Antonio Leone Carmela Gargiulo

Editors

Environmental and territorial modelling for planning and design

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Smart City, Urban Planning for a Sustainable Future

4

Environmental and territorial modelling for planning and design

Antonio Leone   Carmela Gargiulo

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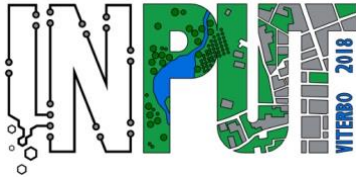
This book collects the papers presented at the 10th International Conference INPUT 2018 which will take place in Viterbo from 5th to 8th September. The Conferences pursues multiple objectives with a holistic, boundary-less character to face the complexity of today socio-ecological systems following a systemic approach aimed to problem solving. In particular, the Conference aims to present the state of art of modelling approaches employed in urban and territorial planning in national and international contexts.

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This book is the latest scientific contribution of the "Smart City, Urban Planning for a Sustainable Future" Book Series, dedicated to the collection of research e-books, published by FedOAPress - Federico II Open Access University Press. The volume contains the scientific contributions presented at the INPUT 2018 Conference and evaluated with a double peer review process by the Scientific Committee of the Conference. In detail, this publication, including 63 papers grouped in 11 sessions, for a total of 704 pages, has been edited by some members of the Editorial Staff of "TeMA Journal", here listed in alphabetical order:
- Rosaria Battarra;
- Gerardo Carpentieri;
- Federica Gaglione;
- Rosa Anna La Rocca;
- Rosa Morosini;
- Maria Rosa Tremiterra.
The most heartfelt thanks go to these young and more experienced colleagues for the hard work done in these months. A final word of thanks goes to Professor Roberto Delle Donne, Director of the CAB - Center for Libraries "Roberto Pettorino" of the University of Naples Federico II, for his active availability and the constant support also shown in this last publication.

Rocco Papa
Editor of the Smart City, Urban Planning for a Sustainable Future" Book Series
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INTRODUCTION

Between 5th and 8th September 2018 the tenth edition of the INPUT conference took place in Viterbo, guests of the beautiful setting of the University of Tuscia and its DAFNE Department.

INPUT is managed by an informal group of Italian academic researchers working in many fields related to the exploitation of informatics in planning.

This Tenth Edition pursed multiple objectives with a holistic, boundary-less character, to face the complexity of today socio-ecological systems following a systemic approach aimed to problem solving. In particular, the Conference will aim to present the state of art of modeling approaches employed in urban and territorial planning in national and international contexts.

Moreover, the conference has hosted a Geodesign workshop, by Carl Steinitz (Harvard Graduate School of Design) and Hrishi Ballal (on skype), Tess Canfield, Michele Campagna.

Finally, on the last day of the conference, took place the QGIS hackfest, in which over 20 free software developers from all over Italy discussed the latest news and updates from the QGIS network.

The acronym INPUT was born as INformatics for Urban and Regional Planning. In the transition to graphics, unintentionally, the first term was transformed into "Innovation", with a fine example of serendipity, in which a small mistake turns into something new and intriguing. The opportunity is taken to propose to the organizers and the scientific committee of the next appointment to formalize this change of the acronym.

This 10th edition was focused on Environmental and Territorial Modeling for planning and design. It has been considered a fundamental theme, especially in relation to the issue of environmental sustainability, which requires a rigorous and in-depth analysis of processes, a theme which can be satisfied by the territorial information systems and, above all, by modeling simulation of processes.

In this topic, models are useful with the managerial approach, to highlight the many aspects of complex city and landscape systems. In consequence, their use must be deeply critical, not for rigid forecasts, but as an aid to the management decisions of complex systems.

ITALIAN METROPOLITAN CITIES

A QUANTITATIVE ANALYSIS AIMED AT THE IMPLEMENTATION OF GOVERNANCE AND INNOVATION POLICIES

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ABSTRACT

The paper analyses the metropolitan system in Italy. The debate on this matter has been going on for 60 years with peaks in specific moments. Aim of the paper, is to verify the adequacy of the system of 15 metropolitan cities in terms of relevance and weight on national and international scale.

The paper begins from the analysis of the backgrounds and of the actual state of the research on the metropolitan issue. A second section analyses the metropolitan cities in Italy in terms of significance on an international scale and in terms of system of rules and functions.

The third part identifies the main sectors influencing metropolitan cities stating it in specific and transversal sectors. The paper deepens the specific sectors using a system of indicators and statistical analyses bringing to the computation of indices of metropolisation. These indexes outline more precisely the belonging of the Italian cities to the metropolitan category confirming the hypothesis that 15 metropolitan cities is a too large sample.

KEYWORDS
Metropolitan Area; Italian Metropolitan Cities; Index of Metropolisation

1   BACKGROUND AND ACTUAL STATE OF THE RESEARCH

With "metropolitan area" we refer to the urban expansion that quickly pours the space surrounding cities. The first extensive attempt to define the metropolitan area notion was the identification, made by the United States Census Bureau, of industrial districts for the Census of Manufactures of 1905 (Berry et al., 1968). The development of the studies in the metropolitan areas has a great push in the period 1960-2000. In US and Europe the researches brought to a deeper knowledge of the topic with significant advances. In 1965 Friedmann and Miller introduced the concept of "urban field" considering the metropolitan area no longer as a physical entity but a network of flows and places formed by people, goods and information. Berry, Goheen and Goldstein (1968) use the travelling for work to define the "commuting fields", namely the combination of the areas of origin of the moves (concentration of housing) and the areas of destination (concentration of labour). In this way, it creates a market of labour focused on a central city. Hall and Hay (Clark, 1982), analyse the Standard Metropolitan Labour Areas (SMLA) and introduce the concept of Metropolitan Economic Labour Area (MELA). The process of building of the Italian metropolitan system started in the 1960s with the researches of Cafiero and Busca (1970), Sforzi (1997), and Marchese (1989).

The study of Cafiero and Busca (1970) had the aim to adjust the territorial and economical dimensions of the metropolitan issue, detecting their evolutionary paths for the following decades. The study did not adopt a specific statistical approach for the determination of the metropolitan areas, given that the logical structure used for the research came from the concept of Standard Metropolitan Area (SMA), introduced in 1949 in US Census (Mazzeo, 2009). Basic indicators were used for the analysis.

In the Italian Census of 1981 the first data collection about commuter's flows was realized. The first research using these data as basis to define the metropolitan state has brought to the definition of 955 local work's systems that are associated in 177 functional work's regions (Sforzi, 1997). In the same period, another line of research proposed to use interaction measurements based on the ability of identifying the relations that form interdependence among simple territorial areas (Chelli et al., 1991; Vitali, 1996). In the last years, new forms of reading of the metropolitan Italian system have come out. Recent studies consider the metropolitan phenomenon as a process extended to a regional dimension (Balducci et al., 2017). The idea that the institutional structures and the territorial areas of narrower extension are inefficient comes from this assumption. Lead concept is the regional character of the new urban era. The hook-up to support this hypothesis is the direct reference to Edward Soja (2006) for which it is not the city to perish, as Friedmann (2002) said, but indeed it enlarges the borders spreading the regional dimension. In this view, it overcomes the metropolis concept by coming to a wider view of urban-regional order.

2   THE METROPOLITAN CITIES IN ITALY. SIGNIFICANCE

The Italian metropolitan areas are identified by a national law, which provides for the institution of ten metropolitan cities on the territory of the previous provinces. The new institutional subject interest the cities of Rome, Milan, Naples, Turin, Genoa, Venice, Bologna, Florence, Bari and Reggio Calabria. The special administrative Regions have identified in their territory other metropolitan cities. Are part of this second list Cagliari in Sardinia, Palermo, Catania, and Messina in Sicily. A last non official entry could be Trieste in Friuli-Venezia Giulia (Gasparini, 2010).

Fig. 1 Italian Metropolitan Cities

METROPOLITAN CITY (MC)	TERRITORIAL AREA (Sq.Km, 2014)	POPULATION (Nr., 2014)	TOTAL ADDED VALUE AT CURRENT PRICES (Million Euros, 2014)
Milan	1,575.65	3,196,825	150,723.72
Turin	6,827.01	2,291,719	62,304.50
Venice	2,472.91	858,198	23,342.27
Trieste (1)	212.51	236,073	6,649.80
Genoa	1,833.79	862,175	25,578.78
Bologna	3,702.32	1,004,323	34,275.72
Florence	3,513.69	1,012,180	31,906.04
Rome	5,363.28	4,342,046	137,724.55
Neaples	1,178.93	3,118,149	50,230.73
Bari	3,862.88	1,266,379	21,670.74
Reggio Calabria	3,210.37	557,993	6,946.39
Cagliari	4,570.41	561,925	10,945.65
Palermo	5,009.28	1,276,525	19,222.49
Catania	3,573.68	1,116,917	16,553.93
Messina	3,266.12	645,296	9,619.03
Overall MC	*50,172.83*	*22,346,723*	*607,694.34*
Italy	*302,072.84*	*60,795,612*	*1,459,881.00*
% MC respect Italy	*16.61*	*36.76*	*41.63*

Tab. 1 Territorial area, population and total added value of the Metropolitan Cities. Data are related to 2014. (1) Trieste is a proposed metropolitan city. Source: Italian Government, http://dati.italiaitalie.it/opendata.aspx

Italian urban structure has developed with great speed after the Second World War and some of the great cities have extended beyond and across the administrative boundaries. The cases of Milan and Naples are paradigmatic of this situation. Other great cities, as Rome, have used their large territory for to ovecome the expansion without overflow.

In all cases, the urban reality in Italy has become more complex and more and more widen urban agglomerations have risen next to traditional cities (Tab. 1).

The choice of identifying such a large number of metropolitan cities can be considered entirely political, given that, technically, only a few can be considered so by demographic dimension, economic weight, and international importance.

Another evidence in support of this comes from the analysis of the presence of Italian cities in international studies on metropolitan cities.

Tab. 2 presents the analysis on nine databases managed by official agencies, research centres, and associations of cities and shows the frequency with which Italian metropolitan cities are present. The emerging figure is that there is a group of seven cities (Milan, Rome, Turin, Bologna, Florence, Genoa and Naples) that are present in over half of the databases, while the others are present only in a sample of cases ranging from two to four. It should also be emphasized that all the centers are present in the first two databases. These, however, belong to Eurostat and can be considered an institutional databases for the European cities.

Metro City	01	02	03	04	05	06	07	08	09
Milan	■	■	■	■	■		■	■	■
Turin	■	■	■	■	■		■	■	■
Rome	■	■	■	■	■		■	■	■
Bologna	■	■	■	■			■	■	
Florence	■	■	■	■			■		
Genoa	■	■	■	■			■	■	
Naples	■	■	■	■	■				■
Cagliari	■	■	■						
Venice	■	■	■	■					
Bari	■	■	■						
Trieste	■	■	■				■		
Messina	■	■	■						
Catania	■	■	■	■					
Palermo	■	■	■	■					■
Reggio Calabria	■	■	■						

Tab. 2 Presence of Italian metropolitan cities in a selection of international studies and internet sites
01. Eurostat. Cities and greater cities. http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=urb_cpop1&lang=en. 02. Eurostat. Functional Urban Areas. http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=urb_lpop1&lang=en. 03. OECD. http://stats.oecd.org/. Regions and Cities. Metropolitan Areas. 04. United Nations (2016), The World's Cities in 2016. Data booklet. 05. Universidad de Navarra, IESE Business School (2017), IESE Cities in Motion Index. 06. www.metropolis.org (15/03/2018). 07. http://www.lboro.ac.uk/gawc (15/03/2018) (2012), GaWC Data Set 26. 08. http://www.lboro.ac.uk/gawc/datasets/da8_1.html (15/03/2018) European World Cities – Office distribution of global service firms, GAWC Data Set 8. 09. http://www.citymayors.com/statistics/largest-cities-mayors-151.html (2017), Largest cities in the world and their mayors.

Moreover, over half of the Italian metropolitan cities are not representative at international level and are not even present in places where visibility come from voluntary activities. This confirms a marked weakness of the majority of these cities. Few of them, in fact, can claim to be at pace with other international cities, and these few are all located in the Central-Northern part of the country. Therefore, the Southern cities weakness is here visible too.

3   THE METROPOLITAN CITIES IN ITALY. REGULATION

The process of identification of metropolitan cities starts approximately thirty years ago, with the Act nr. 142 of 1990 (Local Autonomies Reform). Because of the lack of take-off of the provisions of 1990, in 2014 was adopted the Act nr. 56 (Fedeli, 2016).

Aim of the national law is to provide these territories with a modern administrative structure, so that they can compete more effectively at national and international level. The new institution represents an answer to the need of governance of complex urban areas (Mazzeo, 2015).

The reform process of the Italian administrative system based their fundamental motivations on the thematic of simplification. The achievement of this aim seemed to be necessary both to increase the efficiency of the peripheral structures of the State and to reduce its overall weight on the economic and productive system. The formation of metropolitan cities falls within this process.

The source of law of this administrative body is founded on the Constitution and the Act nr. 56 of April 7, 2014, named "Arrangements on metropolitan cities, provinces, unions and mergers of municipalities". The first describes the metropolitan city as an intermediate institution and assigns to it generic statutory, regulative, administrative and financial authorities (Article 114 and followings). The second, by paragraph 2 to 50, defines the structure of the new local authority and assigns to it specific functions.

The territorial extension, one of the main obstacles faced by 1990 previous reform's acts, is imposed as coincident with that of the deleted provinces. With regards to the aspects connected with territorial planning, Act nr. 56, foresees two different tools. The first is the Metropolitan City Strategic Plan (Piano Strategico Triennale – PST), setting guidelines for the performance of the metropolitan functions, also with regards to the implementation of regional functions, delegated or assigned on the basis of specific acts. The PST has a life of three years and may include an annual review. The second tool is the General Territorial Plan (Piano Territoriale Generale – PTG), a plan that specifically deals with communication facilities, service networks, infrastructures under the jurisdiction of the metropolitan community, and constraints and aims to activity and function's practice of the municipalities included in the metropolitan territory. Territorial plans of the Provinces (PTCP) adds functions, as well as the protection and enhancement of the environment.

Territorial planning of metropolitan areas can be considered as a coordination tool connecting territorial assignments that are part of the metropolitan cities with the needs of the communities that they belong to (Gastaldi & Zarino, 2015).

4   SECTORS INFLUENCING METROPOLITAN CITIES

Urban systems are increasingly at the centre of global development processes (Sassen, 2001). Cities are constantly developing in all continents; they are the place where the majority of the Earth's inhabitants live, with a growing tendency that the forecasts believe certain (Mazzeo, 2016; UN, 2015) (Fig. 2). The growing of the conurbations reinforces the notion of metropolitan areas «that are multi-centred urban regions which develop mainly along functional networks, cutting across institutionally defined territorial boundaries» (Kübler et al., 2002). In Europe in particular the process of urbanization has a specific importance, both in terms of population (about 80% of the total is an urban population), and economic. Within this continental space metropolitan areas present more specificity in terms of concentration of assets, innovation and produced wealth (BBSR, 2011).

Considering urban agglomerations of any dimension, it is possible to highlight a number of factors that favour their evolution in the direction of a larger dimension in physical and functional terms, as well as for the role at national and international level. Certainly, among these factors, economy plays a predominant role; but besides that, there are other factors of greater interest to urban studies, like density and territorial use, mobility, quality, governance, and innovation.
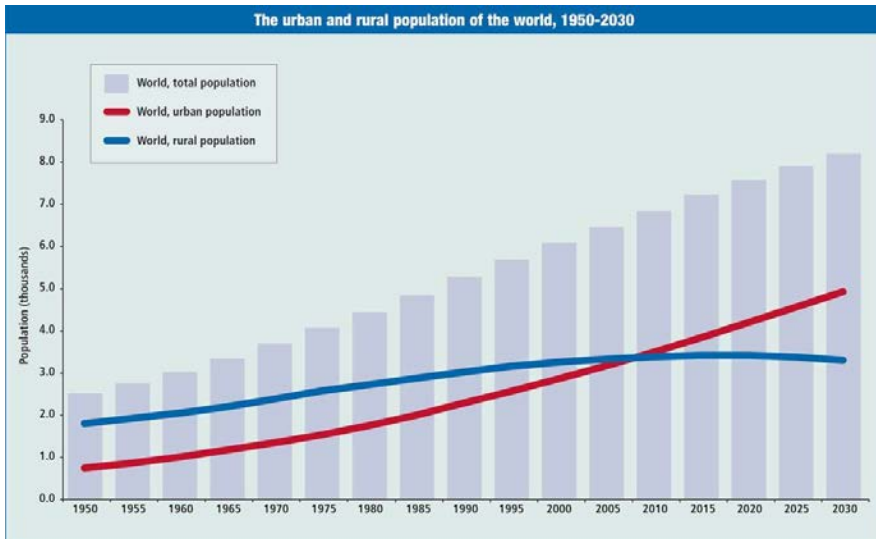
Fig. 2 Urban and rural population. Source: http://www.un.org/esa/population/publications/WUP2005/2005wup.htm

4.1 ECONOMY

Wider urban structures are most successful to fit the actual changings: metropolitan areas and metropolitan regions are among them. For the economists the «large size and rapid recent growth of urban areas are responses to income and employment opportunities provided there. It is but a small step from this observation to the assumption that the conditions of production differ in crucial respects as between urban and non-urban areas and as between urban areas of different size» (Mills, 1967). This is why «the goods production function justifies the existence of the city. The city may be located where the efficiency parameter in the production function for goods is especially favourable» (Mills, 1967).

The economic research bears that the process of agglomeration in metropolitan regions can increase economic and social development, while, on the other hand, fragmentation in metropolitan areas is catastrophic for decision-making. The role of the economic process is fundamental. «Recent concerns with quality of life or with climate change have obscured the basic raison d'être of cities – their productivity, an inclusive productivity that is, to an important extent, a function of their size. Other things being equal, larger metropolitan areas are more productive than smaller ones. Their economies are more resilient and more efficient but, most of all, their advantages stem from their larger, integrated metropolitan labor markets. In large, integrated labor markets, all workers have access to all jobs. Workers are able to find the best jobs and workplaces are able to find the best workers. That is why larger labor markets are more productive than smaller ones» (Shlomo, 2017).

4.2 DENSITY AND TERRITORIAL USES

Density is one of the main indicator on which the debate on urban forms has focused. «Density is a key term which relates the geography of spatial activities to the geometry of places through the built environment» (Batty, 2009).

This assumption can seem a simplification, but it captures a very important aspect of the phenomenon: the passage from city to non-city is when the density decreases, regardless of the curve's trend characterizing it, the urban functions become more uncommon, and the complexity present in the urban agglomerations falls. Urban planners have tried to define tools to overcome the antinomy between the two conceptual forms of city and non-city. Among them, we can cite the attempt to export the urban features outside the city, with the creation of density and centralities (mobility nodes, commercial poles, leisure infrastructure and more) where they did not exist. However, new extra-urban centralities that, if compared to classic urban ones, are much more simplified in their functionality and structure and they need of an efficient mobility network that is able to connect among them points of the territory increasingly distant but more and more interconnected (Gordon et al., 1997). Density is related to time. The evolution that has led to present urban forms has taken place on different temporal arches from city to city. However we are able to measure it for a frame of hundreds of years. Given this time frame, we can assume that the modern city created over the last hundred years is, necessarily, an unstructured and simplified city, compared to the urban areas that possess a much wider stratification. Connected with the density's variance is the processes of uncontrolled urbanization deriving mainly by the self-referential nature of the market economic system and by its indifference towards the environment. In this process, the city becomes a testing site of the economic theories based on unlimited appropriation of the space (Altshuler, 1977; EEA, 2006).

4.3   MOBILITY

Mobility represents for urban centers the pulsating system along which the goods flow and people move. In cities, mobility is a system involving different modes of transport, with its own characteristics, and dedicated to a specific category of user. The combination and coordination of these modalities determines the efficiency of an urban system (Black, 1995). Mobility and economic systems are closely connected, as are the mobility system and density. Furthermore, mobility represents a field of experimentation of another factor, that is the energy necessary to keep the system functioning (Beretta, 2018). In this sense, mobility in the metropolitan area represents the field of application of advanced technologies of movement and control, with the aim to increase the efficiency of the system and to reduce the environmental impacts of the mobility processes.

4.4   URBAN QUALITY

The issue of the quality of the metropolitan systems conflicts with their extension and with the increasing trouble of creating and maintaining their requirements on the territory (Węziak-Białowolska, 2016). It is extremely difficult to think of the metropolitan territories in terms of beauty and quality of space, because the urbanization process has generally created new, mediocre areas, with isolated elements of quality. It follows that living and working in a metropolitan space means living and working in a space that provides poor satisfactions from the point of view of psychological well-being. Usually, we link the quality to the structured urban areas and the usefulness to the metropolitan spaces devoted to production. Quality and utility are connected to each other and generally this relationship is of reverse order, so to a greater utility links a lower quality. This in a classic vision. The most recent studies highlight the «critical links between environmental sustainability, quality of life and the future success of cities expressed in terms of social and economic as well as environmental factors» (EEA, 2009, 9). The study of EEA quotes a well-known report on the economics of climate change, the Stern Report (Stern, 2006), arguing «that the real economic costs of unsustainable living and further climate change are much higher than the cost of investments in climate change mitigation and

adaptation. The shift to more sustainable lifestyles is therefore not simply a matter of putting the environment first but also about recognising that the economic viability of cities must built on a sustainable basis of long-term social, environmental and economic stability and equity» (EEA, 2009).

4.5 METROPOLITAN GOVERNANCE

Generally, if the physical size and the number of inhabitants are the main factors linked to a city assuming the name of "metropolis", the definition of "metropolitan area" is associated with the functional relationships created at the local level, the provision of infrastructure and the size of activities' system, mostly the highly specialized (Salet et al., 2003). For this reason, metropolitan areas are territorial systems which enjoy of particular attention at international level, so to reach the constitution of ad hoc administrative structures, provided with operational both managerial and strategic capabilities. For Hamilton et al. (2004), even though metropolitan administration is the key of process, its probability of success depends on the vertical relations established on a central and local level (just think of financial flows from the centre) and on the horizontal relations between the municipalities belonging to a metropolitan region.

Mentions to the "problem of metropolitan government" are often made in characterizing the issues which are supposed to arise in metropolitan regions. From this point of view, the citizens of a metropolitan region are not provided with the tools of government to deal directly with the range of problems. In addition, there is a multiplicity of national and regional individuals, cities, and special public bodies acting within a metropolitan region. We can assume that «the multiplicity of political units in a metropolitan area is essentially a pathological phenomenon. The diagnosis asserts that there are too many governments and not enough government. The symptoms are described as "duplication of functions" and "overlapping jurisdictions"» (Ostrom et al., 1961). From a managing point of view, the presence of autonomous units of government are considered incapable to resolve the metropolitan problems, thanks to their organization that Ostrom calls of "crazy-quilt pattern". The solution is the «reorganization into larger units to provide "a general metropolitan framework" for gathering up the various functions of government. A political system with a single dominant center for making decisions is viewed as the ideal model for the organization of metropolitan government» (Ostrom et al., cit.).

4.6 INNOVATION

The term innovation can represent an opportunity or a blunder. With it we represent different levels of actions. Innovation can mean to change an administrative process by reducing the necessary steps; can mean using a technology that makes it possible to reduce the time required to carry out an action; can mean using an energy source that does not produce emissions or that transforms centralized production into a capillary production also usable as an exchange currency (Mazzeo, 2013). Innovation in the end modifies the perception and characteristics of reality, bringing it to a different level and condition from the previous one. The economic studies have always considered the city as the most important driver of the dissemination of innovation thanks to the high concentration of population (and brains) present in it (Boserup, 1981). If we want to state the main characteristics of the cities we can state that «1. cities have emerged as the world's economic platforms for production, innovation and trade; 2. urban areas offer significant opportunities for both formal and informal employment, generating a sizeable share of new private sector jobs; 3. urbanization has helped millions escape poverty through increased productivity, employment opportunities, improved quality of life and large-scale investment in infrastructure and services; 4. the transformative power of urbanization has, in part, been facilitated by the rapid deployment of Information and Communications Technology» (UN Habitat, 2016, 27).

5   APPLICATION TO ITALIAN STATE. MATERIALS/METHODS

The governance of metropolitan systems represents a test field about the application of innovations to the city functioning. It is strictly connected with concepts as international competition or with the relevance of the cities in the institutional structure of a nation.

Economic system, density, territorial use, mobility, and urban quality can be considered as the main specific factors (or sectors) connected to the functioning of the metropolitan areas. Above these sectors there are two transversal areas influencing positively or negatively all the metropolitan systems. The first is the governance that is a way to infill in these territories efficient elements for their overall evolution. The governance is a transversal area connecting the previous four (more specified and sectoral) with their decisions and choices and organizing them with the aim to favour the functioning of the system.
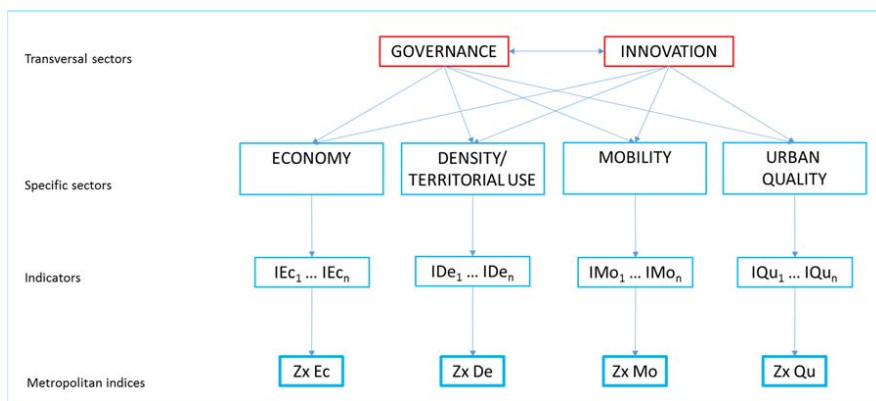
Fig. 3 Logical structure for the building of the metropolitan indexes

The second transversal sector is innovation. Noteworthy are the technological, organizational and system innovations that can give a strong hand to the government in achieving its objectives. Among innovation, particularly interesting are the energetic matters that play a role of fundamental importance for the future of the metropolitan organisations and for their efficiency.

Starting from the partition of the sectors in specific and transversal, the paper (1) associates a system of indicators to the specific sectors, (2) defines a data processing and (3) extracts synthetic indexes explaining a series of phenomena connected with the metropolitan areas (Fig. 3). The quantitative data that associates the indexes to metropolitan cities determines the level of strength or criticality. The identification of strengths and weaknesses makes it possible to build government policies aimed to strengthen the former and develop the latter. The function used to calculate the synthetic indexes, in an ideal model, should comply with certain desirable properties to take into consideration when a technique of calculation methodology is chosen (IESE, 2007):

— existence of the indicator and, eventually, of partial indicators;

— monotony regarding the variations in the partial components. A variation in any of the partial indicators means that the synthetic indicator must have a variation in the same direction;

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- unicity of the partial components; in a given situation, the synthetic indicator yields a single result, for which the property of invariability must be fulfilled;
- homogeneity of grade one of the function, so that, by multiplying each partial indicator by a constant, the synthetic indicator is multiplied by that same constant;
- transitivity;
- completeness in the use of the information provided by the partial indicators, avoiding the duplication of information.

5.1 CALCULATION: INDEXES OF METROPOLISATION

The logic process of the production of synthetic indexes starts from the choice of quantitative data.

In this application the indicators are mainly extracted by the data-base dati.italiaitalie.it of the Italian Government, containing a system of about 300 indicators coming by several sources (Istat, Infocamere, Tagliacarne, and so on), organized in themes going from work to environment, from mobility to innovation. This database is updated to 2015, with the more recent data dated 2014. From this database we extract 36 indicators, each of which is associated to one of the 4 sectors.

The second passage is the use of a statistic structure that brings to the building of an index for each sector and for each metropolitan city defining the performance of a city to a specific system of indicators.

In the construction of the indexes, a double analytical path can be used. The first way considers only the basic indicators, the second assigns to each of them a weight that could change their relative relevance. In this second case, one indicator can assume an emphasis more or less appreciable derived by qualitative considerations or by the aim of the research. In this application the first method is applied because the number of indicators makes it difficult to define the weight of each element in relation to the others.

The data-set is composed of 36 indicators. Each of which is associated with a sector. In particular, 14 for economy, 6 for density/territorial use, 6 for mobility and 10 for quality (See Annex 1).

To compare the different indicators, the first passage is the normalization of the data, using the Z-score technique:

$$Z_x = \left(\frac{x - \bar{x}}{\sigma_x}\right) \qquad (1)$$

where Z_x is the normalized value of the variable x, $\bar{x}$ is the average value for the whole test sample (N is formed by the 15 metropolitan cities), and σ_x the standard deviation of the variable x of a population of N elements, defined as:

$$\sigma_x = \sqrt{\frac{\sum_{i=1}^{N}(x - \bar{x})^2}{N}} \qquad (2)$$

Applying the formulas to the four groups of sectors, the original data are normalized making it possible a quantitative comparison based no more on a matrix 15 x 1 (the single indicator) but on a matrix 15 x n formed by the 15 metropolitan cities and the n indictors of one of the sectors.

Tab. form 3 to 6 report the results of the application of the equations (1) on the basic data.

For intrinsic construction, if Z-score is positive, the corresponding raw score is greater than the mean, if it is negative, the corresponding raw score is lower than the mean. Furthermore, the absolute value of the Z-score defines how many standard deviations the element is away from the mean (in positive and in negative). For each sector, it is possible to sum the Z-values and to use this value as sector metropolitan index. This sector index defines an order of the 15 cases based on the performances of the city measured by the indicators.

A second passage, from the four previous Tab. 3 - 6, foresees the computation of the average of the values of Z-score, as reported in Tab. 8 and in Fig. 4.

ECONOMY	01	02	03	04	05	06	07	08	09	10	11	12	13	14
Bari	-0,43	-0,78	-0,79	-0,37	-0,63	-0,24	-0,05	-0,38	-0,36	-0,15	-0,20	-0,52	-0,53	0,15
Bologna	-0,14	1,03	0,62	-0,02	0,59	0,01	0,63	0,46	-0,19	0,50	0,22	1,34	0,11	-0,37
Cagliari	-0,68	-0,53	-0,81	-0,57	-0,40	-0,52	-0,59	-0,35	-0,10	2,59	-0,69	-0,67	0,43	-0,73
Catania	-0,55	-1,02	-0,79	-0,53	-1,07	-0,50	-0,48	-0,69	-0,57	-1,04	-0,63	-0,67	-0,72	-0,30
Florence	-0,20	0,75	0,26	-0,17	1,43	-0,13	-0,25	0,25	-0,30	0,22	1,43	0,13	-0,49	-0,13
Genoa	-0,34	0,55	0,72	-0,48	0,95	-0,35	-0,42	-0,34	-0,36	-0,29	-0,47	-0,04	-0,30	-0,61
Messina	-0,71	-1,01	-0,99	-0,60	-0,77	-0,70	-0,65	-0,68	-0,32	0,72	-0,67	-0,67	-0,50	-0,74
Milan	2,54	2,41	2,89	3,16	1,80	3,09	3,25	3,13	3,53	0,86	3,14	2,93	2,46	3,14
Naples	0,22	-0,88	-0,32	-0,18	-0,04	-0,09	-0,14	-0,27	-0,21	-0,06	-0,49	-0,55	0,69
Palermo	-0,49	-1,00	-0,49	-0,54	-1,81	-0,63	-0,63	-0,77	-0,61	-1,39	-0,69	-0,66	-0,74	-0,74
Reggio Cal.	-0,77	-1,27	-1,39	-0,62	-0,51	-0,76	-0,67	-0,78	-0,64	-1,36	-0,71	-0,69	-0,73	-0,75
Rome	2,24	0,77	0,68	1,38	0,57	1,20	0,06	0,01	0,58	-0,86	-0,27	-0,41	0,27	0,81
Turin	0,50	0,29	0,08	0,66	1,04	0,96	1,09	1,36	0,42	0,62	0,23	1,17	2,32	0,71
Trieste	-0,78	0,40	0,27	-0,61	-1,09	-0,75	-0,73	-0,59	-0,55	0,38	-0,60	-0,36	-0,62	-0,62
Venice	-0,40	0,29	0,05	-0,50	-0,06	-0,60	-0,45	-0,36	-0,32	-0,11	-0,04	-0,38	-0,44	-0,53

Tab. 3 Z-score calculated for the sector "Economy". Matrix 15*14 = 210 values. 69 positive values (32,86%)

DENSITY AND TERRITORIAL USE	01	02	03	04	05	06
Bari	-0,69	-1,08	-0,67	-0,54	-0,73	-0,33
Bologna	0,50	1,06	1,58	-0,53	-0,89	-0,42
Cagliari	-0,01	-1,21	-0,15	-0,82	-1,20	-0,96
Catania	-1,13	-1,16	-0,53	-0,53	0,26	-0,54
Florence	0,57	1,31	1,26	-0,57	-0,41	-0,50
Genoa	1,88	0,29	-0,18	-0,07	-1,12	-0,47
Messina	0,00	-0,77	-0,78	-0,61	0,34	-0,73
Milan	-0,13	1,63	1,09	2,21	1,48	2,10
Naples	-1,69	-0,99	-1,59	2,35	0,72	2,33
Palermo	-0,93	-1,17	-0,74	-0,59	0,79	-0,78
Reggio Calabria	-0,68	-0,55	-1,70	-0,72	0,23	-0,78
Rome	-0,49	1,20	0,77	0,15	1,39	0,05
Turin	0,39	0,60	0,28	-0,44	1,45	1,15
Trieste	2,11	0,29	1,30	1,07	-1,68	-0,32
Venice	0,30	0,55	0,07	-0,37	-0,63	0,19

Tab. 4 Z-score calculated for the sector "Density and territorial use". Matrix 15*6 = 90 values. 39 positive values (43,33%)

MOBILITY	01	02	03	04	05	06
Bari	-0,40	-0,36	-0,41	-0,94	-0,46	-0,66
Bologna	-0,08	-0,08	0,04	0,15	-1,36	-0,23
Cagliari	-0,46	-0,41	-0,56	0,14	-0,33	-1,06
Catania	-0,12	-0,01	-0,53	-0,98	-0,16	-0,77
Florence	-0,45	-0,53	-0,10	-0,01	1,20	0,10
Genoa	-0,61	-0,64	-0,70	0,01	0,29	0,34
Messina	-0,80	-0,74	-0,82	-1,03	-1,37	-0,74
Milan	2,18	1,80	2,66	1,35	1,72	-0,04
Naples	-0,05	-0,05	0,64	-0,60	-1,38	0,02
Palermo	-0,34	-0,28	-0,72	-1,04	0,12	-0,70
Reggio Calabria	-0,75	-0,71	-0,88	-1,04	-1,40	-0,53
Rome	2,73	3,00	1,15	1,08	0,91	0,68
Turin	-0,32	-0,41	1,39	-0,10	0,79	-0,62
Trieste	-0,65	-0,68	-0,99	0,49	0,52	3,00
Venice	0,12	0,09	-0,16	2,51	0,91	1,23

Tab. 5 Z-score calculated for the sector "Mobility". Matrix 15*6 = 90 values. 32 positive values (35,55%)

QUALITY	01	02	03	04	05	06	07	08	09	10
Bari	-0,62	-0,70	-0,66	-0,48	-0,54	-0,62	-0,12	-1,19	0,40	-0,31
Bologna	-0,44	-0,52	-0,53	-0,50	-0,39	-0,45	-0,05	1,10	0,78	0,83
Cagliari	-0,42	-0,59	-0,58	-0,48	-0,77	-0,49	-0,95	0,79	0,71	0,82
Catania	-0,60	-0,68	-0,61	-0,51	-0,57	-0,78	0,18	-0,87	-1,29	-1,37
Florence	0,11	0,44	0,57	0,88	1,55	2,56	-0,92	1,00	0,90	0,88
Genoa	-0,46	-0,51	-0,50	-0,50	0,13	-0,02	0,85	0,13	0,68	-0,09
Messina	-0,33	-0,49	-0,42	-0,51	-0,72	-0,75	-0,49	-1,15	-1,86	-1,59
Milan	0,03	0,56	0,31	-0,36	0,17	-0,19	1,63	1,34	0,77	1,32
Naples	0,03	0,33	0,12	0,77	0,34	0,03	0,28	-1,15	-0,29	0,31
Palermo	-0,45	-0,55	-0,48	-0,51	-0,84	-0,85	-0,79	-1,01	-1,40	-1,82
Reggio Calabria	-0,67	-0,80	-0,71	-0,45	-1,31	-1,02	-1,88	-1,58	-1,28	-0,97
Rome	1,54	1,84	1,99	3,37	1,34	1,39	1,70	0,46	-0,04	0,04
Turin	-0,12	-0,25	-0,54	-0,15	-0,48	-0,35	-0,49	1,06	-0,08	0,64
Trieste	-0,76	-0,78	-0,66	-0,25	2,45	1,62	1,44	0,72	0,26	-0,06
Venice	3,15	2,70	2,70	-0,31	-0,35	-0,07	-0,41	0,36	1,73	1,37

Tab. 6 Z-score calculated for the sector "Quality". Matrix 15*10 = 150 values. 59 positive values (39,33%)

Sector Index	ECONOMY		DENSITY / TERR. USE		MOBILITY		QUALITY	
Milan	38,31	Milan	8,38	Milan	9,67	Rome	13,63
Turin	11,48	Turin	3,43	Rome	9,54	Venice	10,86
Rome	7,05	Rome	3,07	Venice	4,70	Florence	7,96
Bologna	4,80	Trieste	2,77	Trieste	1,69	Milan	5,58
Florence	2,83	Florence	1,67	Turin	0,73	Trieste	3,99
Genoa	-1,77	Bologna	1,32	Florence	0,22	Naples	0,77
Naples	-3,02	Naples	1,13	Genoa	-1,31	Bologna	-0,16
Cagliari	-3,61	Genoa	0,33	Naples	-1,42	Genoa	-0,29
Venice	-3,83	Venice	0,11	Bologna	-1,57	Turin	-0,75
Bari	-5,29	Messina	-2,55	Catania	-2,56	Cagliari	-1,96
Trieste	-6,26	Palermo	-3,43	Cagliari	-2,67	Bari	-4,84
Messina	-8,28	Catania	-3,62	Palermo	-2,96	Catania	-7,10
Catania	-9,56	Bari	-4,05	Bari	-3,23	Messina	-8,32
Palermo	-11,19	Reggio Cal.	-4,20	Reggio Cal.	-5,31	Palermo	-8,69
Reggio Cal.	-11,65	Cagliari	-4,35	Messina	-5,50	Reggio Cal.	-10,68

Tab. 7 Sector indices as sum of the Z-scores related to the indicators of each sector

Average Z-score	ECONOMY	DENSITY / TERR. USE	MOBILITY	QUALITY
Milan	2,74	1,40	1,61	0,56
Turin	0,82	0,57	0,12	-0,07
Rome	0,50	0,51	1,59	1,36
Bologna	0,34	0,22	-0,26	-0,02
Florence	0,20	0,28	0,04	0,80
Genoa	-0,13	0,05	-0,22	-0,03
Naples	-0,22	0,19	-0,24	0,08
Cagliari	-0,26	-0,72	-0,44	-0,20
Venice	-0,27	0,02	0,78	1,09
Bari	-0,38	-0,68	-0,54	-0,48
Trieste	-0,45	0,46	0,28	0,40
Messina	-0,59	-0,42	-0,92	-0,83
Catania	-0,68	-0,60	-0,43	-0,71
Palermo	-0,80	-0,57	-0,49	-0,87
Reggio Calabria	-0,83	-0,70	-0,88	-1,07

Tab. 8 Average z-score of the four sectors analysed. The order of the metropolitan cities comes from the results in the column Economy

The value of the Z-score (total and average) shows the persistence of a case in the positive or in the negative field of the data and, then, the necessity of the policies to strengthen the obtained results or to change policies as to reverse negative states.
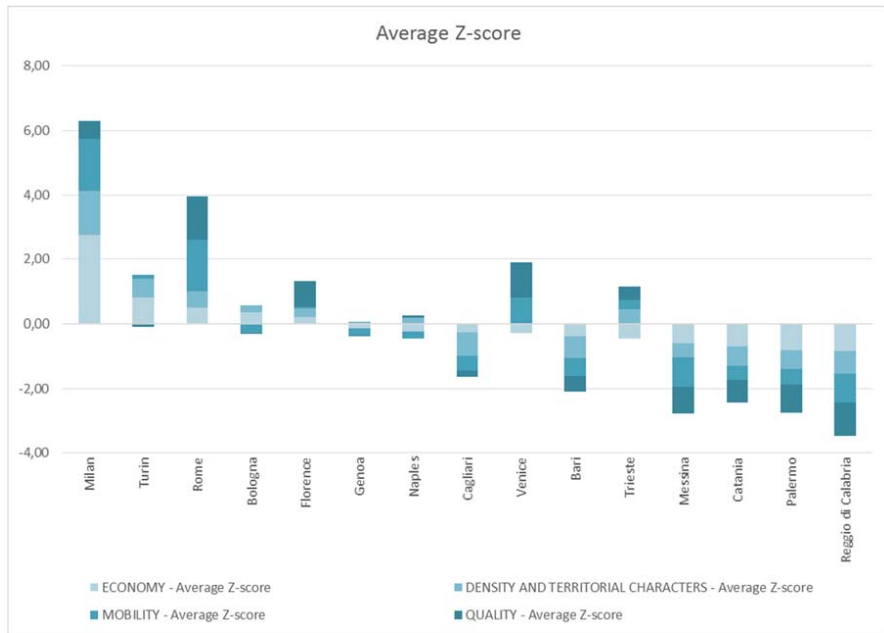
Fig. 4 Average z-score of the four sectors analysed

6   DISCUSSION

The above analytic formulation has confirmed results that, as a whole, are well known, as the Italian metropolitan system presents defined hierarchies based on qualitative considerations and on the economic, social, cultural and territorial performances of the cities.

From the calculations (Tab. 6, 7 and Fig. 3) it is possible to affirm that only three metropolitan cities have all of their Z-score positive (Milan, Rome, and Florence). Turin, Venice and Trieste have three positive and one negative value. Bologna and Naples two positive and two negative, Genoa one positive, Cagliari, Bari, Messina, Catania, Palermo and Reggio Calabria have all the negative values. In addition, the differences among Milan and the other cities are quite evident and, in negative, the distance of a wide number of cities not mainly from Milan but from the average.

The results obtained from this analysis identify the strength of some metropolitan cities and, at the same time, the weakness of others. In this category two types of cities can be classified. The first cities are those that, according to Italian law, are classified as metropolitan cities but, based on international literature and on their own characteristics, are nothing more than regional centers, difficult to consider as metropolitan cities or as a city with a real metropolitan area. The seconds are those belonging to the Southern area of Italy and, in this case, the weakness is structural and derives from a long history of inability to plan a future.

7   CONCLUSIONS

International experiences in the field of metropolitan agglomerations highlight the need to treat the metropolitan areas as specific structures, clearly differentiated from the traditional urban systems. They, indeed, represent specific situations from the agglomerative point of view, and their management can require specific administrative structures as they represent areas of economic, cultural and social strength that must be developed and strengthened. The focal point is the necessity to bypass the daily administrative routine and to practice innovative strategies that are able to compete both at national and international level, working to increase the attractiveness of their territories both in the economic field and in the development processes based on innovation.

In this context, the institutional restructuring process that led to the constitution of Italian Metropolitan Cities had specific potentialities in itself, recognizable in curtailing of the territorial government, in growing of administrative efficiency, and in enhancing of competitiveness (Barbieri, 2015).

On the basis of these considerations, the first outcome of the paper has identified the strenghts of the metropolitan cities, namely the elements on which governance and innovation must act to master efficiency and visibility of the metropolitan system.

Secondarily, the paper has highlighted, on the basis of the performances reached by a number of cities of the sample, that they must not be considered as "metropolitan". Rather, their right size is that of a regional city, confirmed by the critical national and international size and positioning.

The choice to extend the number of metropolitan cities should be considered as negative. In fact a limited number (Milan, Rome, Turin, Naples, Florence, Genoa, and Venice) could have had a more effective impact on the new administrative instrument working on their strenghts. Furthermore, a limited number of metropolitan cities would have allowed to concentrate resources on the most representative cities of the Italian urban landscape in relation to size, economic and cultural weight, infrastructural efficiency and international visibility.Another not secondary element is the gap between the metropolitan cities of the Central and Northern Italy and those of the southern. The first show more attention to the strategic issues that may result by the creation of metropolitan cities, although critical aspects do not lack even in these (De Luca, 2016). The latter continue in the unconcealed aversion to all forms of planning and confirm a persistent inaction of the ruling classes, whose only strategy seems to be the preservation of their constituencies, compared to a clear lack of long term development vision.

The urban history narrates of different characters about planning and programming. The analysis of the Italian metropolitan cities can be referred to local areas that historically have had different attitudes towards planning, ranging from situations with a settled tradition of planning, to realities in which the plans are poorly tolerated. This makes it difficult to think, for some of the cities, to the possibility that they create a proper process of governed evolution of the territorial space.

This is a limitation of the Italian system that seems to be endowed with a high logical construction capacity accompanied by a very low application capacity aimed to achieving effective results. This applies to any problem, including that of the definition of the metropolitan areas system.

ANNEX 1 – DATA SET OF INDICATORS

Annex 1 contains the indicators used in this paper. They are organized in the sectors that the paper considers as strategic for the comprehension of the metropolitan phenomena. The first two number in the first column is the same used in Tab. 3 – 7.

As reported in the paper, the indicators are mainly extracted by the data-base dati.italiaitalie.it of the Italian Government, containing a system of about 300 indicators coming by several sources (Istat, Infocamere, Tagliacarne, and so on), organized in themes going from work to environment, from mobility to innovation. This database is updated to 2015, with the more recent data dated 2014. From this database we extract 36 indicators, each of which is associated to one of the 4 sectors.

	ECONOMY
01-01EC-0027	Total added value at current basic prices – 2014
02-02EC-0044	Total added value at current basic prices per capita – 2014
03-03EC-0045	Total labour productivity – 2014
04-09RS-0498	Total patent applications filed – 2009-2014
05-11IM-0115	Density of non-agricultural active enterprises – 2014
06-13EC-0146	Manufacture of computers and electronic and optical products – 2014
07-14EC-0148	Manufacture of machinery and nca equipment – 2014
08-26CE-0386	Total exports – 2014
09-27CE-0387	Total imports – 2014
10-28CE-0388	Rate of openness of the economy – 2014
11-29CE-0470	Pavitt classification, traditional sectors – 2014
12-30CE-0471	Pavitt classification, specialized sectors – 2014
13-31CE-0472	Pavitt classification, scale-intensive sectors – 2014
14-32CE-0473	Pavitt classification, science-based sectors – 2014
	DENSITY/TERRITORIAL USE
01-06PO-1020	Index of old age – 2014
02-07PO-0026	Share of foreigners residing on the resident population – 2014
03-08PO-1004	Internal net migration – 2013
04-15PO-0218	Density of dwellings – 2011
05-16PO-0223	Non-residential buildings used – 2011
06-40S-SOIL	Consumed soil, percent on total MC area – 2016
	MOBILITY
01-21MO-0312	Air transport, aircraft movements, arrivals and departures – 2017
02-22MO-0313	Air transport, passengers, arrivals and departures – 2017
03-23MO-0360	People working outside the municipality of residence – 2014
04-24MO-4659	Demand for public transport – 2013
05-25MO-4665	Resident population moving daily for study or work in relation to the total population – 2011
06-33IC-0482	Total index of infrastructural endowment – 2012
	QUALITY
01-17TC-0249	Total tourist accomodations, beds – 2014
02-18TC-0275	Total tourist accomodations, tourist numbers – 2013
03-19TC-0288	Total tourist accomodations, presence of foreign visitors - 2013
04-20TC-0299	State museums, monuments and acheological areas, presences – 2014
05-34IC-0491	Total index of social infrastructures – 2012
06-35IC-0492	Total index of cultural and leisure infrastructures – 2012
07-36IC-0494	Healthcare facilities – 2012
08-37CS-0508	Spending of households per capita - 2012
09-38AM-0516	Environmental quality index, Legambiente – 2016
10-39AM-0520	Separate collection rate – 2016

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