	Lyon 8e Arrondissement	691111	H	Audibert-La Virotte	2	3024	0.23	14
0403	693870403	82	69	00758	69387	6938704	Lyon 7e	691021	H	Route de	2	2847	0.21	15

IRIS	DCOM_IRIS	REG	DEP	UU2010	COM	GRD_QUART	LIBCOM	TRIRIS	TYP_IRIS	LIBIRIS	LAB_IRIS	Pop 2011	AreaKm	Aggregation
							Arrondissement			Vienne				
0402	693870402	82	69	00758	69387	6938704	Lyon 7e Arrondissement	691021	H	Jean-Mace	1	5297	0.20	15
0404	693880404	82	69	00758	69388	6938804	Lyon 8e Arrondissement	691081	H	Mairie	2	3597	0.26	16
0303	693880303	82	69	00758	69388	6938803	Lyon 8e Arrondissement	691071	H	Bataille	1	4388	0.40	16
0902	693880902	82	69	00758	69388	6938809	Lyon 8e Arrondissement	691121	H	Grand Trou	1	2825	0.18	17
0903	693880903	82	69	00758	69388	6938809	Lyon 8e Arrondissement	691121	H	Montagny-Saint-Jean-de-Dieu	1	3740	0.65	17
0402	693880402	82	69	00758	69388	6938804	Lyon 8e Arrondissement	691081	H	La Trinite-Mermoz	2	1291	0.12	18
0401	693880401	82	69	00758	69388	6938804	Lyon 8e Arrondissement	691081	H	Latarget-Mermoz	1	1671	0.11	18
0204	690290204	82	69	00758	69029	6902902	Bron	690031	H	Terraillon-Plein-Sud	2	3207	0.26	19
0202	690290202	82	69	00758	69029	6902902	Bron	690031	H	Les-Sapins-Pessivas	2	2023	0.16	19
0203	690290203	82	69	00758	69029	6902902	Bron	690031	H	Caravelle	2	1410	0.12	19
0201	690290201	82	69	00758	69029	6902902	Bron	690031	H	Gerard-Philippe Ferdinand-	2	1840	0.22	19

IRIS	DCOM_IRIS	REG	DEP	UU2010	COM	GRD_QUART	LIBCOM	TRIRIS	TYP_IRIS	LIBIRIS	LAB_IRIS	Pop 2011	AreaKm	Aggregation
										Buisson				
0501	690290501	82	69	00758	69029	6902905	Bron	690051	H	Parilly-Nord	2	2346	0.28	20
0402	690290402	82	69	00758	69029	6902904	Bron	690051	H	Centre	1	3353	0.57	20
0302	691990302	82	69	00758	69199	6919903	Saint-Fons	690191	H	L-Arsenal-Sud	1	2251	0.14	21
0303	691990303	82	69	00758	69199	6919903	Saint-Fons	690191	H	Grande-Terre	2	1498	0.13	21
0602	692560602	82	69	00758	69256	6925606	Vaulx-en-Velin	690291	H	Vernay	1	2106	0.10	22
0601	692560601	82	69	00758	69256	6925606	Vaulx-en-Velin	690291	H	Ecoin-Thibaude	2	2199	0.11	22
0603	692560603	82	69	00758	69256	6925606	Vaulx-en-Velin	690291	H	Vercheres	2	3581	0.44	22
1804	692661804	82	69	00758	69266	6926618	Villeurbanne	690511	H	Poudrette	2	1596	0.21	23
1803	692661803	82	69	00758	69266	6926618	Villeurbanne	690511	H	Les-Brosses	1	2411	0.43	23
0103	692900103	82	69	00758	69290	6929001	Saint-Priest	690621	H	Diderot-Aliende	1	1681	0.21	24
0101	692900101	82	69	00758	69290	6929001	Saint-Priest	690621	H	Bellevue	2	1862	0.10	24
0102	692900102	82	69	00758	69290	6929001	Saint-Priest	690621	H	Alpes	2	1204	0.13	24
0401	692900401	82	69	00758	69290	6929004	Saint-Priest	690661	H	Bel-Air 1	2	1740	0.12	25
0105	692900105	82	69	00758	69290	6929001	Saint-Priest	690621	H	Herriot-Carre Rostand	2	2423	0.55	25
0602	692900602	82	69	00758	69290	6929006	Saint-Priest	690651	H	Village-Est	2	2284	0.41	26
0601	692900601	82	69	00758	69290	6929006	Saint-Priest	690651	H	Village-Ouest	1	2870	0.61	26

IRIS	DCOM_IRIS	REG	DEP	UU2010	COM	GRD_QUART	LIBCOM	TRIRIS	TYP_IRIS	LIBIRIS	LAB_IRIS	Pop 2011	AreaKm	Aggregation
0204	692590204	82	69	00758	69259	6925902	V9nissieux	690321	H	Max-Barel	2	1927	0.16	27
0203	692590203	82	69	00758	69259	6925902	V9nissieux	690321	H	Charreard	1	2508	0.71	27
0403	692590403	82	69	00758	69259	6925904	V9nissieux	690341	H	Amstrong	2	2084	0.15	28
0402	692590402	82	69	00758	69259	6925904	V9nissieux	690341	H	Anatole-France	1	6172	0.40	28
0501	692590501	82	69	00758	69259	6925905	V9nissieux	690301	H	Louis-Pergaud	2	3217	0.22	29
0502	692590502	82	69	00758	69259	6925905	V9nissieux	690311	H	Leo-Lagrange	1	2299	0.24	29
0102	692590102	82	69	00758	69259	6925901	V9nissieux	690301	H	Gabriel-Peri	1	2501	0.49	30
0103	692590103	82	69	00758	69259	6925901	V9nissieux	690311	H	Centre-Nord	2	2770	0.47	30
0103	692040103	82	69	00758	69204	6920401	Saint-Genis-Laval	690231	H	Basses-Barolles	2	3067	1.47	31
0103	691000103	82	69	00758	69100	6910001	Irigny	ZZZZZZ	H	Venieres	4	2416	4.30	31
0402	691490402	82	69	00758	69149	6914904	Oullins	690171	H	Saulaie	2	1481	0.55	32
0102	691420102	82	69	00758	69142	6914201	La Mulati	ZZZZZZ	H	Le Confluent	4	2034	1.27	32
0504	693820504	82	69	00758	69382	6938205	Lyon 2e Arrondissement	690741	H	Sainte-Blandine-Casimir Perier	1	3920	0.16	33
0502	693820502	82	69	00758	69382	6938205	Lyon 2e Arrondissement	690741	H	Rambaud-Seguin	2	3160	0.33	33
0603	693870603	82	69	00758	69387	6938706	Lyon 7e Arrondissement	691031	H	Le Rhone	1	2485	0.10	34

IRIS	DCOM_IRIS	REG	DEP	UU2010	COM	GRD_QUART	LIBCOM	TRIRIS	TYP_IRIS	LIBIRIS	LAB_IRIS	Pop 2011	AreaKm	Aggregation
0801	693870801	82	69	00758	69387	6938708	Lyon 7e Arrondissement	691041	H	Marcel Merieux	2	2239	0.29	34
0704	693870704	82	69	00758	69387	6938707	Lyon 7e Arrondissement	691041	H	Jean-Jaurrs Sud	2	2736	0.15	35
0705	693870705	82	69	00758	69387	6938707	Lyon 7e Arrondissement	691041	H	Jean-Jaurrs Nord	2	2299	0.11	35
0703	693870703	82	69	00758	69387	6938707	Lyon 7e Arrondissement	691051	H	Cite-Jardin	1	4295	0.28	35
0204	693820204	82	69	00758	69382	6938202	Lyon 2e Arrondissement	690721	H	Bellecour-Sala	1	2451	0.16	36
0202	693820202	82	69	00758	69382	6938202	Lyon 2e Arrondissement	690721	H	Bellecour-a Gourjus	2	2292	0.12	36
0201	693830201	82	69	00758	69383	6938302	Lyon 3e Arrondissement	690761	H	Moncey	1	2846	0.10	37
0105	693830105	82	69	00758	69383	6938301	Lyon 3e Arrondissement	690751	H	Mutualite-Liberte	2	3091	0.18	37
0501	693890501	82	69	00758	69389	6938905	Lyon 9e Arrondissement	691161	H	La Griviere	2	1422	0.26	38
0502	693890502	82	69	00758	69389	6938905	Lyon 9e Arrondissement	691161	H	Champvert Nord	1	2733	0.51	38
0403	693890403	82	69	00758	69389	6938904	Lyon 9e Arrondissement	691161	H	Le Beal-Gorge de Loup	1	4000	0.47	39
0302	693890302	82	69	00758	69389	6938903	Lyon 9e Arrondissement	691151	H	Saint-Simon-Marietton	2	2953	0.55	39

IRIS	DCOM_IRIS	REG	DEP	UU2010	COM	GRD_QUART	LIBCOM	TRIRIS	TYP_IRIS	LIBIRIS	LAB_IRIS	Pop 2011	AreaKm	Aggregation
0302	690810302	82	69	00758	69081	6908103	6cully	690121	H	Valvert	2	2941	1.04	40
0202	690810202	82	69	00758	69081	6908102	6cully	690121	H	Centre	2	1801	0.42	40
0201	690810201	82	69	00758	69081	6908102	6cully	690121	H	Pole Enseignement-Recherche	2	2660	0.82	41
0105	690810105	82	69	00758	69081	6908101	6cully	690111	H	Vivier	1	2177	1.47	41
0403	693840403	82	69	00758	69384	6938404	Lyon 4e Arrondissement	690871	H	Bony Bonnet	1	2233	0.12	42
0401	693840401	82	69	00758	69384	6938404	Lyon 4e Arrondissement	690871	H	Saint-Exupery-Popy	2	1761	0.20	42
0604	693890604	82	69	00758	69389	6938906	Lyon 9e Arrondissement	691171	H	La Sauvegarde	2	2805	0.25	43
0301	690810301	82	69	00758	69081	6908103	6cully	690121	H	Charlier	2	2777	1.15	43
0104	693890104	82	69	00758	69389	6938901	Lyon 9e Arrondissement	691131	H	Balmont Est	2	1688	0.18	44
0601	693890601	82	69	00758	69389	6938906	Lyon 9e Arrondissement	691171	H	Balmont le Fort	2	1355	0.22	44
0304	692860304	82	69	00758	69286	6928603	Rillieux-la-Pape	690611	H	Semailles Nord	2	2142	0.20	45
0303	692860303	82	69	00758	69286	6928603	Rillieux-la-Pape	690611	H	Semailles Sud	1	1965	0.15	45
0101	690910101	82	69	00758	69091	6909101	Givors	690131	H	Vernes-Haut	2	1382	0.11	46
0102	690910102	82	69	00758	69091	6909101	Givors	690131	H	Bas-Vernes	1	2528	0.42	46

Tab. 49 – Legend

IRIS	IRIS
DCOM_IRIS	Department + Commune or Arrondissement + IRIS
REG	Region
DEP	Department
UU2010	Unité Urbaine
COM	Commune or Arrondissement
LIBCOM	Libellé commune ou ARM
TRIRIS	TRIRIS
GRD_QUART	Grand quartier
LIBIRIS	Libellé de l'IRIS
TYP_IRIS	Type d'IRIS
LAB_IRIS	Label de l'IRIS en 2011
Pop 2011	Resident Population 2011
AreaKm	Surface of the IRIS in km^2
Aggregation	Code of aggregation