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Morphogenesis of urban peripheries in the 20th century : examples from the French Riviera.

Abstract. In this paper, we present the first urbanization and the subsequent transformations of the urban fabric in peripheral areas around the cities of the French Riviera, with a focus on the 20th century. More specifically, two urban sectors are analyzed in the cities of Nice and Cagnes-sur-Mer. Cadastral maps, aerial images and urban plans over a century and a half constitute the main inputs of the analysis. These coastal cities represent two paradigmatic contexts for the French Riviera. In Nice, the first urbanization was channeled by different plans of the street network, with different spatial logics in the 19th and in the 20th centuries. In Cagnes-sur-Mer, planning interventions were much more fragmented and sometimes completely absent. The second after-war period constitutes a paradigm shift in the urbanization process. A general scheme of the different phases of the morphogenetic process is proposed to summarize our main finding. It shows that the observed urban forms can result from different evolutionary paths. At the same time, strong path-dependencies characterize the sequence of the morphological processes. Compact city forms can be catalyzed by a planned urban grid, but can also evolve more spontaneously. Planned tree-like structures with built-up plots blocking the dead-ends produce less evolutive residential forms. Topographic constraints and urban pressure linked to accessibility patterns in a context of urban growth are also important factors in explaining the observed processes.

Keywords. Morphological Process, 20th Century Urbanization, Urban Expansion, Peripheral Areas, French Riviera

1. Introduction

Most of the urban growth in Europe has taken place in the course of the late 19th and the 20th centuries. Given the temporal inertia of the material city, understanding the forms and processes of urban growth during this period is paramount to understand the degrees of freedom of future urban reorganization. This is even more true as demographic and urban growth is foreseen to stall in the coming decades in much of Europe.

In France, for example, according to the National Institute of Statistics and Economic Studies (INSEE 2017), most of the housing of the central municipalities within urban areas were built between 1949 and 1974, whereas the period of maximum housing production is 1975 to 1998 for their suburban municipalities. These statistics take into account housing units, which account for around 70% of the national building stock, and include building substitutions within already urbanized areas. However, they help us understand the capital importance of the second after-war period for building production nationwide, to which we should add the pre-war period for central areas of the most important cities (Paris, Lyon, Lille, Marseille, Nice).

The forms of past urbanization are not simply a question of building stock, though. The peripheral growth of cities around their historical centers has produced specific forms of the urban fabric since its first development cycle. As urban morphology theory shows (Whitehand 2001), subsequent cycles of urban development can significantly modify the original urban fabric. The most elementary growth process is the extension and intensification of land-use of a given urban fabric, through additive and repletive processes of built-up elements and their supportive

street network. Accretive processes can mark the juxtaposition of new forms of urban growth to more traditional ones. Adaptive processes can produce a different urban fabric from an original one, through building substitution and some plot amalgamation/subdivision, although the supportive street network remains globally the same. Even more radically, transformative processes can profoundly modify the supportive morphological infrastructure (both plots and street network) and bring about completely different built-up cityscapes. Path-dependency is important in the morphological process. It is important from the very beginning, when the presence of a matrix route (Caniggia and Maffei 1979) and of pre-existing rural plot patterns constrain the forms of the first urbanization. It is still important afterwards, as adaptive and transformative processes are local responses to the shortcomings of the inherited forms in a changing urban context. Still, the pace of urban growth is not uniform and more extensive urban land-uses can create fringe belts around stagnating peripheral growth (Whitehand 1987), resulting in a very specific form of accretive growth. Fringe belts can later evolve and adapt to replace previous extensive uses with new ones (an old factory turned into a university campus, with some building substitutions) or be reabsorbed in the ordinary city through more thorough transformative processes.

Urban peripheral growth and successive transformations during the 20th century is thus becoming an increasingly important aspect of morphological research. Ünlü (2013, 2021) has investigated the fast 20th century urban growth and morphological transformations of the city of Mersin, Turkey. Filion (2012) offers us a transatlantic perspective with the evolution of a transect of suburban development in Toronto, Canada, from the 1940s to the present. Kantarek et al. (2022) explore the post-socialist changes in the fabric of peripheral areas of Belgrade, Serbia, and Krakow, Poland, after their first development in the second after-war period. Most of Strappa's book (Strappa 2020) on the eastern periphery of Rome is dedicated to the 20th century development and redevelopment of this vast peripheral area of the Italian capital city.

It is in this tradition that the present paper has been written. Focusing on the cities of the French Riviera, in south-eastern France, we want to understand the spatial logics of the first urbanization and the subsequent transformations of the urban fabric in their peripheral areas. The diversity of the forms of the urban fabric on the French Riviera has already been studied (Fusco and Araldi 2017, 2022). The more precise goal of this research is thus to identify the morphological processes giving shape to today's observable form of the urban peripheries on the Riviera. Our analyses will also aim at delineating the spatial extent of these morphological processes, producing a map of the processes behind the forms.

The rest of the paper will be structured as follows. In the next section, we present the two case studies in the French Riviera. Section 3 presents data and methodology of the analyses. Section 4 shows the main results of the analyses for the two case studies, and the related maps of the morphological processes. Section 5 compares and discusses these results, proposing a synthesis in the form of a general scheme of the observed morphological processes. A conclusion section will also give perspective of future research.

2. Case Studies

The case studies of the present paper are two coastal cities of the French Riviera: Nice and Cagnes-sur-Mer. More precisely, we will focus our attention on the eastern section of the city of Nice, behind its port and on the central part of the city of Cagnes-sur-Mer, around the old city center (Figure 1). In both cases, we will observe the forms of the urban expansion that took place between the end of the 19th century and the beginning of the 21st century and we will relate them to the different processes that produced them over this period.

Although just 12 km apart on the Mediterranean coast, the two case studies are representative of two different ways of producing the material city on the French Riviera. In Nice, the urbanization was channeled by several plans of the street network, even if with different spatial logics, in the 19th and in the 20th centuries. In Cagnes-sur-Mer, planning interventions were much more fragmented and sometimes completely absent.

The urban history of Nice is an exception in the French context (Graff 2000). Having belonged for almost five centuries to the Dukedom of Savoy (later Kingdom of Sardinia, one of the many Italian pre-unitary states), Nice was shaped by a pre-modern urban planning model, after the example of the capital city of Turin (Graff 2000). Since the end of the 16th century, Turin gradually established a way of anticipating urban growth through plans of the morphological infrastructure of the future city (Comoli Mandracci 1983): streets and squares of the future

urbanization were laid down in a regular orthogonal grid, with a clear hierarchy between main streets (avenues and boulevards defining a large mesh) and ordinary streets (defining the fine grid within the mesh). Main squares were located at the interfaces between older neighborhoods and the new urbanization, as the starting points of the avenues, smaller ones were carved out of the urban grid as unbuilt blocks or half-blocks. Simple compositional rules allowed for the formation of perimeter blocks within this regular grid, with alignment rules for the buildings. This scheme was already used in Nice in the first half of the 19th century, for the neighborhood of the port, a direct extension of the old city, east of the hill of the old castle (Graff 2000).

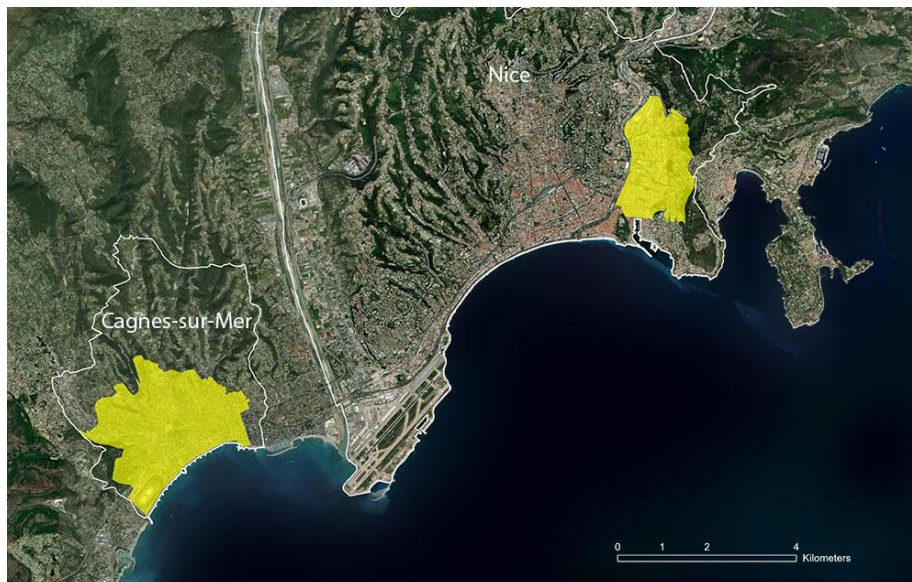


Figure 1 - In yellow, the study areas: Nice-Est and Cagnes-sur-Mer on the French Riviera.

The port neighborhood is the southernmost section of our study area. The first peripheral extension conceived in the last decades of the 19th century is the Riquier neighborhood, north of the port. Its plan was established in 1878 by François Aune (Figure 2), the architect in chief of the city of Nice, after the annexation of Nice to France in 1860. The urban grid was imposed on the pre-existing rural structure and inglobbed a few small faubourgs that were beginning to grow north of the port neighborhood. The plan was conceived as a sort of ideal urban expansion, following the Nice-Turin model (Graff 2013), but its enforcement was particularly defaulting in the French regulatory context and many of the public spaces initially foreseen were not realized. Overall, the plan acted as a guidance of the municipality's wishes for private developers. The latter were the final agents of the urbanization process. Following both municipal guidance and shared cultural schemes, they often developed the blocks in the form of perimeter blocks of aligned and adjoining multi-storey buildings.

The northern limit of the 1878 plan of Riquier was the Nice to Genoa railway. Over the decades, agricultural land north of the railway gradually made room for extensive land uses (military barracks, gas storage facilities, railway yards, etc.) in a typical fringe belt. A further urban expansion was thus planned during the interwar period by the municipal 1931 Cordudet plan (Figure 3), giving birth to the Saint Roch neighborhood. Once again, the enforcement of the plan was relatively defaulting (Graff 2013) above all in the second after-war period, when new government-led plans interfered with it, until a new master plan was produced in 1962, with a more functionalist land-use approach. The Cordudet plan tried to re-engage with planning main avenues and boulevards to structure the peripheral urban extension, but did not lay down a complete urban grid, above all in the areas where industrial and logistical land uses were already in place. Sometimes, smaller blocks were created in the course of time, but the perimeter block was not the only cultural reference for the new modernist buildings. Overall, the flatlands of the eastern periphery of Nice were developed over more than a century by a myriad of small developers and sometimes by bigger industrial actors, with changing cultural schemes but always within the constraints of the planned street layout. The last relevant episode of urban planning in the eastern periphery of Nice follows the 1996 urban master plan (Ville de Nice 1996), fostering the resorption of the vast fringe belt north of the railway, with the creation of a new university campus by city hall and some commercial developments by private investors.

Unlike Nice, Cagnes-sur-Mer did not experience this fast urbanization process during the second half of the 19th century. In 1901, it was still an old compact village on a hill 2 km away from the Mediterranean coast, with a population of 3,400 inhabitants. The urban expansion towards the coast was just beginning and kept on increasing during the 20th century: 5,400 inhabitants in 1921, 11,000 in 1954 and 35,000 in 1982 (more than 10 times its population at the beginning of the century). The population growth continued even afterwards, to reach 52,000 inhabitants in 2019. Differently from Nice, no urban plan was laid down to channel the spontaneous urban expansion of Cagnes-sur-Mer. In the second after-war period, public authorities (municipal and governmental) did build new road infrastructure, but without an overall urban plan for the fast expanding city. The newly created accessibility was thus used to expand both the municipal and the private street network, creating the conditions for further development of agricultural land. New urbanization schemes arose, such as the homogeneous suburban subdivision and the free-standing modernist building within relatively large lots. At the same time, as the small vernacular village was becoming a new relay of urban growth for the city of Nice, the necessity of a new urban center arose, and the first faubourg around the old village gradually let place to a new compact city-center fabric, connected by the railway and the new motorway to the wider metropolitan area. In the periphery, a more intense pressure for urban development was generally exerted in the coastal area, with easy access to the leisure facilities (marina, hippodrome, beaches) and the transportation infrastructure. Inland, the situation was more similar to the one observed on the flanks of the hills in Nice, but often with a 20-40 years delay in the urbanization process, accounting for some cultural differences in the observed formal patterns.

The first planning document in Cagnes-sur-Mer was the 1979 government-led land-use plan. Like all functionalist land-use plans, the focus was more on the localisation of public facilities (including new roads) and rules to regulate building quantities and functions. No particular attention was given to the planning of a coherent urban grid to catalyze specific forms of the urban fabric. We can thus observe a peculiar and mainly legal plot-by-plot urbanism (Karaman et al. 2020, whose examples are often illegal urban expansions) where each plot was developed according to cultural rules and market demand in a relatively weak (before 1979) or form-indifferent (after 1979) regulatory context. After municipally-led revisions of the land-use plan in 1993-94, the municipality of Cagnes-sur-Mer finally established its first local urban plan in 2011 (NCA-Cagnes-sur-Mer 2011).

3. Data, Methodology

For each study area, seven dates were selected to represent the different phases of urban development. Depending on the time, different historical data sources were used. For the 19th century, we used the Napoleonic cadastre (AD06 2022), the first accurate map which presents all buildings, roads and plot boundaries, which we vectorized on a GIS software. For Cagnes-sur-Mer, the cadastre dates from 1834, and for Nice from 1871.

For the 20th century, aerial photography (IGN 2022) became an additional source, together with cadastral maps. Aerial photography has the advantage of being available at different dates, of having a large view and allowing to differentiate the building types. However, the information about the plot boundaries are missing. Various dates of aerial photography were selected to have fairly regular time steps (Table 1). To study the contemporary urban form and identify blocks and block sections for the analysis, the vector-based BD-Topo by IGN (2020) was used. Precise time steps vary between Nice and Cagnes-sur-Mer according to data availability and the need to follow the rhythm of their urban development. These historical data were used to identify the type of network structure and the building types for each date.

We identify three structure types for the street network in our study areas: *urban grid structure* (whether regular or irregular), *tree-like structure* and *linear structure*. This is an extremely simplified typology. The first corresponds to the three categories named A (Altstadt), B (Bilateral) and C (Conjoint) in Marshall's ABCD scheme (Marshall 2005). The second corresponds to Marshall's D-type (Dendritic). Both are current today, even if the A-type is generally the heritage of vernacular urbanization. The linear structure appears at the early stage of urbanization within rural networks. Within it, built-up plots are directly accessible from a single, relatively long, public street, eventually through a private alley that serves a single building. It is a transitory structure that evolves towards an urban grid or a tree-like structure during the additive and repletive processes of the first urbanization cycle.

Table 1 - Type and date of historical data used for analysis.

| Nice | | Cagnes-sur-mer | |
|------|---------------------|----------------|---------------------|
| 1871 | Napoleonic cadastre | 1834 | Napoleonic cadastre |
| 1920 | Aerial photography | 1935 | Cadastre |
| 1946 | Aerial photography | 1946 | Aerial photography |
| 1959 | Aerial photography | 1958 | Aerial photography |
| 1975 | Cadastre | 1977 | Aerial photography |
| 1988 | Aerial photography | 1999 | Aerial photography |
| 2020 | BD Topo IGN | 2020 | BD Topo IGN |

Types of buildings (Figure 4) are defined by use and form. Six very general types of buildings can be defined. The old city *vernacular adjoining townhouse* is a pre-existing type present before the late 19th century urban expansion. Within our study areas, it is almost exclusively observed in the old city of Cagnes-sur-Mer. The latter underwent minimal modifications during the study period and will be considered as fixed for the sake of this study. The vernacular townhouse is also used in early faubourg expansions. Modern townhouses are relatively rare in our study area. A few residential subdivisions were developed in the form of small series of townhouses only in the last decades. The mid-size *adjoining in-line building* is the classic building of compact city fabric during the 19th and the first half of the 20th century. In Cagnes-sur-Mer, it is a narrow building, 3 or 4 floors high. In Nice, its surface can be slightly bigger and its height can reach up to 6 floors (smaller buildings like in Cagnes-sur-Mer are also present, though). In both cases it normally has two neighboring buildings with abutting walls and is aligned on the street edge. A modern adjoining in-line building version arrived in the second half of the 20th century, taller (6 to 9 floors), longer, but always joined together and aligned. The *individual residential building* aggregates all types of isolated buildings with residential use for a single household (detached houses, villas). *Collective isolated residential buildings* are modern free-standing within the plot, medium- or big-sized blocks of flats. Finally, the remaining buildings, classified as *specialized buildings*, aggregate the industrial, commercial, workshop and service buildings, as well as sport facilities. Their structures can take different specific forms, but they are all defined by an exclusively non-residential function and an extensive use of space. If in the same unit of analysis more than one building type is present, the unit will be considered as typologically mixed.

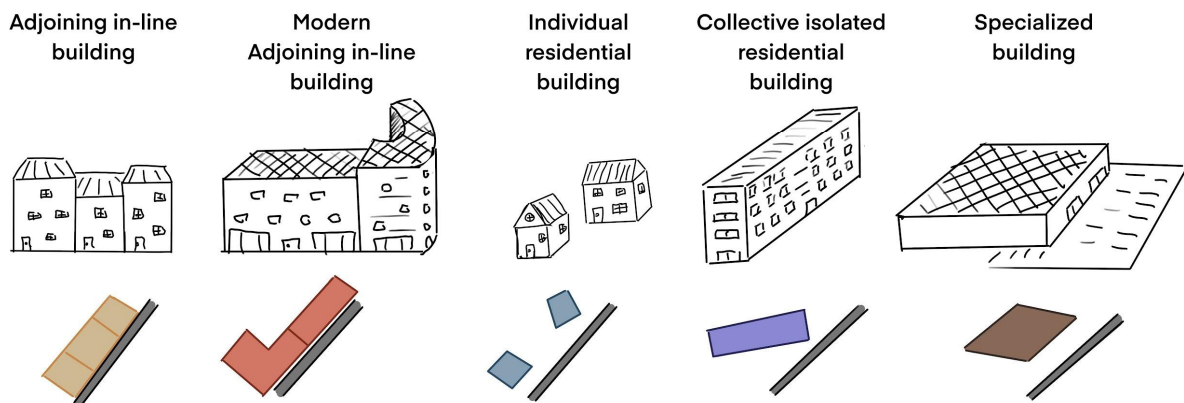


Figure 4 - Types of building considered for analysis.

The methodology was conducted in 3 steps: selection of study area and identification of analysis units, enrichment of analysis unit information with network and building types, and finally compilation of information to identify the different operating morphological processes.

Our study of the urban form evolution privileges the analysis of street networks and of buildings. Plot geometry and the relationship between plots and buildings are a subsidiary element whenever the information is available. However, an analysis performed building by building or street by street would be too focused on each single element, whereas we prefer to have a more holistic view. The choice was made to identify more appropriate analysis units, sub-spaces with a given final, more or less homogeneous, plan unit and with fixed boundaries. Within these units, we can follow the different processes having led to the final result. The block defined by interconnected public streets is a pre-existing division, but it is pertinent only within an already urbanized space. In rural and suburban areas, very large partially developed blocks can contain several plan units. Within consolidated urbanized areas produced during the 19th and 20th centuries on the French Riviera, street segments define more or less regular urban blocks whose surface lies normally between a minimum of 0.3-0.4 ha and a maximum of 1-2 ha. Their lots normally have direct access to the perimetral streets. In Mediterranean vernacular old cities, blocks can have much smaller surfaces (they range between 0.05 and 0.25 ha in the old cities of Nice and Cagnes-sur-Mer). Larger blocks allow the creation of internal streets, sometimes even several of them organized in tree-like structures, giving access to internal plots. Caniggia and Maffei (1979) propose the concept of the pertinent band of a street segment, defined as the set of the plots having direct access from it. The assemblage of the pertinent bands of interconnected internal streets within a block defines block sections within the larger block. Suburban blocks are usually made up of several block sections with different access to the perimetral streets. The creation of the analysis units consists in the identification and division of urban blocks and block sections (Figure 5). This identification of the units was realized from the present-day data given by BD-Topo (IGN 2020).

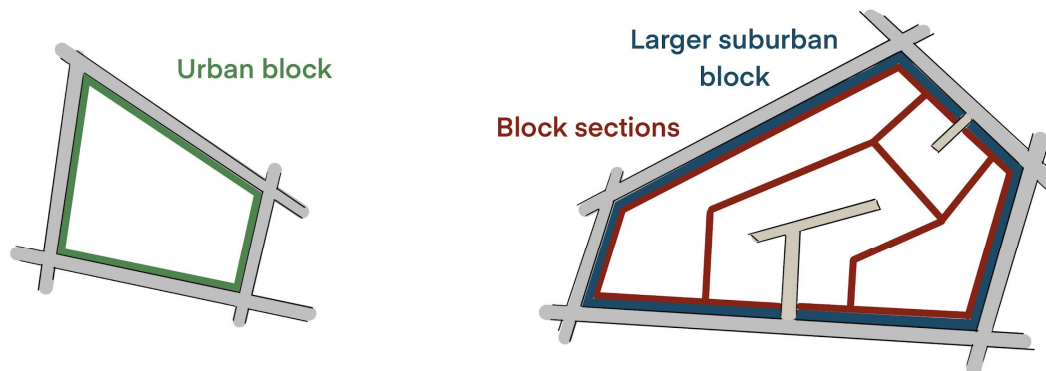


Figure 5 - Scheme of block division used in the method

The different historical data were georeferenced and overlapped with the layer of analysis units. Each block or block section was enriched with historical data. Information concerning the type of network structure and building types was gathered. Additional information, such as topographic information or alignment of buildings on the street network, was used to describe analysis units. This allowed us to determine for each time frame, the urban development stage of the unit. The sequence of urban development stages can be used to identify the general development and redevelopment process of each spatial unit. We can thus identify relatively sudden processes, where the final morphological state was produced within a few years (a single time frame within our analysis); progressive, i.e. gradual, additive and repletive processes, achieving the final morphological state within several time frames; interrupted processes, where the final stage of a given typo-morphological phase did not saturate the spatial unit. The urban development processes were mapped within their spatial extent, analyzed, named and organized. In the next section, the mapped processes are presented with a focus on smaller sections of the study areas where they are relevant. Afterwards, the spatial extent of these processes will be mapped on the whole of the study areas of Nice-Est and Cagnes-sur-Mer. This allows us to compare the different spatial logics of the morphological processes in the two cities.

4. Results

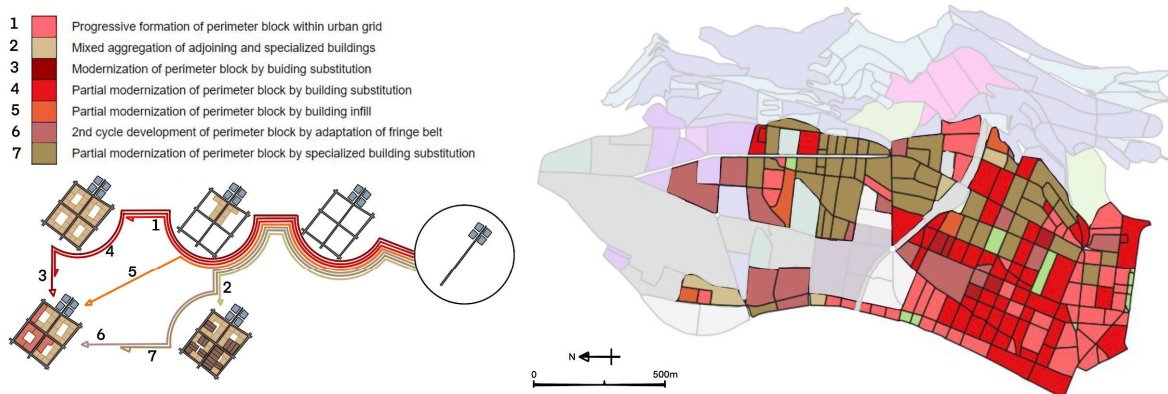


Figure 6 - Process of creation and adaptation of perimetral blocks.

In what follows, our analyses of the morphological processes will be presented according to the end-results in terms of urban form, by constantly comparing findings in Nice-Est and Cagnes-sur-Mer.

Compact city development. The two study cases show two characteristic processes of the formation of the compact city. The planned compact city area of Nice Saint Roch (Figure 6) can be compared with the more spontaneous compact city development of Cagnes-sur-Mer (Figure 7).

In Nice, urban planning documents define the street layout. The urban grid is created before most buildings. From the urban grid, the compact city is developed through the perimetral block formation process, fostered by building rules allowing for abutting walls and requiring street frontages. A few main axes are the starting point of a gradual development of the perimetral block. The development of a compact street frontage of adjoining mid-rise buildings is done along the main axis, then successively along parallel streets one by one, until the closure of the perimetral block on the perpendicular streets. At the same time the closed perimetral block can become filled with repetitive buildings in its courtyard. Repletion is characterized by 1- or 2-storey buildings, mainly used as parking facilities or workshops.

In the periphery of the compact city, a fringe belt is created by installation of various types of specialized buildings. The type of building and associated activity is determined by the available surface. On the planned urban grid area, the urban block proposes small available surfaces (0.3 to 1 ha). The main activities which can be settled here are workshops. A progressive development of this compact fringe belt can be observed at the turn of the century, mainly in the east of Riquier and, further north, in what will become the neighborhood of Saint Roch. This development is gradually mixed with the adjoining buildings of the compact city. Along the railway, few larger urban blocks (2 to 3 ha) allow settling more extensive activity.

From 1975 on, a redevelopment cycle of modernization of the perimetral blocks can be observed. This cycle leads to the closure of the last non-complete perimetral blocks with modern adjoining buildings and to the adaptation of the old compact fabric by building substitution. In classic perimetral blocks, the original adjoining buildings are substituted by taller adjoining modern buildings.

The modernization also concerns fringe belt perimetral blocks. The resorption can result in the total disappearance of workshops and in the densification of the urban grid by the split of a few larger urban blocks. In the old fringe belt perimetral blocks, workshops disappear. Only the “TNL” block (formerly tram parking station and today a shopping mall with blocks of flats above) keeps the original size of these larger urban blocks in the peripheral fringe belt. The modernisation process is not completed everywhere and we can still observe today the different steps of the perimetral block development process.

The development of the compact city extends beyond planned urban grid areas. It continues along planned main axes (those of the 1931 Cordudet plan) that will only gradually become the support of a meshed network. Here, no pre-established grid constraints the building form, but buildings and grid segments are conceived almost together. The resulting urban grid is less regular, larger and supports the same process of development of a mix of workshops and adjoining buildings.

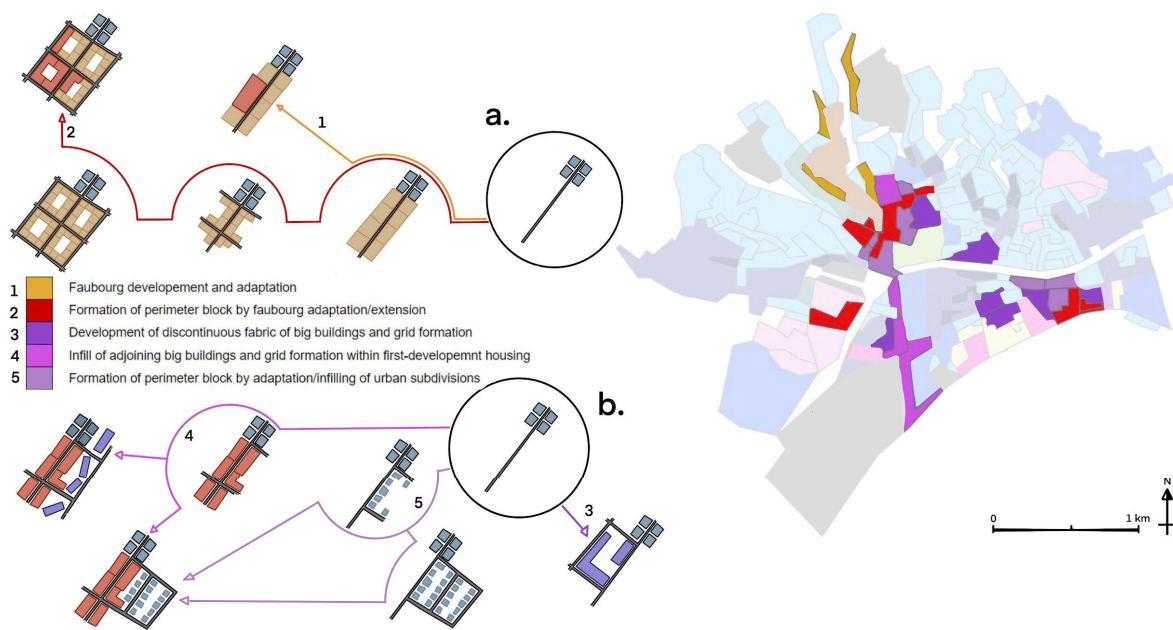


Figure 7 - Scheme of faubourg (a.) and new city frontage (b.) development processes

Nice is a large compact city defined by perimetral blocks within a completely or partially planned street layout. What we observed in its eastern section is a good example of the processes leading to this end result. The smaller compact city of Cagnes-sur-Mer grew through faubourg formation (figure 7), a more spontaneous growth of adjoining structure along a pre-existing main axis (a matrix route in Caniggia's terms). The compact city was developed from the faubourgs next to the old city and the small fishing port of Cros-de-Cagnes which are the two urban cores in 1934. Sometimes, the original faubourg is doubled by a parallel street, with a few continuously built connections creating an irregularly meshed network. The resulting form is a perimetral block, like in Nice (path 2 in figure 7). The rest of the compact city keeps a linear form (path 1 in figure 7). Perimetral blocks or linear faubourgs are modernized through an adaptation process of substitution by modern adjoining buildings (figure 7.a).

In 1958, a new axis is created between the city center and the seaside and allows the connection between the two old centers of Cagnes-sur-Mer. The strategic position of this axis, connecting the old city and its extension to the seaside, fosters the development of a compact street frontage of adjoining modern buildings. Like in the peripheral growth of Nice around the axes of the Cornudet plan, this development leads to the creation of new perpendicular streets and finally to a meshed network. The compact form, though, is limited to the frontage of the main axis, while the backs of the urban blocks receive isolated residential buildings resulting in a discontinuous fabric (figure 7.b).

Residential area development. Urban and suburban subdivisions are the main structures of residential development. The mainly pre-war urban subdivision creates smaller regular plots with buildings facing perimetral streets. The mainly post-war suburban subdivision creates more irregular plots and buildings facing internal streets. In both cases the network can originally be tree-like, but only the urban version has the potential of a meshed network, because a last developed plot typically closes the cul-de-sacs in the suburban subdivision.

Since the 1950s, Nice has become highly urbanized with limited availability of easy-to-develop areas. In our study area, the only undeveloped sector is the hillside on the east, presenting a few topographic constraints (Figure 8). Development of urban subdivisions begins with houses along hill road paths. This subdivision leads to the building of regular houses facing the winding roads. The network remains tree-like due to the difficulty of creating connections on the hill flanks. The hill is progressively developed, creating a wider tree-like structure. Observed from 1975 on in our data (but with some construction already in the 1960s), modernist developments lead to a mix of houses and isolated big buildings, created by accretion in large undeveloped plots or substitution of older houses in a context of increasing urban land values.

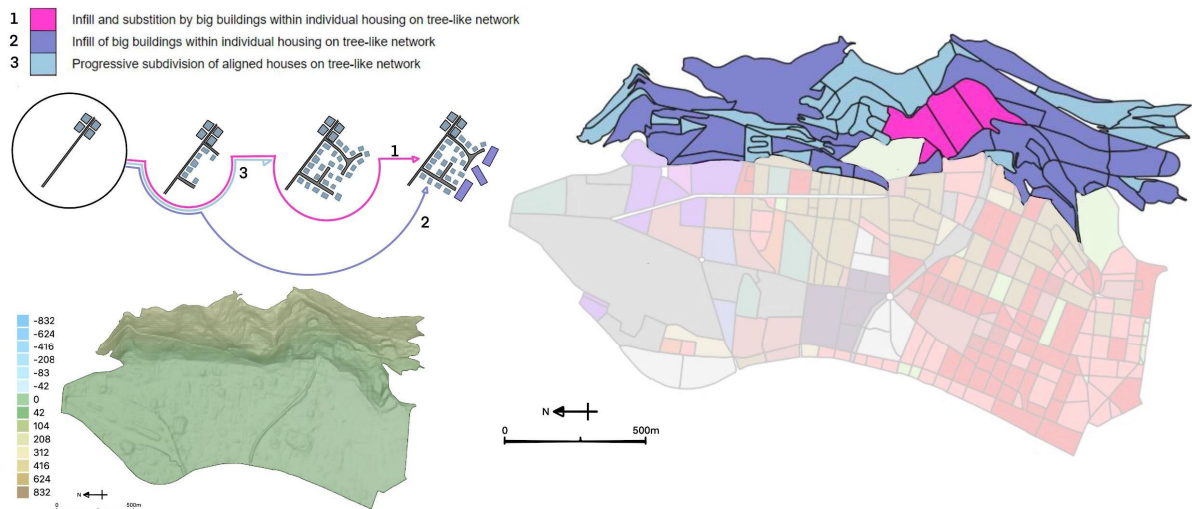


Figure 8 - Map and Scheme of peripheral residential area development process.

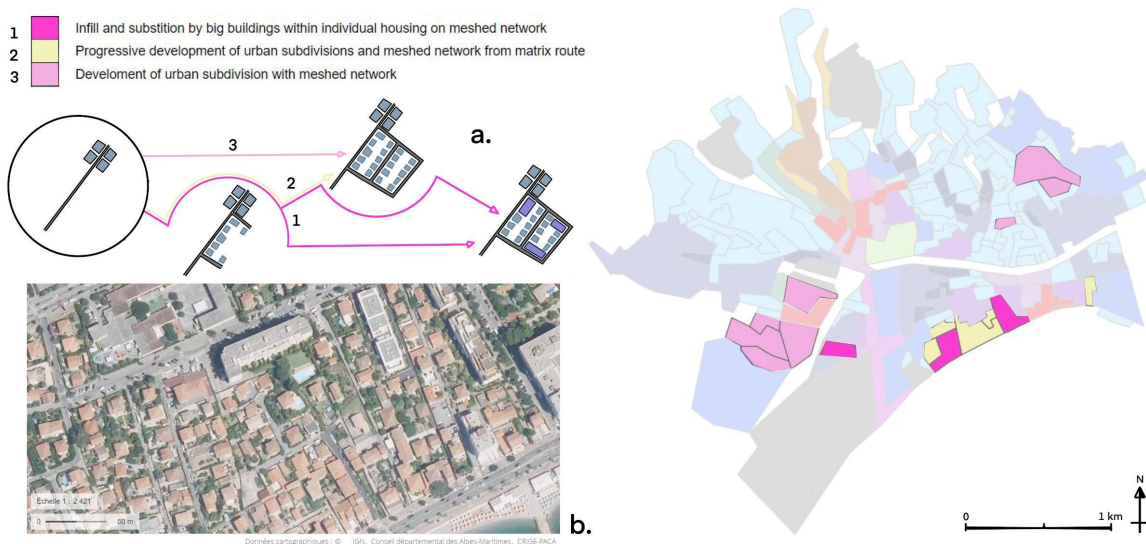


Figure 9 - Scheme development of urban subdivision and meshed network processes (a.) and illustration of this process with Cros-de-Cagnes seaside (b.)

A large part of Cagnes-sur-Mer is residential with variations depending on the proximity to the compact city and the main axes, on the beginning date of the first development process, and on the previsual final form.

Next to the compact city and along an existing network, houses are built using urban subdivision principles (Figure 9). They are aligned, similar, have a small plot and face the street. Then, by an additive process, new houses are built on new perpendicular streets (planned building routes in Caniggia's terms). The process is the same as the hillside development in eastern Nice. In topographic unconstrained areas the development can lead to a meshed network through the creation of connecting routes (path 2 in Figure 9). The blocks of this urban grid are characterized by a regular width (twice the depth of the typical plot) and varied length. From the 1970s, the unbuilt plots are infilled with modern isolated buildings, creating a mixed fabric. Mixed or pure-house fabrics can evolve through adaptive processes (path 1 in Figure 9). Some houses are substituted by modern isolated buildings. This is illustrated by the seaside neighborhood near the Cros-de-Cagnes fishing port.

Since 1946, some meshed residential urban subdivisions have been created (path 3 in Figure 9). Even if they are only progressively built-up, their pre-established urban grid becomes a robust morphological infrastructure, non-modified by subsequent adaptation or transformation. Sometimes, building substitution can take place (which is an alternative way for path 1 in Figure 9).

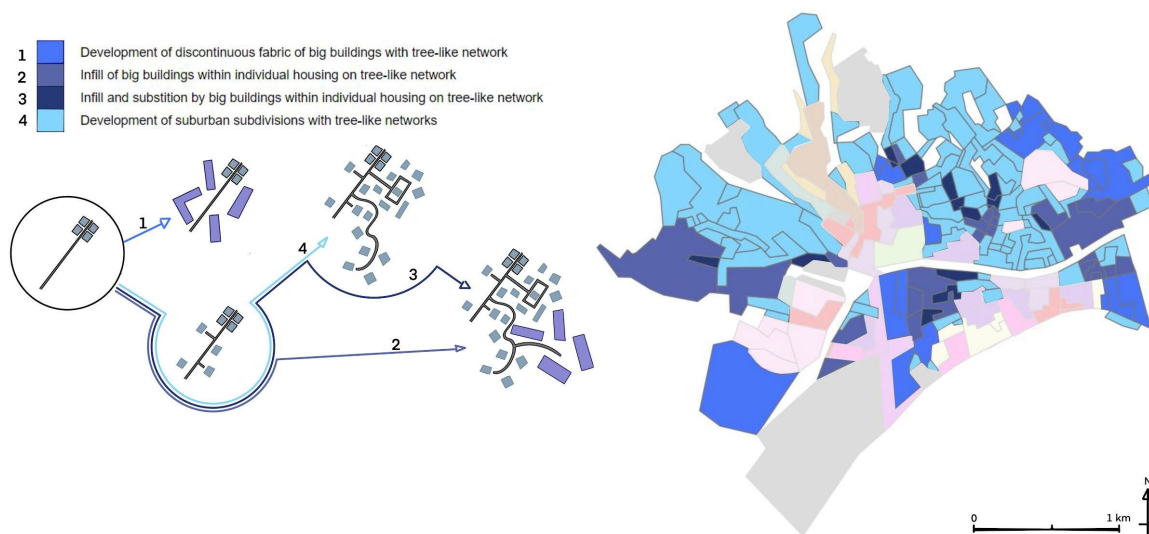


Figure 10 - Scheme of tree-like peripheral residential development process

The rest of Cagnes-sur-Mer's residential areas are developed around tree-like street networks (Figure 10). The first step is the development of loose plots along a pre-existing rural linear network. During the development new planned building routes are created to serve inaccessible plots. Large rural plots are truncated and used for creating clumps of houses served by the new street. As already noted, a house normally blocks the dead-ends of the subdivision, to prevent future connections generating through-traffic. Next main arteries are also created after the 1950s, but they are no longer conceived as main streets with building frontages. They are mainly roads for motorized traffic, from which the planned building routes of the suburban subdivision depart. Sometimes they serve commercial developments (see below). Even after 1975, new streets are created around these main routes to serve isolated buildings or new subdivisions (path 1 in figure 10). In Cagnes-sur-Mer, these peripheral subdivisions have normally low urban pressure and are generally not concerned by a second cycle of development.

Fringe belt development. The last general process is the formation (and sometimes resorption) of fringe belts. Nice-Est and Cagnes-sur-Mer are contrasting examples. Nice has a large development of fringe belts in its eastern section, as the latter was historically the hinterland of a commercial port. However, as already seen, part of this fringe belt was constrained by a planned urban grid and thus hasn't the characteristic form, and development, of a classical 20th century fringe belt. Otherwise, unconstrained fringe belts in Nice-Est and Cagnes-sur-Mer have a characteristic form.

In the north and west sections of Nice Saint Roch, before 1975, very large blocks (10 to 30 ha) were created with the installation of more extensive activities (freight station, gas depot, military barracks ...). In the 1970s, a phase of modernization and fringe belt resorption started; the availability of very large blocks allowing the development of a large variety of urban forms.



Figure 11 - Fringe belt transformation in Nice Saint Roch: discontinuous fabric of modern buildings (*left*) and university campus of Saint Jean d'Angély (*right*).

In sectors where the street network is already well meshed, the process of development and modernization of perimetral blocks continues. Beyond these sectors, unbuilt areas are used to produce a discontinuous fabric of modern collective building (Figure 11, left). The transformation of very large blocks allows developing specific urban projects. Transformative process of fringe belt resorption is characterized by the total destruction of the ancient form and the opening of new streets. The best example is the transformation of a military complex into the university campus of Saint Jean d'Angély, foreseen in the 1996 master plan (Figure 11, right) (path 1&2 in figure 12). A last part of the old fringe belt undergoes adaptation, with warehouses and service buildings replacing industrial ones.

Today, the south-east of Saint Roch and the east of Riquier have a relatively homogenous form (Figure 6). The steps of the development process for compact cities were followed in the 2nd cycle of modernization by infill or substitution. The variety of urban structures depends on the progress of the modern perimetral block process. By contrast, the northern section of Saint Roch is organized around an irregular urban grid, mixing perimetral blocks and discontinuous fabric. In the west, compact city and extensive service areas are characterized by the prevalence of modern forms (Figure 12).

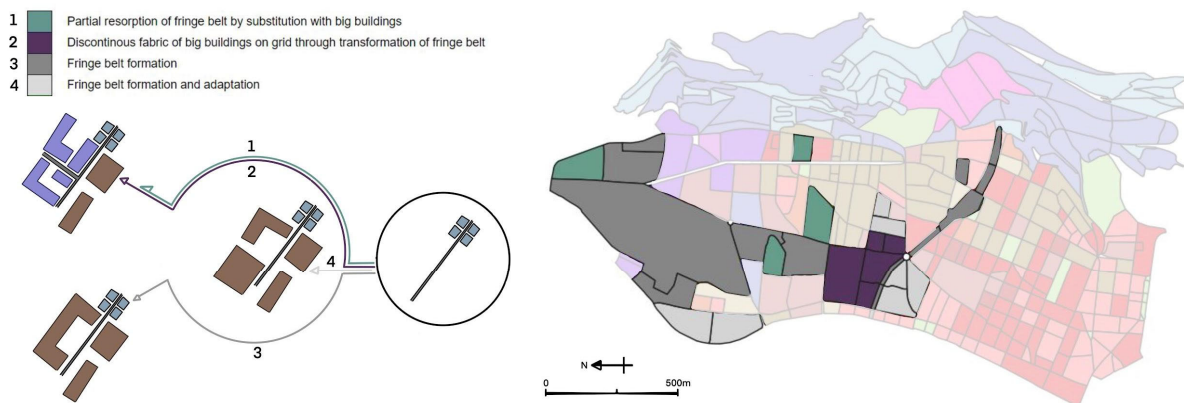


Figure 12 - Complete process of creation and adaptation of fringe belt.

In Cagnes-sur-Mer, the fringe belt areas are much more limited. The exception is the large racecourse built soon after the war to replace the one in Nice, which was transformed into an airport. Apart from it, before 1977, only two spaces host extensive uses beyond the urban front line. Because of a growing urbanization, a progressive resorption of fringe belts by transformation is observed. After 1977, and following a relatively slow down of the population growth, new fringe belts of services and large retail stores are developed, the most notorious includes the large retail complex of Polygone Riviera, in the north-eastern section of our study area. The proximity of a main road (the coastal road for the racecourse, the axes linking Cagnes-sur-Mer with its hinterland) is the main trigger for fringe belt development in the after-war period.

Generally, a fringe belt is present in each city. It is developed mainly along roads allowing motorized traffic and on the outer outskirts. The older fringe belts are resorbed due to the urban front line progress. The classical change is adaptation to services fringe belt or to isolated modern buildings (with or without an urban grid development). Afterwards, a new fringe belt is created beyond the actual urban front line.

5. Synthesis and discussion

Mapping of evolution processes. A general map of evolution processes (Figure 13) allows us to display the localisation of each morphological process, its extent and relative proximity to the urban core. The common evolution processes between Nice-Est and Cagnes-sur-Mer are represented by the same color for an easier comparison of the results.

The most apparent difference is the size of the compact city (orange, red, and brown colors): 1km² for the eastern section of the city of Nice, against 0.2km² for the whole of Cagnes-sur-Mer. This difference is partly explained by the size of the two cities, but also by the long-term effect in Nice of plans having fostered and guided the

compact city development. In addition, we can see the different spatial organization of the compact city. In Cagnes-sur-mer, it is limited to relatively narrow bands compared to the large extent in all directions in Nice-Est. In Cagnes-sur-Mer, most of the developed area (approximately 80%) is for residential use. In Nice-Est, residential use is mainly present on the hillsides. In the two cases, we can observe a progressive spatial sequence of various residential types from center to periphery. In proximity to a compact city, the first residential types are mixed residential areas of houses and buildings, and meshed areas of houses (dark blue and beige). Beyond these densified residential areas, there are only-houses areas that have not evolved much after their first development (light blue and light pink). In Nice, they correspond to the end of the city boundary and houses are more and more distant. In Cagnes-sur-Mer, we can observe an additional residential fringe, only made of collective isolated buildings (royal blue).

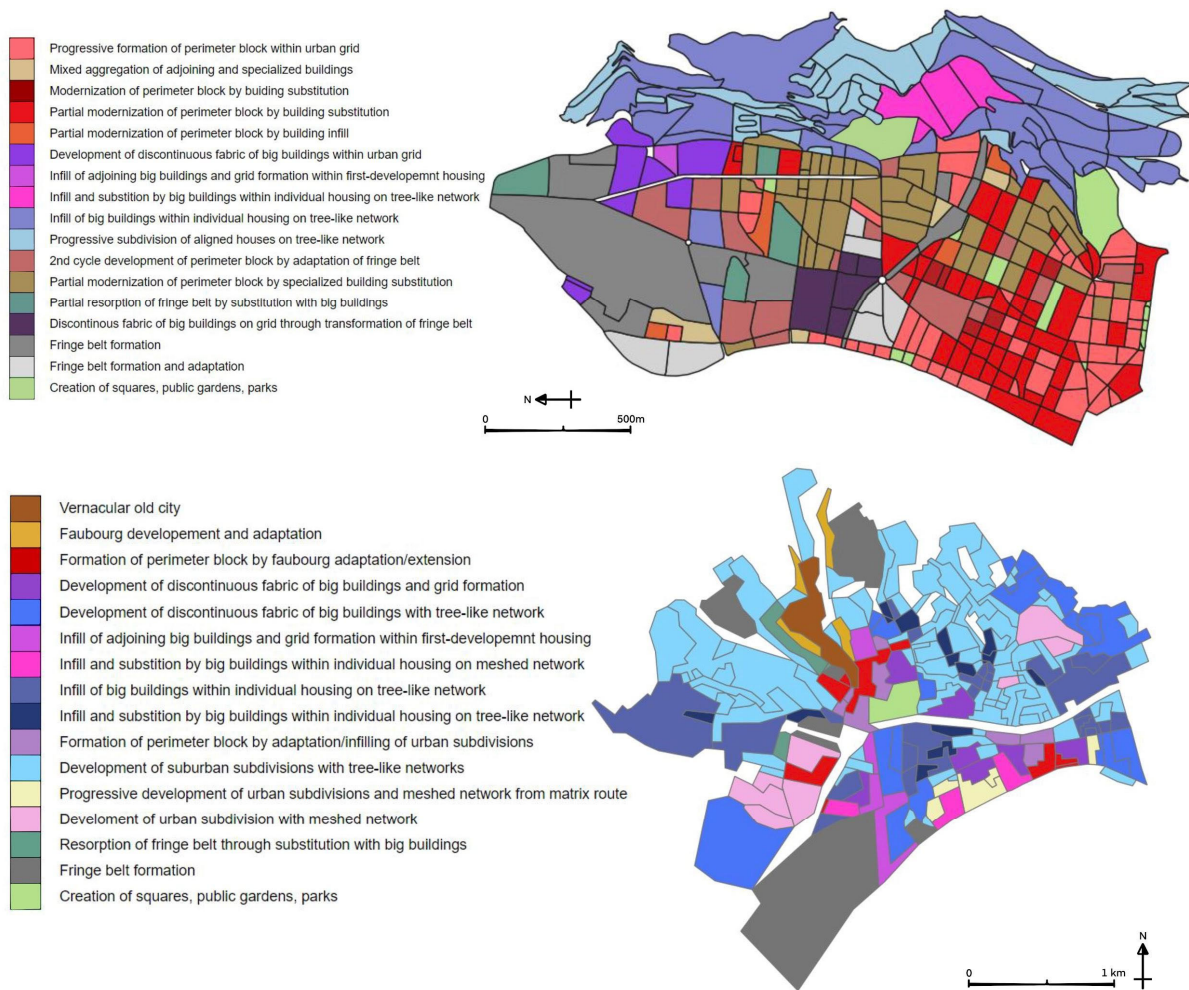


Figure 13 - General map of evolution process on Nice-Est and Cagnes-sur-Mer.

General scheme. All morphological processes studied for the two cities are presented on a general scheme (Figure 14) which proposes a logical organization and connection of the processes. The starting point of the scheme is always a preexisting urban core and a main route departing from it (initial state). The morphological processes unfold following precise steps, which produce new intermediate or final states. Several steps make a more articulated evolutionary path. We can see that various paths can start from the same state and that the same urban form (final state) can sometimes result from different evolutionary paths. At the same time, everything is not obtained from everything else, and strong path-dependencies characterize the sequence of the morphological processes. Urban peripheral development is steered by the following constraining elements. Particular attention has been given to name the steps within the scheme, more than the states.

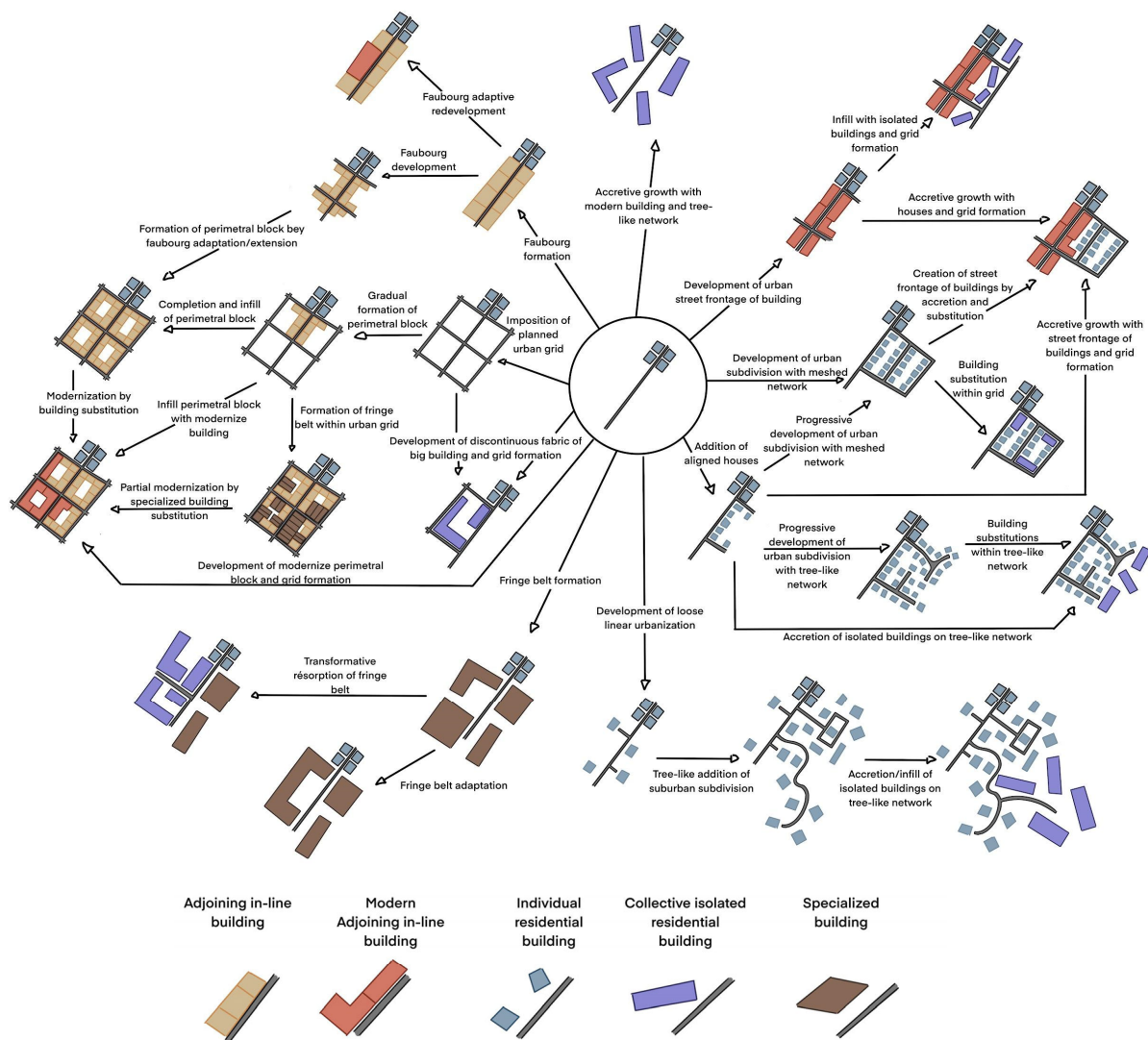


Figure 14 - General scheme of the morphological processes on the French Riviera.

i. Before all, the *morphological infrastructure of the street network*. The planning of a regular urban grid in the immediate proximity of the urban core, with formal or informal rules of building alignment on the street, leads to the development of the perimetral block. Although different forms are possible for a first development, successive adaptations or transformations go towards the modern perimetral block. The development of compact cities can also start with a linear structure such as faubourg or urban street frontage buildings. The planning of a regular urban grid in an urban subdivision can also foster compact city development, even if not in the form of perimeter blocks: densified urban subdivisions (after repetitive and adaptive processes) can produce compact linear frontages along main axes. In some cases, initial linear and spontaneous growth of tree-like structures can still evolve in relatively compact urban forms supported by an urban grid. On the contrary, planned tree-like structures with built-up plots blocking the connection of the dead-ends will normally produce less evolutive residential forms, whether as single-houses subdivisions or compounds of isolated collective buildings.

ii. Another constraint element is the *topography*. Steep hill flanks stop the development of a meshed street network and hinder the localization of extensive urban functions other than residential. Compact city (at least not in the vernacular forms), fringe belt and discontinuous fabric are constrained by steep slopes. The only possibility is thus the development of a residential area supported by a tree-like network. However, tree-like networks are not limited to the hills.

iii. In unconstrained areas, a main factor is *urban pressure*, which is in turn linked to the accessibility to urban centers (through the main transport infrastructure) and to the growth of the urban economy and population. Strong

urban pressure on previously peripheral, but now semi-central areas, induces the transformative resorption of fringe belts and the adaptation of the most extensive residential uses through infill and building substitution. As long as a fringe belt remains on the urban front line, it is not concerned by resorption, and eventually adapts to other extensive urban uses.

Our main results show also that the second after-war period constitutes a paradigm shift in the urbanization process. Main arteries are still developed after the 1950s but tend to lose the role of matrix routes as they no longer structure plots and buildings. Planned building routes develop in tree-like patterns and no longer accept connections among them. The lower part of the scheme becomes thus more preponderant, as witnessed by the case of Cagnes-sur-Mer, where most of the peripheral growth happened in the last seventy years.

Of course, these processes and phases thereof are those observed in the case studies of Nice-Est and Cagnes-sur-Mer, on the French Riviera. We think they are representative of the main paths of development of urban peripheries in the French Riviera metropolitan area, with the exception of a few unique large scale urban projects like the technological park of Sophia-Antipolis and the new city of Carros-le-Neuf. Further empirical research will be necessary to generalize these findings to other French, European or Mediterranean urban contexts.

6. Conclusion

The large growth of present-day urban form on the French Riviera shows the plurality of the morphological evolution processes and of the variables of these evolutions. Identifying the different steps of these evolutions is of key importance to understand the potential of the present urban forms. The analysis of historical data for Nice-Est and Cagnes-sur-Mer allowed us to identify specific instances of more general evolution processes already studied by the classical schools of urban morphology. The comparison of these processes, broken down in a few intermediary steps, allowed us to create the final scheme of morphological processes on the French Riviera. The schematic representation leads to grouping similar urban forms created by the same processes. This scheme shows 33 possible transitions linking 24 different morphological phases. Some areas have undergone several transitions, others only one or two. Some are presently in intermediate phases, others in much more stable end results.

Within our research, the scheme was used to give a logical organization to the great variety of observed processes. However, it also has an urban prospective potential. The step by step structure of the scheme allows positioning observable urban forms in possible paths of future evolution. In the middle step, a given form has a known potential of evolution, according to paths connecting it to further developments/redevelopments. The final step could be thought of as an optimal form under a given set of constraints. The prediction of the evolution process depends on matrix routes, plans of the street network, environmental constraints, city growth and accessibility patterns.

This scheme is a first attempt to generalize our findings, leaving room for unobserved transformation patterns. Analyses of different case studies of French, European and Mediterranean peripheral urban growth during the 20th century are needed to confirm or improve the proposed scheme. In this prospect, the next step will be conducted on the peripheral extension of the city of Bordeaux, in south-western France. Our long-term goal is also to develop a rule-based prospective model for the evolution of urban peripheries in French cities.

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