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Regenerative design processes in urban morphology

Marco Maretto[1], Chiara Finizza[1], Alice Monacelli[2], Barbara Gherri[1], Emanuele Naboni[1], Daniela Maiullari[3], Marco Iannantuono[4]

[1]University of Parma, Department of Engineering and Architecture

[2]La Sapienza University

[3]TU Delft

[4]University of Bologna, Department of Engineering and Architecture

Abstract

A city is an organism made of "fabrics". Social, economic, cultural, smart and environmental fabrics, on whose interaction depends the form, the functioning and the very life of a city, its urban fabrics, its public spaces. Reading and de- signing the city of the 21st century is therefore a complex process that involves very different needs, interests and disciplines. The aim of this research is to develop an analysis and design methodology capable of acting as a catalyst for all the main players involved in the strategies of Sustainable Urban Design. At the basis of the methodological approach lies the concept of Public Space as the preferential place for reading, designing and living a city. Operationally, the proposed methodology rests on three main disciplinary areas (and three con- sequents working toolkits): Urban Surveying, Environmental Analysis, Urban Morphology. Through the first, conducted with graphic rendering softwares and laser scanner, it is possible to detect the physical forms of the city, to read its historical and material consistency. The second focuses its attention mainly on the microclimatic analysis of public spaces and outdoor comfort, using sophis- ticated environmental softwares such as Envi-met, LadyBug etc. Finally, the third area is particularly important. Urban Morphology, due to its multilayer character is the discipline capable of keeping all the others together, allowing them to interact. The tools adopted for this purpose are the Morphological Map, the Geographic Information System_QGIS, the Global Positioning Sys- tem_GPS. The synergistic union of these three areas allows the development of a dynamic, multilayer and transdisciplinary methodology for urban analysis, very useful for guiding the regeneration and transformation processes of the contemporary city.

Introduction_Urban analysis and urban morphology in XXI century

Urban analysis is a complex topic, it requires a multiplicity of tools and involves a multiplicity of data and informations that must necessarily be compared in order to achieve credible and useful results. These data involve physical and material aspects of urban fabrics, linked to their history, to the state of maintenance, etc., but also intangible aspects, linked to the use that citizens make of the city and its public spaces, up to all those environmental aspects from which any process of urban analysis and transformation cannot ignore. Furthermore, many of these data are dynamic and change over time and space. The task that Urban Morphology must face today is therefore increasingly complex, requiring the adoption of new analytical tools and, above all, a new capacity for synthesis between different disciplines, needs and informations.

This paper represents a first part of an ongoing research aimed at developing a transdisciplinary methodology for reading urban phenomena both in their static aspects and in their dynamic development over time. For

this purpose, the knowledge of Urban Morphology is integrated with that of other disciplines using new generation softwares. In the following paragraphs the adopted methodology will be indicated and a first experimentation on a case study will be presented.

Methodology_A glimpse through a transdisciplinar methodology for the analysis and design of the Sustainable City

As we stated in the introduction of this work, a city is an organism made of "fabrics". Social, economic, cultural, smart and environmental fabrics, on whose interaction depends the form, the functioning and the very life of a city, its urban fabrics, its public spaces. Reading and designing the city of the 21st century is therefore a complex process that involves very different needs, interests and disciplines. The aim of this research is to develop an analysis and design methodology capable of acting as a catalyst for all the main players involved in the strategies of Sustainable Urban Design. At the basis of the approach lies the concept of Public Space as the preferential place for reading, designing and living a city. It is in urban public spaces that it is possible to understand the material history of a city, it is in them that citizens live and interact, it is starting from public spaces that the main strategies of environmental analysis and control can be adopted. Operationally, the proposed methodology rests on three main disciplinary areas (and three consequents working toolkits): Urban Surveying, Environmental Analysis, Urban Morphology. In the tradition of the Italian School of Urban Morphology, direct observation of urban fabrics, through the reading of the facades that shape public spaces, has always been fundamental. Today, this important process of Urban Surveying is enhanced using softwares such as RDF, photoscan and laser scanner, through which it is possible to detect the physical forms of the city and to read its historical and material consistency. Through the photogrammetric scan of the facades, infact, it is possible to obtain a very important series of informations on the “physical” city. We can obtain dimensional data such as the height of the buildings, the degree of opening of the facades and ground floors. We can obtain information on the type of building and the historical period of construction and transformation of the tissue. We can obtain valuable information on its state of conservation and on the actual functions. Furthermore, tools such as the laser scanner allow for absolute precision and accuracy of the analysis as well as an easy return of the data obtained. The other important disciplinary area of the proposed methodology concerns the microclimatic analysis of public spaces and outdoor comfort. It is conducted using sophisticated environmental softwares such as Envi-met, LadyBug (Grasshopper) etc.[1] The analysis is aimed at identifying the criticalities and microclimatic potential offered by the context. In particular, the analysis concerned the phenomena of solar radiation, sunshine and shading, humidity, the Albedo values and the behaviour of the winds, over 24 hours, 365 days a year, with reference to threshold values relating to the equinoxes and solstices. The same experiment was then conducted with reference to the year 2020 and projected, to the year 2050, where the ENVI-Met simulation highlighted a diurnal increase of outdoor thermal stress.[2] All these factors strongly influence the use that citizens make of public spaces and therefore their ability to structure the city. Finally, the third disciplinary

area on which this methodology is based is Urban Morphology. This research area is particularly important. The Morphological Map[3], in fact, can provide us with a large amount of information on the subdivision system of the area under consideration, on the building types and on the evolution of the typological process. It provides us with data on the functions present within the context and their distribution in the urban fabric. Through the Nodality Survey[4], it tells us about the different nodality values and the hierarchical relationships that determine the transformation of urban fabrics. Moreover, using the Geographic Information System (QGIS) and the Global Positioning System (GPS) (or sensors, WIFI sniffer) it is possible to analyze the dynamic data that underlies the formation and functioning of urban fabrics: the Pedestrian Movement Flows (PMF).

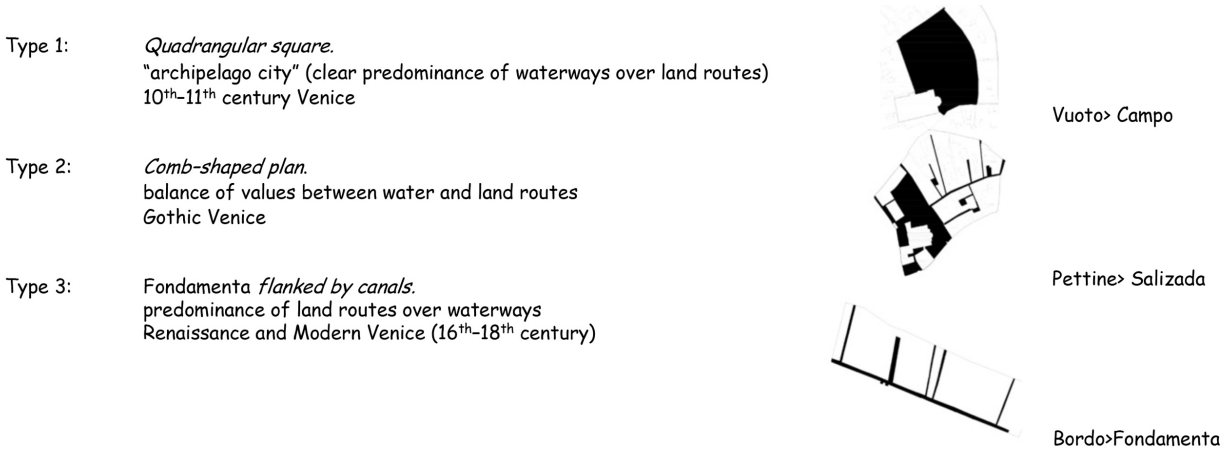

Figure 1. *Typical structures within the Venetian urban fabric*

Finally, due to its "structural" and multilayer character Urban Morphology is the discipline capable of keeping all the others together, allowing them to interact. This is of the utmost importance. Perhaps the real success of a transdisciplinary analysis methodology lies not so much in its ability to collect the largest possible amount of data, but in its effective ability to make them communicate with each other. It is from their interaction and from the ability that the methodology possesses to create synapses, that we can obtain, perhaps, the most significant and most useful data to support the transformation processes of the contemporary city. Thanks above all to the use of QGIS it is possible, in fact, on a quantitative level, to integrate the material data (height of the buildings, porosity of the facades, etc.) with the typological and functional data, with the state of conservation of the buildings and with their historical stratigraphy, up to and including all the data deriving from the Environmental Analysis. But it is on the qualitative level that Urban Morphology plays an important catalytic function telling us if a given public space is flanked by a type of buildings, characterized by certain functions etc. It tells us what the degree of openness of their facades is, what is the state of conservation and the period of their construction, as well as any historical stratifications that occurred. It is Morphology that tells us about the environmental comfort conditions of that space and of the buildings that define it, and it is always Morphology that explains the nodal value of this public space, the use that citizens make of it and therefore its potential of transformation.

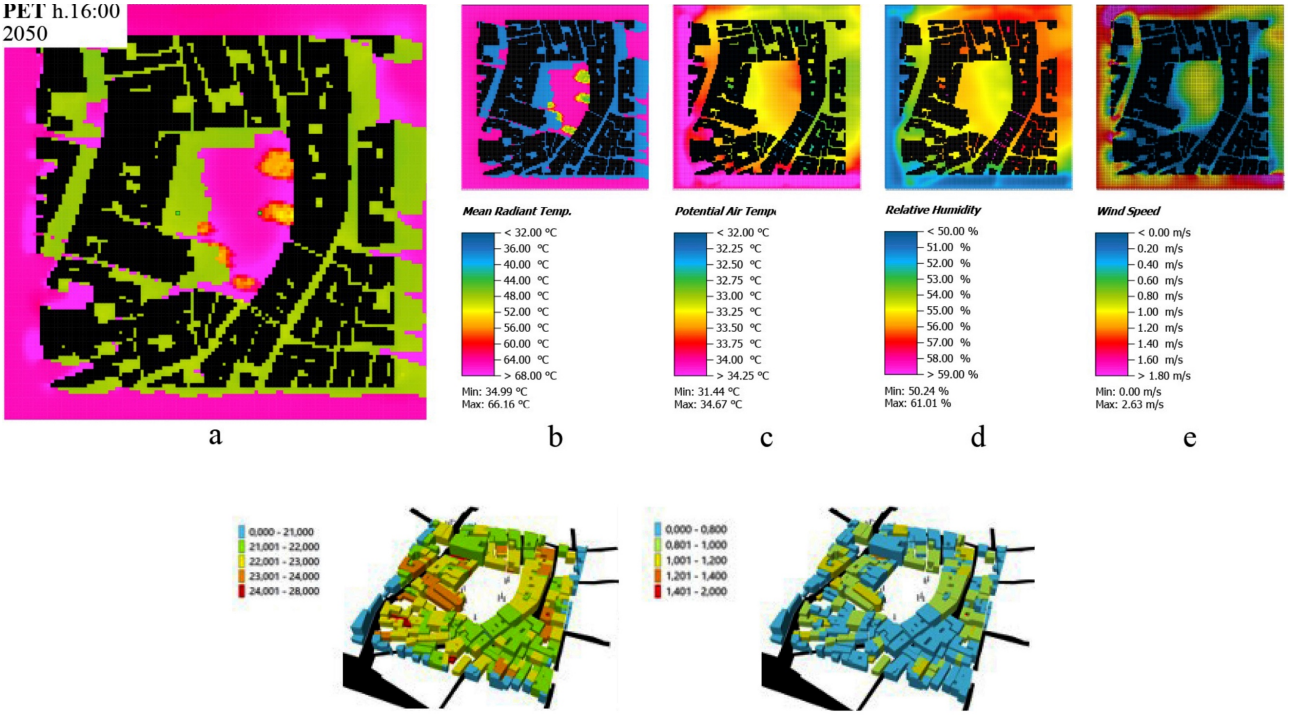

Figure 4. *Environmental Analysis of Campo San Polo in 2050*

Urban Morphology and Pedestrian Movement Flows (PMF)

Urban fabrics tend, by their nature, to be hierarchical. Hierarchies are, in fact, "attributions of priorities" indispensable for the very life of every human being. Daily priorities and long-term priorities, instinctive and programmatic, private and collective, all concurring to the definition of a changing system of hierarchies through which every human being organizes his or her life and transforms the surrounding environment. In morphology, the element that conditions and determines, more than others, the attribution of these hierarchies are the paths. The routes, in fact, being the main vehicles of the life of a city, are an effective context of synthesis between the civil priorities of a community and the building hierarchies that arise from these priorities. Moreover, they are also the places where the *forma urbis* "manifests itself" and therefore the preferential place, as mentioned in the introduction, where to read urban fabrics. For this reason, the mapping of daily Pedestrian Movement Flows, using GPS data (or through other non-empirical techniques) can constitute a new tool for reading and designing the city. The movement flows of citizens-users within a given physical area, be it a city, a neighborhood, a public space, a building, inform us about how that area is used. They inform us about the "value" that the various citizen-users give to that area, about the role that this area plays within its own context (urban, economic, social). But not only that, the Pedestrian Movement Flows carry concrete data that are updated in real time and are therefore endowed with great dynamism, allowing them to trace their trends over time, thus identifying any trend lines, critical issues, etc. For this reason, the mapping of the daily Pedestrian Movement Flows within the city can become a new tool-guide for reading and addressing all urban strategies, from the strictly architectural-regenerative ones to the socio-cultural ones, up to the economic and financial ones. The Map of the daily Pedestrian Movement Flows (Flows Morphology Map) of a given urban area and for a given time interval, built through the processing of GPS

data (or sensor, WIFI sniffer) together with the GIS data can constitute, then, a dynamic and multidisciplinary tool, extremely effective both in the analysis of a given urban environment and in the definition of conscious transformation strategies in the medium and long term. The GIS data linked to the flow data give us, in fact, a very wide range of information: from the purely physical ones (height of the buildings, degree of permeability of the facades, state of maintenance, historical period, etc.), to those typically social-economic (types of functions, types of uses, etc.), to environmental ones, up to the entire data system that can derive directly from the analysis of movement flows (use of public space, safety, etc.). Ultimately, the analysis of the daily flows of pedestrian movement gives us back that system of hierarchies-priorities of which the paths are a direct expression and on which, as mentioned, the transformative processes of urban fabrics are based, coming to constitute a dynamic element capable of synthesizing and systematizing the morphological data with the socio-economic and cultural ones.[5]

Table 1. Application of Pedestrian Movement Flows_PMF to Urban Morphology (Maretto, 2020: 125-133)

The flow values	***The flow classes/****range*	***The value maps***	
Quantity of units/crossing per hour	**Nodality** levels (*quantity*)	Nodality **value**	***FLOW TRENDS***
hourly ***Speed*** of these crossings	**Urbanity** *levels* (*speed*)	Urban **value**	***FLOW TRENDS***
preferential ***Direction*** of said units	**Relationship** *levels* (*direction*)	Relationship **value**	***FLOW TRENDS***

Case study: Campo San Polo in Venice.

The case study in which this methodology is being tested is Venetian urban fabrics. The city of Venice, in fact, for the clarity of its transformation processes, for its substantial pedestrianism and for the incredible topicality of its urban structures in a sustainable and smart city perspective, seemed a perfect opportunity for experimentation. We present the case of Campo San Polo. The Venetian urban fabric is mainly attributable to three typical settling systems[6]:

- The *quadrangular 'campo' type*, with the parish church, the "family houses" and the collective courts, each with its own distinct "water door". It is the typical example of Roman Venice up to the 10th-11th century[7], the so-called "archipelago city", organized by island-parishes, with the clear predominance of waterways over land.[8]

- The *comb type*, with primary water and land routes on parallel axes spaced from secondary structures placed orthogonally: *calli*, courtyards, large buildings. It is the Gothic Venice par excellence, in a substantial balance of values between water and land systems.

- The *type with Fondamenta* flanked by canals, with houses aligned on the *fondamenta* or streets orthogonal to it. It is the typical type of Renaissance and Modern Venice (16th-19th centuries), characterized by the

gradual pre-eminence of terrestrial paths over water ones, but it is also the typical structure of the clogging processes of the urban fringe belts (see Cannaregio, Fondamenta Nove, Fondamenta Bragadin etc.).

The case of San Polo belongs to the first type, to the "archipelago city", made up of self-sufficient island-parishes. In this typology, land systems are morphological antinodal "resulting" areas that will progressively intersect with those of water to substantially replace their urban and social role.[9] Today “campi”, calli, collective courtyards, *fondamenta*, are the main structures of contemporary Venice, leaving the very rich canal system a predominantly service role.

Figure 2. *San Polo Island-parishes axis*

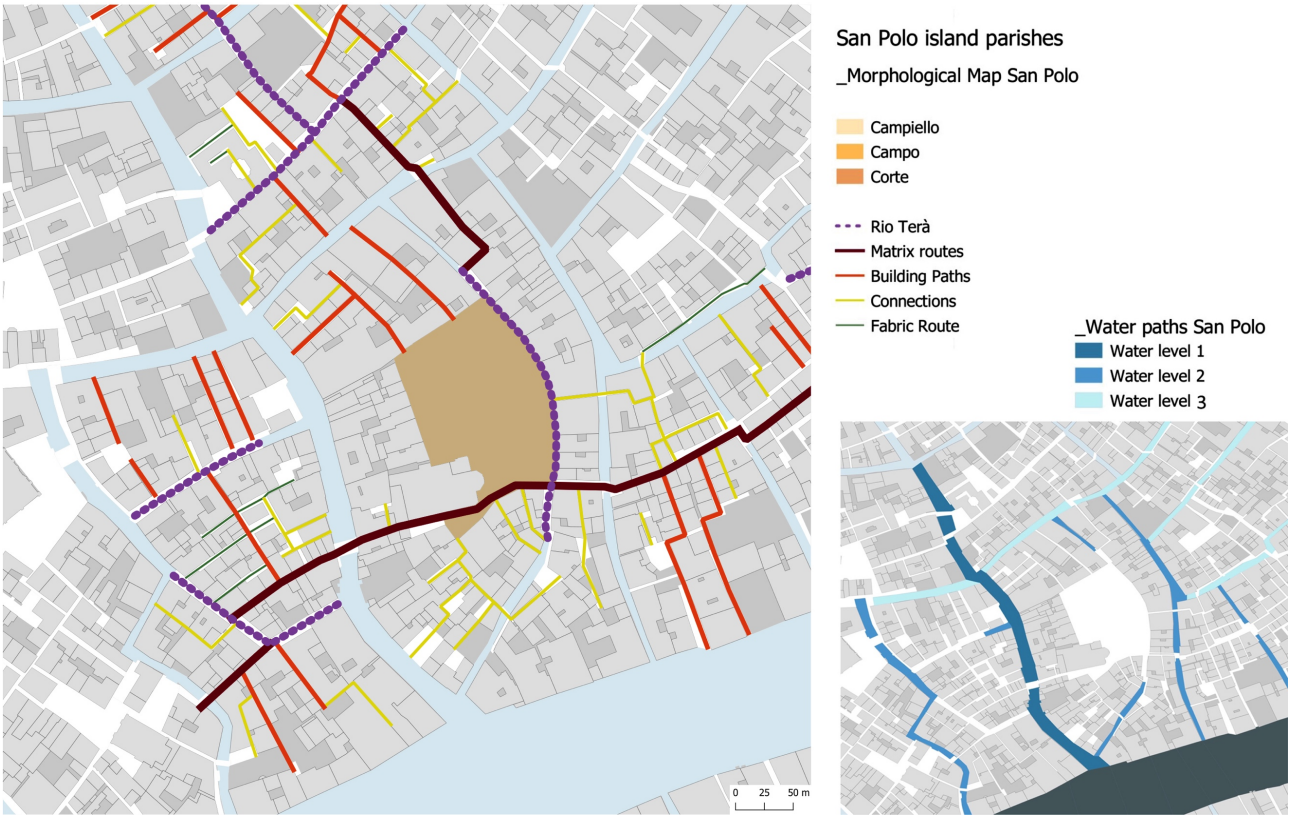

Figure 5. *San Polo, Paths Morphological Analysis*

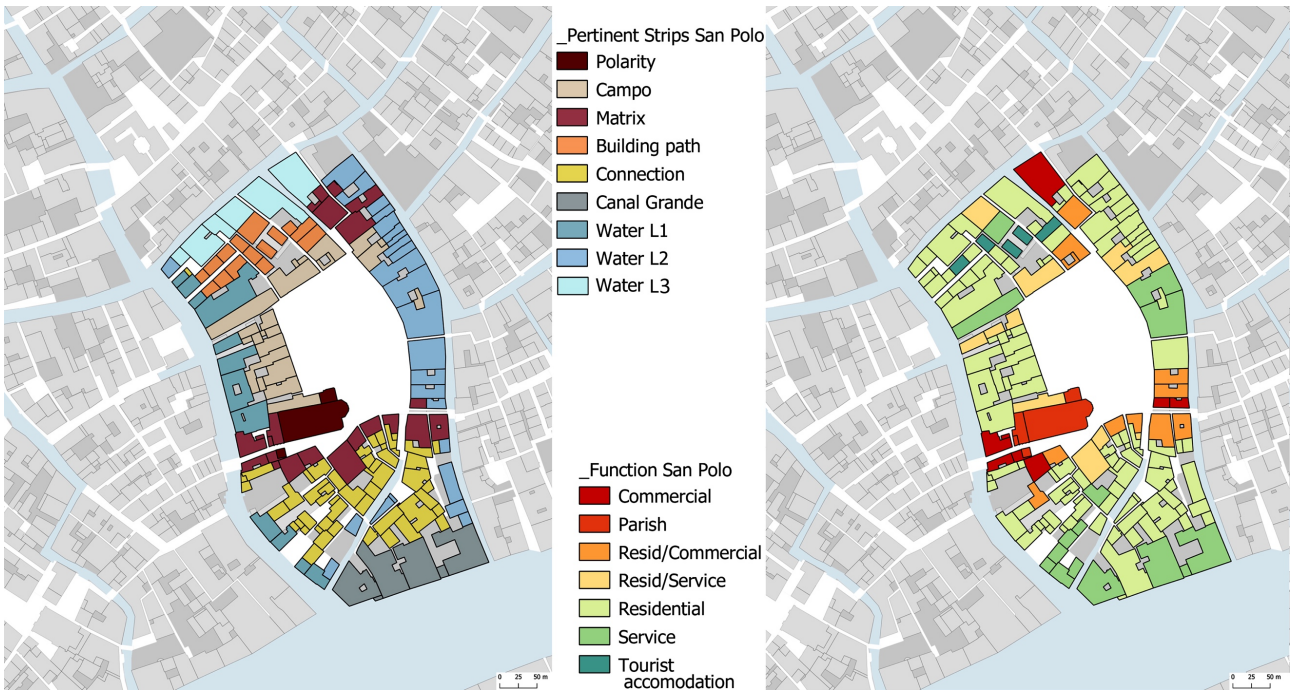

Figure 6. *San Polo, Pertinent Strips (left) and Functions (right)*

A Morphological Analysis was carried out on Campo San Polo aimed at identifying the hierarchical structure of the routes. The analysis of the Movement Flows has identified the presence of a Matrix route built on the edge of the pertinent strip of the houses built on the Canal Grande. A second Matrix has been identified, on the other hand, in correspondence with the northern connection with the other island-parishes of this part

of the Venetian fabric. The first is clearly more important and temporally preceding. On it opens the parish church, along it the major commercial functions are located. In a phase of development of the fabric in which the water paths were clearly prevalent over the land ones, in fact, the connection between the various parish communities took place mainly through the canals, leaving the terrestrial connection to any resulting spaces.

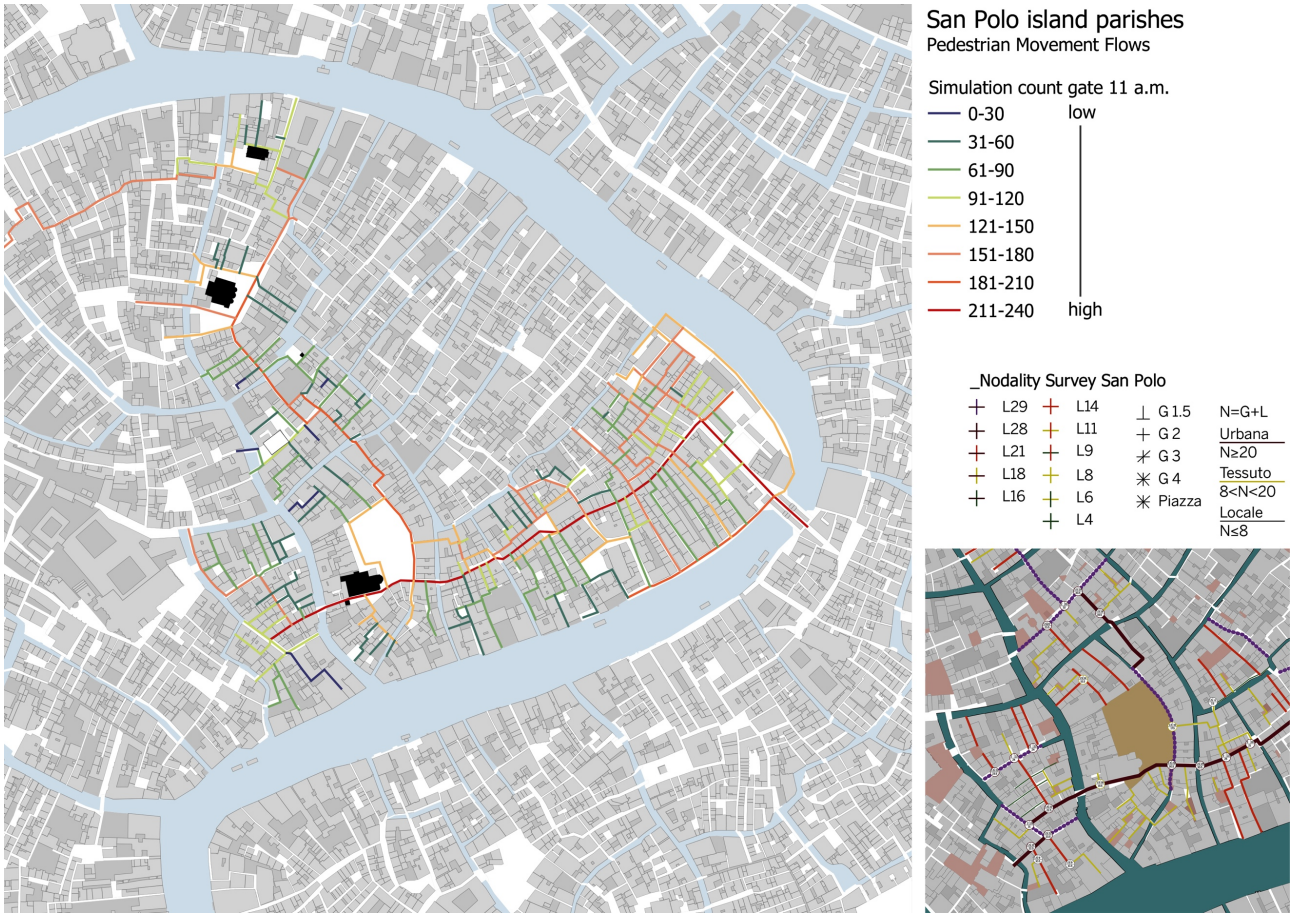

Figure 7. *Pedestrian Movement Flows_PMF in San Polo Island-parishes Axis*

In correspondence with this second type of Matrix routes, clearly hierarchized, the functions are mainly residential (except in one case), while the Campo remains substantially devoid of specialized functions. This confirms the anti-nodal nature of the "campo" which even when, once the urbanization process of the city was completed, it assumed the identifying role of the community of San Polo, it maintained a substantial "morphological periphery". The historical-typological analysis conducted through the Urban Survey then confirmed a "water" genesis of the building fabric starting from the Canal Grande towards the San Polo Canal and the Rio della Madonetta with a construction of the building fronts on the Campo clearly late. The tall buildings built on the eastern front of the Campo must not be misled. Their genesis is linked to the Rio della Madonetta and the “Rio Terà” once it intersects the whole campo in a vertical direction.[10] Finally, the parish of San Polo itself clearly has its back to the Campo by opening its door on the main Matrix route. From the Matrix routes and the canal system (which is also hierarchical) then a series of highly hierarchized Building paths and connections come off. The survey of the ground floors, the study of the building walls, of the

accesses (from land and water), of the heights and of the different historical stratifications, of the degree of porosity of the facades, give us a campo that is still strongly anti-nodal and scarcely used. This "peripherality" is then confirmed by the environmental analysis, which gives us a public space characterized by heavy criticalities in the summer season (excessive sunshine, high temperatures, poor ventilation, etc.) all competing to further reduce the use of this important urban public space pooring the conditions of indoor comfort for the neighboring buildings. Sensitive improvement strategies, both environmental and urban, of Campo San Polo are however possible and arise from the integration of the analysis tools adopted. The strengthening of the second Matrix route through the inclusion of non-residential functions along the western side of the Campo, where the buildings are more recent, the types more easily modifiable, the less stringent historical-artistic constraints and the less critical conditions of decay, would lead to a wider use of the Campo. An intervention aimed at mitigating environmental criticalities, through the inclusion of trees along the secondary matrix route, would allow greater use of the entire public space, favoring crossing paths and diagonal use of the Campo. It appears evident, despite the partiality of a first case study, how the methodology adopted allows not only a multidisciplinary reading of the urban fabric but creates the basis for setting the necessary and conscious processes for its transformation.

Conclusions

The experimentation on Campo San Polo, part of a wider field of research in progress, has demonstrated the usefulness and potential of an analytical methodology which, through the synergistic union of three disciplinary fields, allows the development of a dynamic, multilayer and transdisciplinary methodology for urban analysis, very useful for guiding the regeneration and transformation processes of the contemporary city. The research is still ongoing and involves the other two typical Venetian settlement typologies (the “comb” system and the “a Fondamenta” system). Much work is still being done around the digital monitoring (GPS, WIFI) of the Pedestrian Movement Flows and particular attention is being paid to the generalized application of the methodology not only to water cities but to the whole contemporary city.

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