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THE CONSTRUCTION OF THREE METROPOLISES

A geographic, productive and configurational process.

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ABSTRACT

The explosive urban growth in developing countries has often resulted in social and territorial disparities, with zones well-provided with urban services, equipment and amenities for affluent groups and vast areas lacking infrastructure and services populated by the poor. This paper proposes that a configurational analysis of the urban process of metropolitan cities could shed light on the spatial mechanisms behind urban inequality. Specifically, we attempted to analyse (i) the historical urban tendencies related to changing economies and (ii) geographical constraints that determinate the suitable land for urban development.

Three Chilean cities (Santiago, Valparaíso and Concepción) accommodate more than half of the national population. For each metropolitan area, a set of historical axial maps was drawn (1875, 1915, 1965 and 2015) that were analysed in relation to the geography and productive activities of the moment. With the global (HH) and local (r_3) integrations, the main changes in the urban structures were identified, highlighting the migration of the centres and the characteristics of the most integrated/segregated areas.

The trends of urban growth in the three cities evidence a process that starts with a geographic positioning of the city, very much in line with its economic vocation and viability, enhanced by a spatial configuration that potentiates both the geography and the economic potentials of the region. Nevertheless, when economic, social and cultural conditions vary the city adapts, centralities change and develop and in some cases the deep structure of the city changes. The configurational analysis allowed us to understand three very different cases which we believe can be compared and shed light in the development of other cities.

KEYWORDS

Urban growth, metropolitan areas, historical growth.

1. INTRODUCTION

In many developing countries, the explosive urban growth has been accompanied by high socio spatial inequalities, with well-provided areas inhabited by the accommodated groups on the one hand, and highly deprived areas populated by the poor on the other. Latin America, the most urbanised area in the world (ONU-HABITAT, 2012), has been part of this tendency and most metropolis of the region exhibit high levels of segregation and inequality. Irregular settlements, neighbourhoods impoverished by economic cycles or indirectly produced by public action, coexist with well-located wealthy areas, with exclusive services and high quality facilities (Clichevsky, 2000).

In the case of Chile, with over 87% of urban population (INE, 2010), the national population is centralised in its three main cities: 38% lives in the capital Santiago, and 20% in Concepcion and Valparaiso (Hidalgo & Arenas, 2009). Although these three cities have slowed their population growth in the last decades (2,0% Santiago, 2,5% Concepción and 1,2 % Valparaíso between 1982-2002, according to Hidalgo & Arenas, 2009), they have consumed vast areas of surrounding territory: between 2009 and 2015 Santiago consumed 558 hectares in average per year, Concepcion and Valparaiso occupied 135 and 83 per year respectively (Valencia, 2016). Moreover, this explosive urban growth lead into a systematic socio spatial segregation process distancing the more affluent groups from the most deprived.

The national literature points out that segregation in Chilean cities has been indirectly promoted by public policies. Through aggressive governmental social housing programmes, massive production of housing was significantly increased and effectively decreased the number of irregular settlements, but displaced deprived groups towards a distant and poor periphery (Ducci, 1997; Sabatini, 2000; Rodríguez & Sugranyes, 2004). In parallel, the construction of highways and the liberalisation of the urban land markets triggered an intense suburbanisation of the countryside by higher-income groups (de Mattos, 1999; de Mattos, 2002; Hidalgo & Zunino, 2011). However, and despite both processes, this paper argues that the current social and spatial fragmentation in Chilean cities is deeper and has roots on (i) complex geographies which determinate the availability of land and (ii) changing economies that can trigger violent transformation on the urban dynamics.

2. DATASETS AND METHODS

A syntactic analysis of the three main Chilean cities –Santiago, Concepcion and Valparaiso– through their different stages of development was carried out in order to better understand the urban growth and construction of metropolitan areas. The main tool used was the axial maps, representing all public space and streets with the minimum number of straight lines that cover the whole system (Hillier et al., 1984). The axial maps of each stage allowed us to recognize the spatial configurations built by the relationship of each part with all the other parts of the system (Hillier et al., 1998; 2000). This approach highlights topological relationships; in other words, it recognises that the characteristics of a specific part are intimately defined by the correlations with the other parts of the system in which it lies (Hillier, 1996).

A group of historical axial maps was elaborated for each city highlighting four periods: (i) the first period (between 1870 and 1880) was marked by urban operations inspired in the Paris of Haussmann. (ii) The second moment (1910-1920) corresponds to the Centenary of the Republic, characterised by several urban interventions intended to sanitise and embellish the rising metropolises. (iii) Industrialisation process and the arrival of modern urbanism (1960-1970) are reflected in the third period. (iv) The fourth and last period (2005-2015) captures the effects of the neoliberal model established in Chile since the 80's until today. The maps were reconstructed using historical maps from the accorded periods. In the case of Valparaiso, the available maps of the 19th century did not cover the entire territory currently occupied by the metropolis, hiding key connections between the settlements of the time. The connections were inferred from written evidence but they are less precise than in Santiago and Concepcion.

After the construction of the axial maps of each metropolis, and with the use of Depthmap software, global (HH) and local (r3) integrations were calculated. The resulting maps were juxtaposed with the geography of the cities, recognising the geographical barriers that are relevant in Santiago (mountains), Valparaíso (hills) and Concepción (rivers and wetlands). Furthermore, the main economic aspects of the city were captured in existing bibliography and later contrasted with the changes in the global and local integrations. Lastly, the maps of global integration along with the geography are fully represented in the figures of the paper. Local integrations are partially shown in minor fragments according to their relevance in the analysis.

3. THE THREE CITIES

Santiago de Chile is the capital of Chile and has almost 7 million people in a territory of 750 km². Concepción and Valparaíso have almost one million each in areas of 130 and 110 km² respectively. Founded during the 16th century, Santiago is the oldest city of the trio, located between the Andes coastal range and the Pacific Ocean, in a valley crossed by three rivers: Maipo, Mapocho and Zanjón de la Aguada. Its central location in the country, crossed in the north-south direction by the Panamerican Highway and tensed east-west by its position between mountains and ocean, it has developed in a radial structure (figure 1).

Concepción was part of the southern frontier of the country until the end of the 19th century, when the last territory unconquered by the Spanish Crown, the Araucanía, was annexed to the recently formed nation of Chile. The current metropolis is in the estuary of the river Biobío, in a rich ecological area that includes wetlands and forests. The city exhibits two clear axes of urban development; one of them runs in the plains between hills and the river, while the other follows the coast. This area is home of four active ports (figure 1).

Valparaíso does not have a clear date of foundation, it emerges spontaneously in a small bay during the 16th and 17th centuries, and was the main port of the country until recently. It later conurbated with Viña del Mar, the second city of the country, and in 1980 it became the legislative capital of Chile. Like Concepción, Valparaíso has two axes of growth delimited by the coastal line and the inner valleys. The coastal axis occupies littoral plains and the surrounding hills, creating natural amphitheatres. The second axis penetrates inland, following valleys created by small rivers and ravines (figure 1).

All three cities have known natural and man-made disasters -battles, earthquakes, great fires- and have been reconstructed more than once.



Figure 1 - Santiago, Concepción y Valparaíso.
Source: personal elaboration.

3.1. SANTIAGO

The spatial analysis of Santiago in figure 2a shows the urban grid of the city towards the end of the 19th century. The city displays a pattern dominated by east-west roads contained by natural margins (the already mentioned rivers Mapocho, Zañon de la Aguada as well as the Santa Lucia hill), transport infrastructures (train tracks on the east and southwest) and big boulevards inspired by the urban interventions in Paris at the time. Within those margins, the extension of the historical roads towards the west created a homogenous, regular, mainly orthogonal grid in which the richer population lived (DOMS, 2000). To the south, the regularity of the urban growth is interrupted by big plots owned by the Catholic Church. Outside this planned city, irregular settlements start to crystallise a less structured grid linked to the roads which communicate the city with the rest of the country and its countryside.

Due to the natural extension from the centre to the west, the highest values for global integration are in the roads which follow east-west directions. The integration of the historic centre and the aristocratic residential neighbourhoods are the highest in the city. The irregular growth also assigned high integrations to those roads that communicate the city with its surrounding territory. Along with the high east-west integrations, those external roads configure a cross-shaped pattern which will be intensified in the following decades with the exploitation of the –before unproductive– south periphery.

With the opening of artificial canals, the southern periphery was transformed into productive farmland, triggering a rapid process of fragmentation of the property along the Camino del Sur (South Road, current *Gran Avenida*, and part of the Panamerican Highway). This old north-south road, which connected Santiago with the small town of San Bernardo, was regularly divided in lots of one kilometre delimited by new east-west streets. The crossing between those new roads and the *Camino del Sur* configured the first sub-centres of the city and the first places with high local integrations outside the city centre (Forray et al., 2013). The new productivity of the south turned the pattern of high integrations from east-west to north-south and created a ‘tree-shaped’ configuration in which a highly-integrated road (trunk) collect transversal streets (branches).

However, the high integration of the south did not coincide with the movement of the more affluent groups. On the contrary, under a local interpretation of the Garden City, high-income groups sought refuge in the new eastern periphery, with low integrations and enclosed by mountains and rivers (Palmer, 1994). Those new suburbs, with curvy roads and big houses started a new process; the richest groups of the society would seek proximity with the services of the main centre, but distance from the rest of the city by enclosing themselves in the lower, but rough, parts of the Andes range (figure 2b)

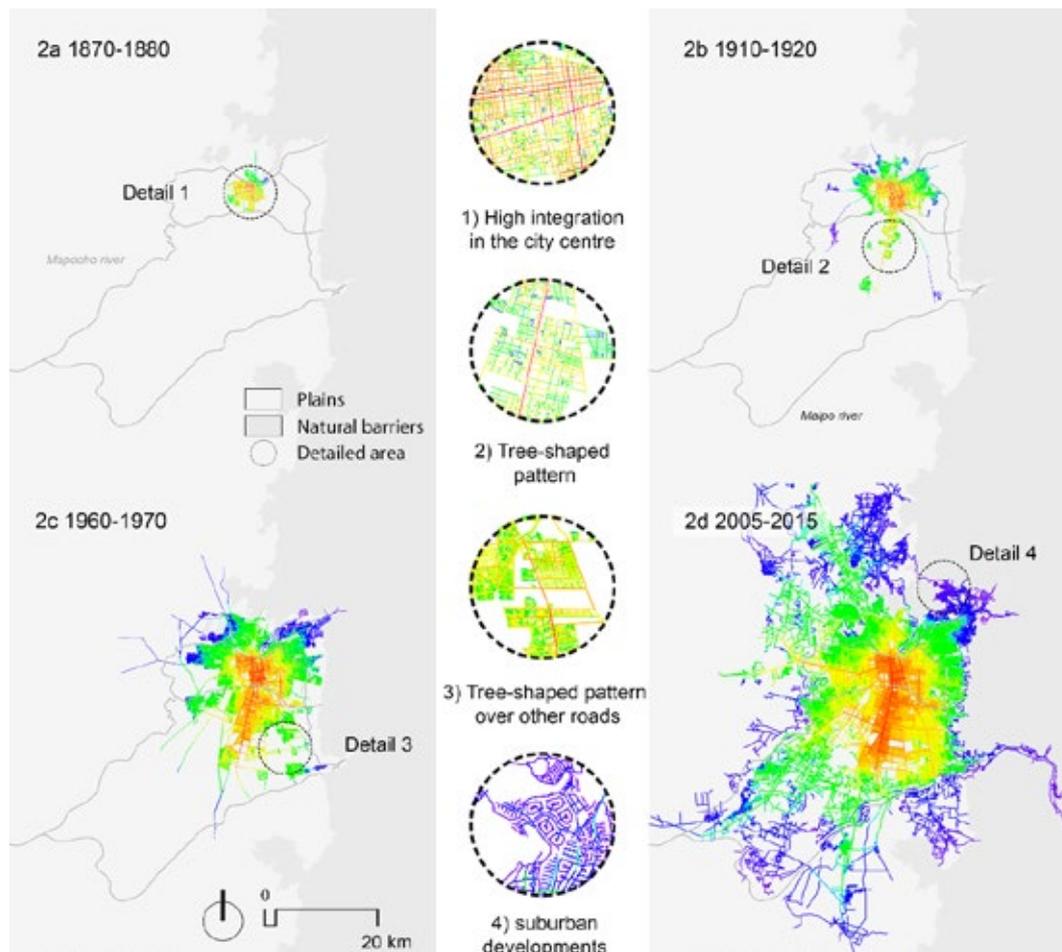


Figure 2 - Axial maps of Santiago (warm colours, high integrations, cold colours, low integrations).

This agricultural development was soon replaced by a strong industrial development and was attracting massive migration flows from the countryside. The new flows and the modern urbanism influence reinforced the growth north-south axis (figure 2c). Additional radial roads, supported by sound urban norms, are widened to receive motorised traffic and then urbanised with industries in their borders in the tree-shaped pattern described before (Parrochia, 1980; 1994). The simultaneous growth over several arteries configure the star shape of the current city; long avenues with high integrations guide the urbanisation process, while settlements with lower integrations fill the gaps between them. The north-south integration is reinforced by the industrial avenues, while the lowest integrations are now in new and differentiated models of urbanisation in the periphery.

At the same time, while wealthy settlements continue to move closer to geographical enclaves in the east, under a model based on the use of cars, in the other directions (south, west and eventually north) emerges a new deprived periphery, also with low integration. Produced by informal settlements and social housing policies, this new low income periphery sometimes following the appropriation ideals of John Turner (1976) or the sanitation governmental schemes (Figueroa, 2011; Greene et al., 2014; Figueroa & Forray, 2015) generated complex grids as infill to the integrated radial roads coming from the centre to the periphery.

In the last period (figure 2d) the metropolis experiments the 'tertiarization' of its productive basis with two growth processes: the extension of the periphery and the densification and expansion of the existing downtown. The neo-liberal policies support a real-estate development that follows the pre-existing roads, now transformed into highways, thus reinforcing the tree-shaped scheme. New suburban gated communities with low integrations also 'jump'

over natural barriers (rivers and hills) and find unexplored natural enclaves (de Mattos, 2001). Public policies push further social housing developments, intensifying the urban segregation of the metropolis (Ducci, 1997). At the same time, the historic centre is densified and extends towards the wealthy area in the east (Fuentes & Sierralta, 2004). This new expanded downtown consolidates as the most affluent of the city (Tokman, 2006), with high local integration towards its rich neighbourhoods, but with low global integration connections with the rest of the city (Greene & Soler, 2004). A few minor centralities emerge in small towns or in big street crossings (shopping) where integration is brought in though the presence of highways.

3.2. CONCEPCIÓN

Figure 3a displays the global and local integrations of the city of Concepcion at the end of the 19th century. The future conurbation has two independent systems separated by the river Biobio: in the south, a productive system consisting of Lota's coal mining and Coronel's port capacity (Vivallos & Brito, 2010); in the north, the main city and administrative centre of the south, Concepción, sharing features with Santiago. Concepción, after being destroyed by an earthquake during the 18th century was re-founded with an orthogonal grid exhibiting high integration values. In following years (figure 3b), the southern settlements grow into their own periphery maintaining their spatial configuration; while in the north secondary settlements emerge around Concepcion adding complexity to this sector. The new settlements are irregular, with low global integration, occupying geographical plains left by the river Biobio, its wetlands, the coast and the hills. Among the hills meander the roads that link the urban area.

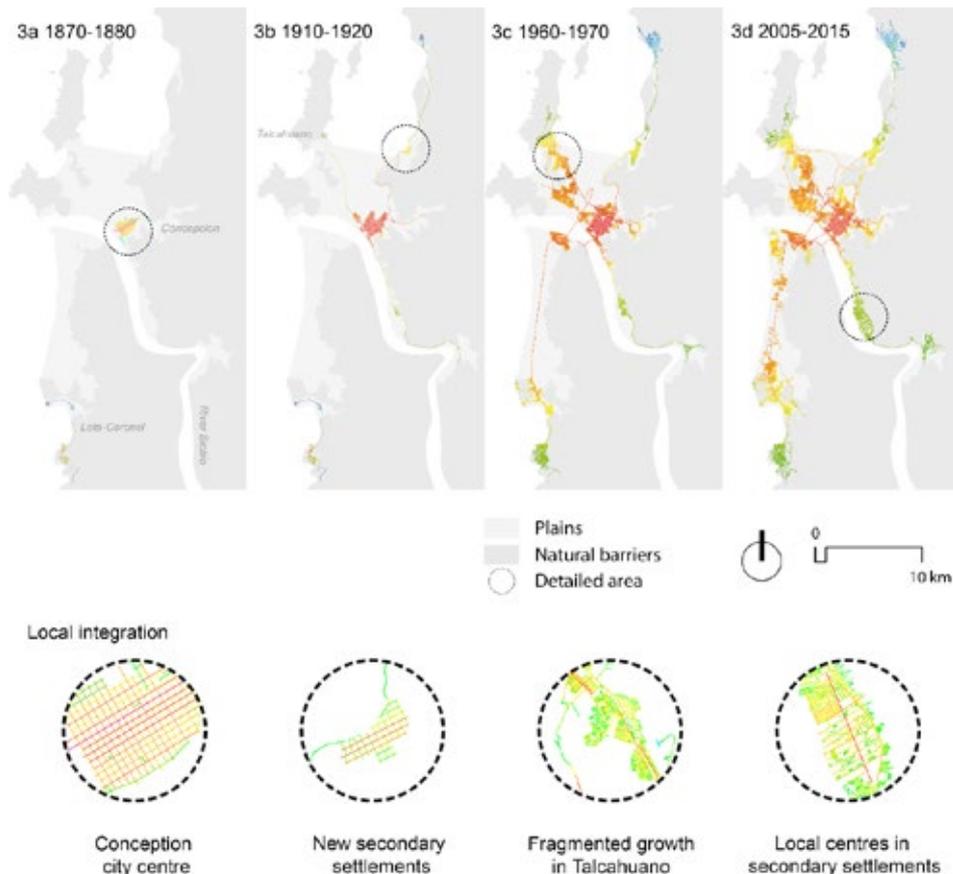


Figure 3 - Axial maps of Concepción (warm colours, high integrations, cold colours, low integrations).

With modernity and the construction of heavy infrastructure the configuration of the conurbation is modified (figure 3c). Two bridges over the river link both northern and southern systems, creating a highly-integrated corridor between them. This corridor prompts the emergence of new settlements in the –until that time– inhabited south riverbank. In the north, Talcahuano, driven by the port and the metal industry, grows in fragments over hills, ravines and littoral planes, avoiding the wetlands and the land not suitable for construction. The new urban ‘patches’ have low integration values and established a pattern that will be repeated in the other settlements of the conurbation (Pérez & Salinas, 2009; Aliste, 2012). Each settlement will grow independently, centred on its own activities, adjusting its growth to the available land (Baeriswyl, 2009). Long roads communicate the system with integration values, which decreases as distance from the main centre increases. Nevertheless, all the roads go through the main centre (Concepcion), increasing systemically its integration. This is being reinforced with the construction of a third bridge and the highways linking the north and the southern systems.

The independent pattern growth exhibited by the parts of the system will probably be intensified in the following decades with the accelerated suburbanisation of the settlements. As figure 3d displays, each settlement keeps its own centrality (high local integrations), and grow with ‘tentacles’ or ‘islands’ on the suitable land (Rojas et al., 2009; Zunino & Hidalgo, 2009; Aliste, 2012). The values of global integration depend on their relation to the main core (Concepcion) and the sinuosity of the roads. The high integration of Concepcion is strengthened with new highways with big infrastructure (airports), shopping malls and new industries locating in their intersections.

3.3. VALPARAISO

In contrast with the two previous metropolises, Valparaiso was originally unplanned and does not have an ordered grid. It emerged spontaneously in the 16th century around a bay surrounded by hills (figure 4a). The analysis of this city at the end of the 19th century shows a grid with high integration in the low and flat areas of the bay, around the port. The hills show an irregular grid, with low integration values, that follow the topography of the place. The city is at the same time the most important port of the country, a key point in the global navigation (specially before the Panama Canal was built) and a popular beach for the affluent families of Santiago. At the north of Valparaiso, the town of Viña del Mar founded in the 19th century grows in the littoral areas created by the river Marga-Marga, starting point of the inner valleys of the area. The grid of Viña del Mar is regular, have almost only industries, and, contrary to Valparaiso, does not reach the coast. The link between the pair is through trains and a complex road that goes among the hills located in between (Muga & Rivas, 2009).

Figure 4b displays the situation of the city on the beginning of the next century, during Valparaíso’s economic boom based on its mining activities and international trade. The integration pattern of the system changes with the opening of the coastal and inner roads to the north and west respectively. Although Valparaiso keeps the highest global integration of the area, the global integration values increase in Viña del Mar, now the beginning of the inner road (Camino Troncal) and the geometric centre of the coastal road (Booth, 2014).

The grid of Valparaiso is reconstructed, after the earthquake and a later fire of 1907, with new avenues which increase the numbers for global integration. At that time, the affluent families, as they did in Santiago, start moving to the garden city of Viña del Mar, which is transformed from the former industrial area into a popular beach and suburb of Valparaiso (Cáceres & Sabatini, 2003). Inland, two new towns emerge around the Camino Troncal, Quilpue and Villa Alemana, growing linearly closely linked and integrated to the main road followed by a fragmented urbanisation of rough lands in the hills (low integration).

Valparaiso’s boom ends in 1930 with the decay of mining activities and the opening of the Canal of Panama, and starts a process of obsolescence and impoverishment. Informal settlements populate the hills with a tortuous and discontinuous urban grid. On the contrary, Viña del Mar becomes a resort for the richer groups of society. The city reaches to the coast with an ordered

and regular grid, luxurious chalets and second residences for the inhabitants of Santiago. The integration of Viña del Mar increases and the city becomes the administrative, commercial and business centre of the region (figure 4c).

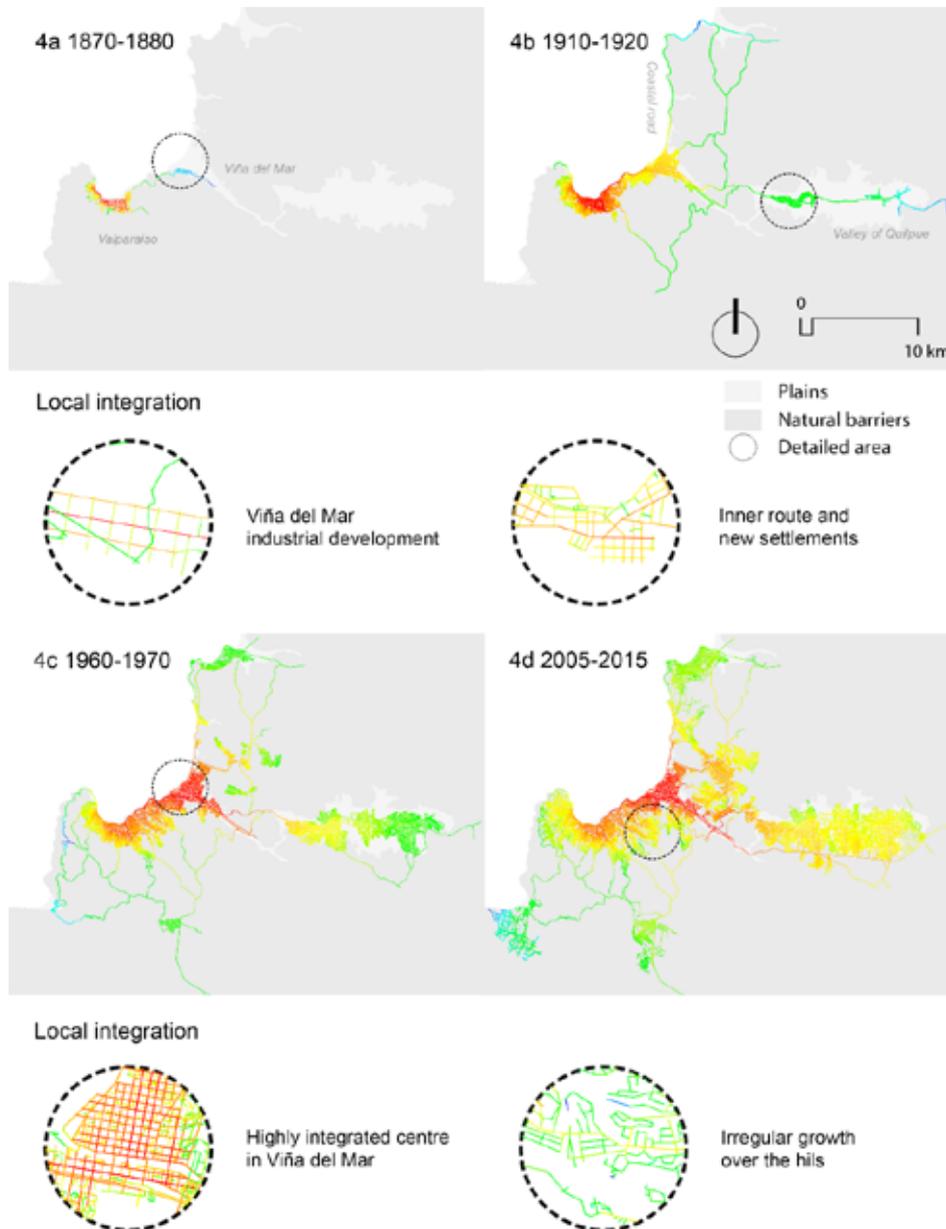


Figure 4 - Axial maps of Valparaiso (warm colours, high integrations, cold colours, low integrations).

Finally, figure 4d displays the structure of the current metropolis, the integrated centre has been moved from the historical area (Valparaiso) to the new centre (Viña del Mar). Global integration exhibits its greatest values in Viña del Mar, Valparaiso has lower values. New highways increase the integration of the inner valley, accelerating their linear growth and triggering the urbanisation of the ravines that originally separated the valley from Viña del Mar (Muga & Rivas, 2009). The north repeats the scheme with linear urbanisations and inland development between the hills. Suburbanisation appears in two models; detached from the main area and connected with highways with the rest of the metropolis, and continues in the borders of Viña del Mar and the inner valley. Moreover, all the settlements (including the rich Viña de Mar) grow

irregularly over the hills, replicating the issues already displayed by Valparaiso; low integrations and connectivity which prevent the access to the services located in the lower parts (Vásquez & Ledesma, 2013).

4. CONCLUSIONS

The syntactic analysis of the three main Chilean metropolises displays three different processes of urban growth. In the case of Santiago, the growth follows a pre-existing national road, with high integration, in a tree-shaped scheme: radial trunk roads and secondary branches that stem into the neighbouring areas. In Concepcion, the growth is concentric around each one of the existing settlements that conform the conurbation. In Valparaiso, the model considers a change in centrality and longitudinal growth on the linking roads (figure 5). Nonetheless, the three models have particularities that are relevant to detail.

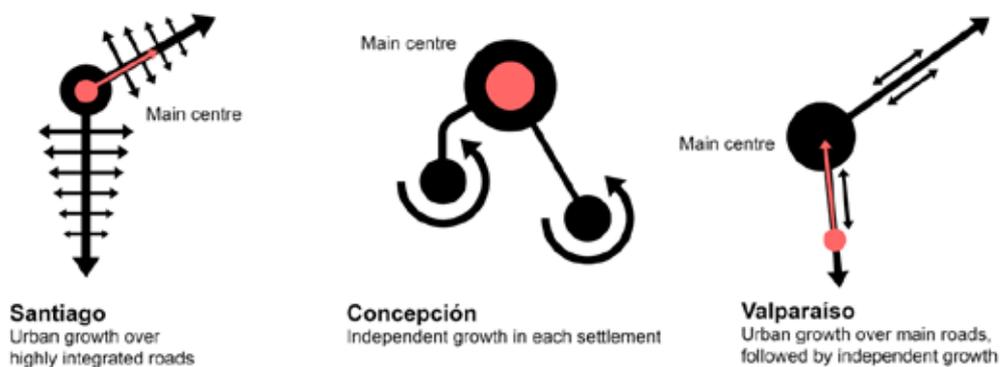


Figure 5 - Schemes of urban growth in Chilean metropolis. In red, movement of the centre.

Santiago proves that high global integration is not necessarily accompanied by services and facilities. The search of natural exclusive enclaves by wealthy groups dragged the financial district to places with high local integration but with low global integration. The high local integration makes the centre highly accessible to its affluent surroundings, but distant from the rest. Poor areas, on the other hand, are far from the main centre of Santiago.

Concepcion evidences simultaneous independent urban growths, which allowed the construction of local centralities with high local integrations. These are articulated through a system of roads that links them together with the original core. This implies that every trip made in the metropolis must go through Concepcion and thus it exhibits the highest global integrations in each one of the studied period. Authors, such as Rojas et al. (2009), have signalled that this pattern may jeopardise the development of minor centres that can be absorbed by Concepcion and reduced them to local administrative functions.

Lastly, Valparaiso is the only metropolis where the historic centre does not maintain the highest integration of its system. Viña del Mar, the neighbour city, displaced Valparaiso as the most integrated settlement of the metropolis by the middle of the 20th century. In this process, Valparaiso suffered a general process of impoverishment aggravated by a slow, but constant, migration of the services to the new centrality, Viña del Mar. The old core of Valparaiso went from 'centre' to 'periphery' while the geographical conditions of the place (hills) blocked the possible growth to inner land. The historic city, in contrast to Santiago and Concepcion, weakened with low global and local integrations in the metropolitan system.

There are signs of convergence in the growth of the three cities, though. The geographic complexity of the three sites, the presence of the Andes ranges in Santiago, the surrounding hills in Valparaiso and the river and wetlands in Concepcion, generates natural enclaves of poorly integrated values that facilitate the development of segregated areas, thus setting up the physical milieu that have allowed the development of the socioeconomic process of exclusion

that characterises many Latin American cities. The construction of modern urban highways, that began in the nineties, accelerated the process of suburbanisation (either across the city, as is the case of Santiago, or linking the surroundings, as in Valparaiso and Concepcion), making it possible the construction of shopping malls and disperse centralities for the car.

Even more than the specific findings for each city, the main result of the exercise presented in this paper is to demonstrate that the configurational description of the three metropolises in a set of relevant time frames, coupled with the recognition of the geographical conditions, offers the possibility of synthetizing socio spatial patterns in the urban realm as well as the development of centralities. By understanding the productive development of the region at each time frame, and the geographical conditions as the possibilities and restrictions for its development, light can be shed on the mechanisms that generate the location and relocation of social groups, as well as the creation and growth of new centralities. The configurational relations expressed in the man-made urban grid, can be understood as an adaptive system relating its parts to respond to the needs and aspirations of the time, giving the form and nature to the metropolis itself.

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