Understanding the City as a Whole: An Integrative Analysis of Rio de Janeiro and its Informal Settlements

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Abstract

Informal settlements are an increasing global phenomenon. Since the mid-century Rio de Janeiro went through a series of paradigmatic changes, trying to cope with this phenomenon. The scope of these interventions ranged from entire eradications of these settlements in the 1960s to present in situ programmes of infrastructural upgrades. Up to now favelas are seen as independent parts of the city, spatial manifestations of urban poverty and intra-urban inequality in the need to be solved. Even recent attempts to integrate favelas socially and spatially with the city failed to remove the physical and conceptual boundaries between the formal and the informal. Underlying these approaches is the perception of those areas as something different, rather than an integral element of the complex urban system. Trying to overcome the fragmentation of the city this study combines formal and informal parts into an integrated model of the whole city. Following a syntactical analysis using GIS mapping and space syntax, this study explores the morphology of favelas in the context of metropolitan Rio throughout different scales and in relation to their topographic location. 60 different local areas are then selected and compared against each other according to their configurational characteristics. The analytic results highlight the affordances and constrains of informal and formal structures. Understanding the particularities of those two differently perceived systems and the ways in which they interact with each other can inform future analysis and policymaking.

Introduction

Informal settlements are increasingly becoming dominant parts of contemporary cities around the globe, housing in some cases as much as the thirds of the city's population (Financial Times 5/6/2015). Portrayed either as precarious shantytowns encroached within developing nations, or self-organised communities in advanced capitalist countries, since their emergence informal settlements have been stigmatised for being areas of extreme poverty, violence and marginality. Having started out as illegal occupations of unclaimed land by poor population groups and in spite of having been consolidated over time, they usually are not integrated into the cities within the limits of which they are located. This paper looks at the metropolitan spatiality of one of these cities, namely Rio de Janeiro, so as to overcome the distinction between formal and informal. It provides one of the first representations and space syntax analysis of informal settlements in Rio forming a study that is the first of its kind. The purpose is to understand informality in the context of the city as a whole and any potential interdependencies between the two sides. In Rio de Janeiro, despite three decades of public policy efforts to tackle informality, informal settlements have rapidly increased both in terms of number and size. According to the *Instituto Brasileiro de Geografia e Estatistica* (2000), during the 1990s and 2000s the favela growth rate was almost four times higher than the growth of the formal city. However, many studies (Leeds and Leeds 1970, Castells 1974, Portes 1972, Valladares 2008, Perlman 2010, Fernandes 2013, Lacerda 2015) have outlined the overriding perception of favelas as being socially, culturally, politically and economically excluded – if not marginal – from the rest of the city. Furthermore, Novaes (2014) has recently demonstrated through a series of cartographic examples how the mental model of exclusion has also shaped the spatial representation of the metropolitan Rio over the years, strengthening its impression as a divided city. To add to this, the urban development strategies pursued by the local municipality to deal with informal growth such as Favela-Bairro, PAC and Morar Carioca have been criticised for reinforcing even further this prejudicial notion of inequality between the formal and the informal areas (Brandão 2006, Pamuk and Cavallieri 1998, Acioly Jr 2001, Riley, Fiori, and Ramirez 2001, de Oliveira 2008, de Souza Pereira 2010, Samper 2011, McGuirk 2014). It is noteworthy that the "Rio-Cidade Project" which was simultaneous to the "Favela-Bairro Project" recognised the local centres in favelas to be different from the rest of Rio (Andreatta 2005, Soares and Soares 2005, Mendes 2006). Even with the ideological shift of the 70s towards refusal of the myth of marginality (Perlman 1979) and instead appraisal of the ingenuity of these communities (Turner and Fichter 1972, Turner 1976), there is still an underlying view that favelas are different and closed territories, an archipelago of enclaves rather than an integral element of the urban structure. In most cases such perspectives are not based on analytic approaches that can deal with urban complexity and the ways in which favelas relate to the global street network. In light of the 2016 Olympics and the multimillion-dollar infrastructure invested for re-shaping the city and its image, it is more urgent than ever to understand the relationship of favelas with the city of Rio de Janeiro as a whole.

So far, analyses of the network structure of favelas have been mainly visual with only recent maps representing the actual conditions (Novaes 2014). Thus few findings have been supported by precise quantitative evidence combined with visual representation. While scholars (Leeds 1969, O'Hare and Barke 2002, Dovey and King 2011) agree that Rio favelas are located in peripheries, steep hillsides and close to the infrastructural network, there is no adequate explanation of the effect of their location and topography in their spatial performance. Furthermore, in 2002 O'Hare and Barke (2002) presented a more dynamic spatio-temporal analysis of favelas both in relation to the rest of the city and to each other. Although the authors rightly avoided treating favelas as a homogeneous entity, they plotted data in five planning zones (APs) and thirty administrative regions (RAs) defined by the planning of the city since 1930 (Borges 2007). Their statistical analysis based on these zoning boundaries raises questions regarding the accuracy of results. At the same time their analysis fails to capture the micro-spatial patterns of these communities' growth.

The present paper employs a detailed street-network model for the whole metropolitan Rio. The road-centre line model is analysed configurationally with the help of space syntax theory and methods, revealing the spatial constraints and affordances of movement in favelas across all scales. Its syntactical values are related to their physical morphology and investigated in relation to topography. The objective is to understand the spatial structure and logic of favelas along the metropolitan region and identify their inherent potential for further development and consolidation. To do so, 60 morphologically distinctive areas from both the informal and formal parts of the city are selected and compared. The findings show that favelas have a dense and complex network, which lacks of clear hierarchy between foreground and background network (Hillier, 2004). The spatial identity of these settlements appears to be internally weaker than their formal counterparts. Yet they are linked to the global structure of movement. Building on the concept of movement economy (Hillier and Penn 1996), the specific approach can be beneficial for future planning and design interventions in Brazilian favelas or other similar contexts.

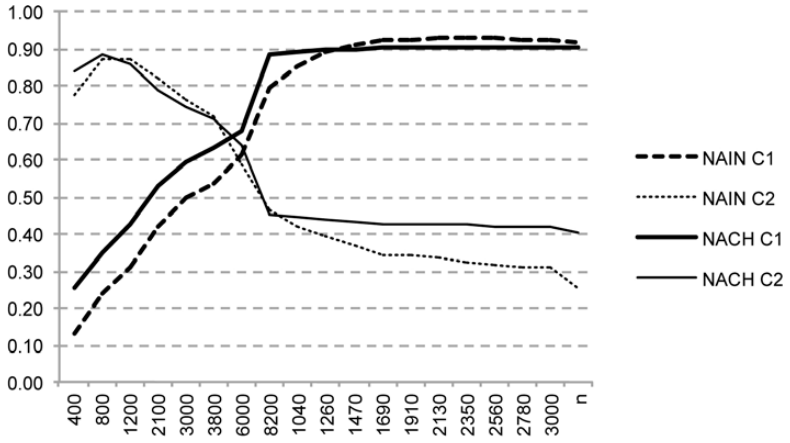
Socio-spatial representation of favelas over time

The growth of Rio de Janeiro and its informal settlements has been strongly influenced by public policies, the development of academic discourse (Valladares 2008) and critical cartography (Novaes 2014). It is true that the social and spatial representation of favelas contributed to the image of a divided city defining its past, present and certainly future. By the early 20th century, 20-25% of Rio population lived in poor living conditions in the centre of the city (Vaz 1985 cited in O'Hare and Barke (2002, 232)). During the 1900s and the governance of Pereira Passos, almost 3000 cortiços (slums) were demolished relocating the residents to social housing schemes in the urban periphery (Brandão 2006, 39). Unable to afford such relocation, the poorest families started squatting at steep slopes in downtown determining in this way the beginning of favelas' emergence (Figure 2). Furthermore, rural to urban in-migration of 1920s-1940s led to a rapid increase of the number of favelas. Different employment opportunities attracted poor working class first to the Zona Norte (north zone), and later to the Zona Sul (south zone). Eventually, favelas grew almost ten times in 40 years (1920-1960), despite the fact that through the 1930 Plano Agache public authorities aimed to relocate urban poor to state housing projects in the suburbs (Brandão 2006, 40). This plan was never materialised due to lack of financial resources. However, this period marked the first time that the hitherto 'cidade maravilhosa' (marvelous city) was losing control to a 'cidade partida' (divided city). Now the distinction between the favela and the city was mainly grounded upon social, cultural and economic differences and the need for social reform (Valladares 2008, 4). According to the *Atlas for Social Exclusion in Brazil Vol. 2* (Campos et al. 2003), between 1960-1980, favelas were considered socially excluded because of their low income, education level, and high percentage of migrants, women and Afro-Brazilians (Perlman 2005, 12). Cartographically, favelas had neither social nor spatial representation. They were absent in the press – mapped as either empty or green areas (Novaes 2014). Authorities regarded them as ephemeral – *fait accompli* – in the expectation of an imminent disappearance but even more as 'a social problem' (Valladares 2008, 5).

Only after the mid-1960s, favelas started attracting serious attention. A number of political and economic events such as economic recessions, post-war industrialisation and weak governmental presence helped favelas to grow in numbers and consolidate themselves into self-organised communities. Having gained the attention of politicians, social scientists and academics (Valladares 2008), they started to get cartographically highlighted but only as "marginal clusters" (Jornal do Brasil 1963 quoted in Novaes (2014, 210)). Mapmaking gradually shifted to a stigmatizing representation exclusively emphasising drug trade, (ibid., 214) and further reinforcing divisions within the city.

In the beginning of 80s, favelas got recognised as part of Rio's reality by the public authorities. Social scientists and architects were no longer considering favelas as a problem but more of a bottom-up solution to housing problems or an inspiration for self-organising

Table 1. The two tables on the left show the rotated component matrix of normalised integration (below) and normalised choice (above). Each matrix shows the correlation of 19 metric scales with the two respective components. The diagram on the right illustrates the distribution of the loadings for each component (NACH 1, NACH 2, NAIN 1 & NAIN 2). The peaks indicate the individual components theorised as local and global network.



Rotated Component Matrix[a]

NAIN metric	Component	
	1	2
400	0,131	0,776
800	0,239	**0,874**
1200	0,309	0,872
2100	0,418	0,822
3000	0,500	0,763
3800	0,537	0,718
6000	0,613	0,590
8200	0,796	0,463
1040	0,851	0,421
1260	0,888	0,394
1470	0,910	0,365
1690	0,921	0,343
1910	0,924	0,341
2130	0,928	0,336
2350	**0,930**	0,325
2560	0,927	0,319
2780	0,924	0,311
3000	0,922	0,309
n	0,915	0,253

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 3 iterations.

Rotated Component Matrix[a]

NACH metric	Component	
	1	2
400	0,254	0,840
800	0,348	0,**883**
1200	0,423	0,858
2100	0,529	0,789
3000	0,591	0,742
3800	0,630	0,707
6000	0,675	0,637
8200	0,886	0,451
10400	0,893	0,444
12600	0,896	0,438
14700	0,900	0,433
16900	0,902	0,429
19100	0,903	0,427
21300	0,903	0,425
23500	0,904	0,424
25600	0,904	0,422
27800	**0,905**	0,421
30000	0,905	0,420
n	0,902	0,403

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 3 iterations.

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communities to learn from when designing anew. A series of upgrading programmes *in situ* such as Rio Cidade, Favela-Bairro, Growth Acceleration Programme (PAC) and Morar Carioca proclaimed to remove the physical and conceptual boundaries between the formal and the informal and integrate favelas into the rest of the city. There are conflicting opinions regarding the success and failure of these programmes. Accord-

ing to McGuirk (2014, 128), the policies lacked a holistic approach tackling both the social and spatial sphere of the phenomenon. Even recent interventions ahead of the 2014 World Cup and 2016 Olympics focused mainly on building up physical walls or establishing armed police forces within favelas further contributing to the perception that favelas are different and dangerous to the outsiders (Novaes 2014). It is proposed that together with the public policies the social and spatial representations of favelas have reinforced the image of otherness in the subconscious of Brazilian people. The perception of favelas being distinctive areas of poverty, fear and marginality is reproduced to such extent that cariocas belonging to middle and upper class treat them as one single segregated entity, entirely different from the rest of the city (Valladares 2008, Novaes 2014).

By criticising the division, this paper does not suggest there are no differences between favelas and the rest of the city. Instead, it seeks to shed light into their spatial structure within the metropolitan region of Rio, and explore the contribution of space in better understanding their relationship within the city as a whole. Studies using space syntax argue that favelas and their embedding within the urban context can affect their development, degree of consolidation and participation in the wider socio-economic networks (Hillier, Greene, and Desyllas 2000). Parham (2012) discussed how their spatial structure differs from the wider city leading to their natural isolation. Mohamed et al. (2013) noticed that informal settlements in other contexts, such as Cairo, show a strong internal structure and are weakly linked to their immediate surroundings and the city as a whole. The issue of integration of favelas into the formal city is particularly difficult and certainly not just a matter of spatial analysis. However, what is argued here is that since informal communities are part of Rio's socio-economic practices and everyday reality, it is essential to have an understanding of how they work spatially, independently as well as in relation to the whole city.

Methodology

The paper sheds light on the spatiality of Rio de Janeiro with a particular focus on informal settlements in relation to their spatial configuration and topographic location. Their structural particularities such as the degree of 'accessibility', 'structure' and 'order' are compared to those of formal areas exhibiting further clues about the process of their formation. Rio is analysed by applying space syntax, a theory and method that describes configurational characteristics of street networks and relates them to patterns of use, social activity and cultural meaning (Hillier & Hanson, 1984). The strength of such an approach is that street networks constitute systems, which can be analysed across different scales, allowing comparisons of localities to city or even region wide structures. Research has shown that cities share two fundamentally similar structural characteristics (Hillier, 2012). They have few long or continuous lines constituting a foreground network that optimises movement attracting economic activity, which in turn stimulates further movement (Hillier and Penn 1996). These are set against many short lines creating a background network of primarily residential activity. While the foreground network is economically driven, easing movement through the city, the background network tends to restrict movement and is culturally oriented, varying from city to city.

Space syntax uses two main measures, 'integration' (closeness centrality in network analysis terms) and 'choice' (betweenness centrality) at different kinds of distance (topological, angular and metric distance) and radii (varying from the walkable scale of 400m to metropolitan scales of 10,000m or 30,000m to n(global) meaning the entire system). 'Integration' is an indicator for accessibility, measuring to-movement potentials, while 'choice' accounts for through- movement between any pair of origins and destinations in an urban complex. The normalised angular choice (NACH) and normalised angular integration (NAIN) serve as the principal measures in this paper, allowing comparisons between different urban elements and areas in Rio (Hillier et al, 2012).

The analysis is organised in three parts: The first part uses street network analysis based on a road-centre line map of Rio de Janeiro, derived from the Instituto Pereira Passos (IPP). It features the road network and includes streets and alleys within most of the fave-

las. This enables to put local areas into regional context and understand the informal settlements in an integrative way. The street network is analysed on 19 different radii from local metric distance (400) up to global (n). In order to overcome the arbitrariness of radius selection, a principle component analysis (PCA) was applied to the dataset, first introduced in space syntax research by Serra (2013). PCA is a statistical procedure that aims to identify patterns in datasets by reducing their dimensions, while maintaining minimal loss of information. The number of components is at least less than or equal to the number of initial variables.

Different from Serra, PCA was applied to the normalised measures of choice and integration (NACH, NAIN), resulting in two components for each measure (Table 1). The rotated component matrix highlights the extent to which each original variable is contributing to each component. This contribution should be seen as a smooth transition rather than a precise separation, as cities and regions consist out of 'pervasive centralities', which blend into each other (Hillier 2009). Two components are derived for NACH and NAIN the first of which can be thought of as a *local* network (radius 800) describing the neighbourhood scale, while the second as a *global* network (radius 12600 up to 30000) embedding the former within the city and region. These two scales form the basis for this analysis.

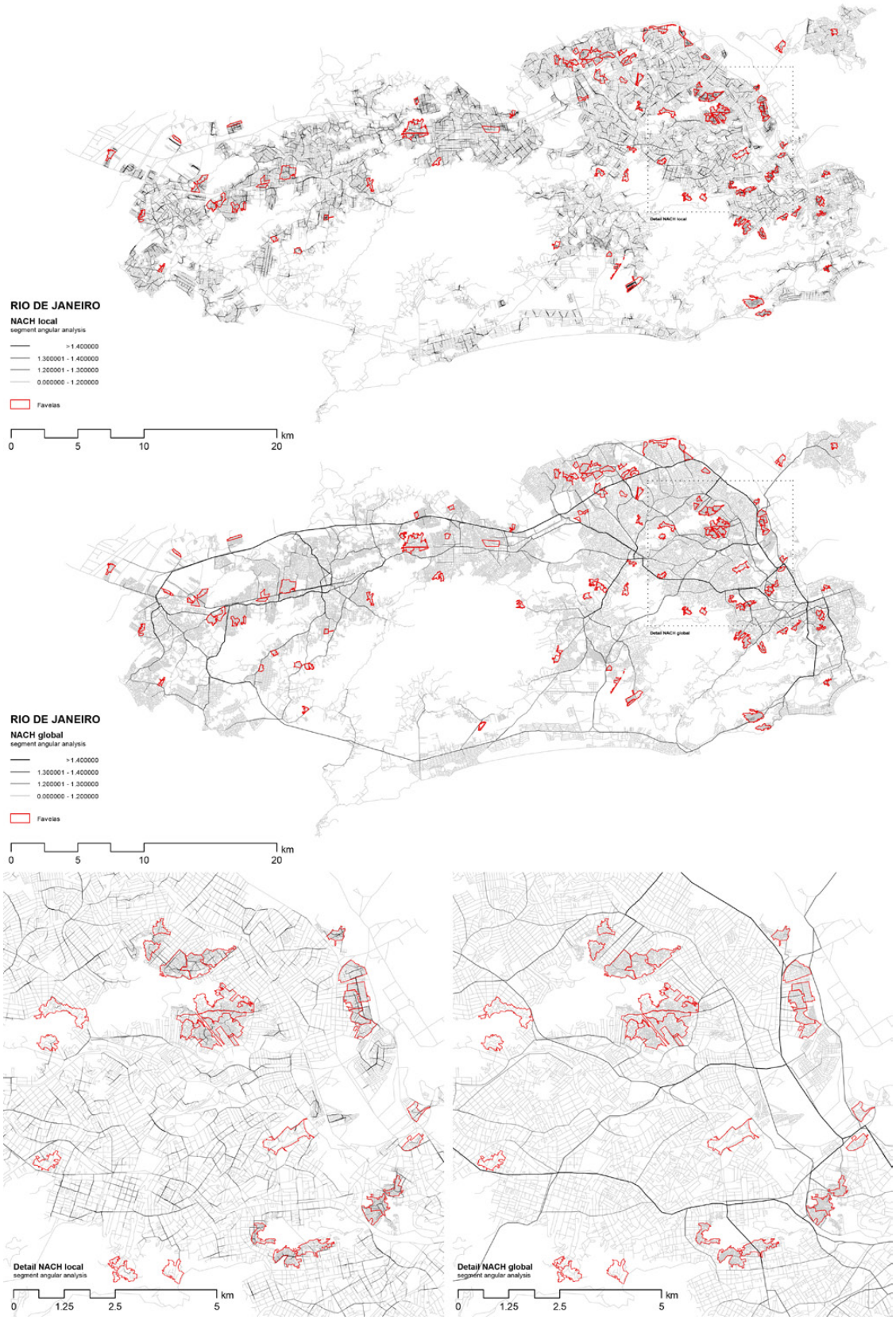
The second part of the analysis looks at the spatial topography of Rio de Janeiro, which plays a crucial role in the development of the city and region. For this reason syntactic analysis is combined with an examination of the topographic conditions of favelas. The spatial distribution of favelas has been always related to the condition of topographical height in research literature (O'Hare and Barke, 2002). One assumption is that favelas are more likely to emerge on unclaimed land, such as sloping sites or railway sidings. To investigate to what extent this is a valid assumption, especially after the spread of favelas for more than 110 years, we calculated the steepness degree for 997 favelas. This was done by generating the mean altitude difference between geodesic points of 5-meter distance based on 10-meter contours over the region. The resulting map illustrates area steepness based on values ranging from 0.1 to 7.0 (0% to 85% incline) of difference in height between geodesic points.

The third and final part of the analysis investigates the spatial structure of 30 informal and 30 formal areas. The aim here is to understand the structural differences and similarities between them as well as the processes by which they were created. These areas are selected by applying the syntactic measure of metric mean depth (MMD) for consecutive metric radii. This method helps identify morphologically distinctive regions within the urban system revealing characteristics that reflect their 'natural area-isation' (Hillier et al. 2010). In the case of Rio, the radius for MMD analysis is based on the previously identified local scale, that is, metric 800 (Figure 4). Upon the selection of 60 syntactically identifiable areas, their mean and max values of normalised choice (NACH) and integration (NAIN) are plotted on four radar charts. Mean and maximum values of choice (NACH) for radius n are considered as indicators of the degree of 'structure' and 'order' in spatial structures respectively. The higher the mean NACH, the more regularised and continuous is the background grid with direct connections but not high structure. The higher the maximum of NACH, the more structured is the foreground in relation to the background network (ibid.,163). The mean and maximum of NAIN for radius n indicate the 'accessibility' of the foreground (max) and background (mean) networks. These values provide clues about the spatial performance and structural particularities of these local areas in relation to the regional whole.

Metropolitan spatiality

Looking at the *NACH global* analysis (Figure 1), one can identify the metropolitan spatial structure of Rio forming a ring that connects suburban areas with the wider whole. The historic regional growth is legible through this analysis. High values cluster in the historic east and indicate the starting point of development, followed by a spread over the industrial northeast and towards the western parts of the region. A view on the locations of favelas within this structure shows that favelas are not segregated, but in most of the

Figure 1. Spatial analysis of Rio de Janeiro. At the top: NACH global and below NACH local, segment angular analysis, including highlighted 1.4, 1.3 & 1.2 structures (dark grey) and the location of 100 largest favelas (red). At the bottom: details of the NACH global (right) and NACH local (left) analysis.



cases are in close proximity to it. Focusing on the 100 largest favelas out of the 1049 in total, one can identify three different types of favela locations in relation to the foreground structure: *a)* in immediate proximity, on or next to a high choice value road (value >1.4) (57% of all favelas); *b)* in a distance of at least 500 metres from second range high value roads (value > 1.2) (34% of all favelas); and *c)* a small percentage that does not have proximity to the foreground structure (9%). The majority of favelas is hence located very close to the global structure of movement. This finding contradicts results of similar analysis in the context of Cairo (Mohamed et al. 2013). This could be an indicator for a development that favours beneficial locations in terms of relation to the formal city rather than following the principle of unclaimed land. The *NACH local* analysis demonstrates a wide spread of clusters of high choice value – potential local centres – over the region of Rio de Janeiro (Figure 2). It can be observed that informal as well as formal parts of the city feature such centres. Their distribution however is slightly different. While the formal parts constitute a more continuous network of the clusters distributed in linear way, favelas display in most cases centrally such core. This core extends throughout large parts of the favela, but is segregated from the formal network.

In terms of *NAIN global* analysis, the wider region shows a strong structure in the industrial north-east extending towards the west, with a wide continuous pattern of values above 0.7. It is interesting to see how this structure traverses the entire northern region but excludes favelas (Figure 2, detail). A view of the *NAIN local* analysis reveals similar results with those observed in relation to the global structure. Local centres are widely spread throughout the region forming clusters, while favelas are not captured by the analysis. This is a surprising finding, as previous authors emphasise the strong internal structures of favelas in other cities. So, in the case of Rio, informal settlements do not have strong internal structures. Following Parham's theory (2012), it is the complex, dense and irregular spatial structure of favelas that turns them into identifiable urban patches, forming an archipelago of isolated 'islands'. This is visible through their central cores – local centres – as they form discontinuous islands in relation to the global structure. However the theory that favelas are isolated cannot be affirmed. Instead, favelas feature a disparity between NACH and NAIN structure particularly in relation to formal areas. Therefore, the arising question is what drives the process of spatial production of these informal settlements and whether the location plays any role in this process.

So far, the location of favelas in Rio de Janeiro has been related to hillsides and high degree of steepness. A view on the topographic location of 997 favelas (Figure 3) shows that the assumption that favelas are predominantly located on steep sloped locations is not correct. The regional map shows that favelas on steep sloped locations are found around the historic core of the city. However, a remarkable number of favelas are located on different kinds of topography ranging from sloped to rather flat areas. This detailed view gives account on the methodology, but moreover on how certain areas are characterised by steep slope, slope, entire flatness or a variety between those. The histogram (Figure 3) presents the distribution of values in the data set. Almost 60% of all favelas are found on ground that is below 2.0 (10% grade) which is regarded as not steep slope. 40% however feature a steepness degree above 2.0 (>10% grade). The analysis shows that the emergence of favelas is a more diverse and complex phenomenon that incorporates a spatial production at flat as well as at incredibly steep areas.

Is this truly a divided city?

As aforementioned the authors plotted the mean and max for NACH and NAIN for 30 selected formal and 30 informal areas. Based on the previous analysis of favela locations in relation to their topography, the samples comprise 10 favelas on steep sloped areas, 10 favelas on sloped areas and 10 favelas on flat areas. The thirty formal areas, all located on flat land, were selected according to their size and degree of comparability. All selected areas are highlighted centres by the metric mean depth (MMD) analysis for metric 800. Their standardised mean and maximum of values of NACH and NAIN were plotted in 15 radar charts (Figure 4). Three diagrams for each of the topographic category of fave-

Figure 2. Spatial analysis of Rio de Janeiro. At the top: NAIN global and below NAIN local, segment angular analysis, including highlighted 1.4, 1.3 & 1.2 structures (dark grey) and the location of 100 largest favelas (red). At the bottom: details of the NACH global (right) and NACH local (left) analysis.

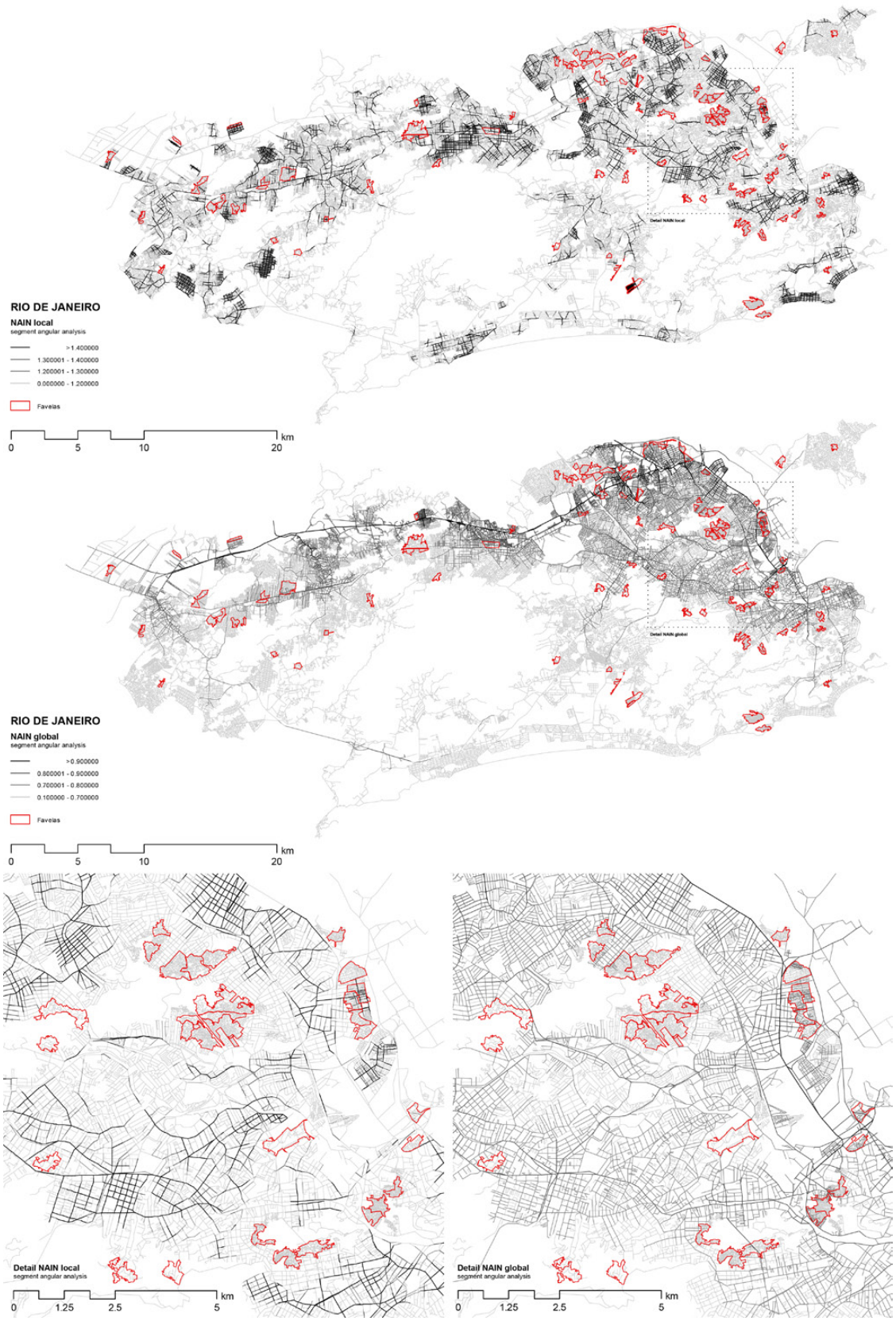
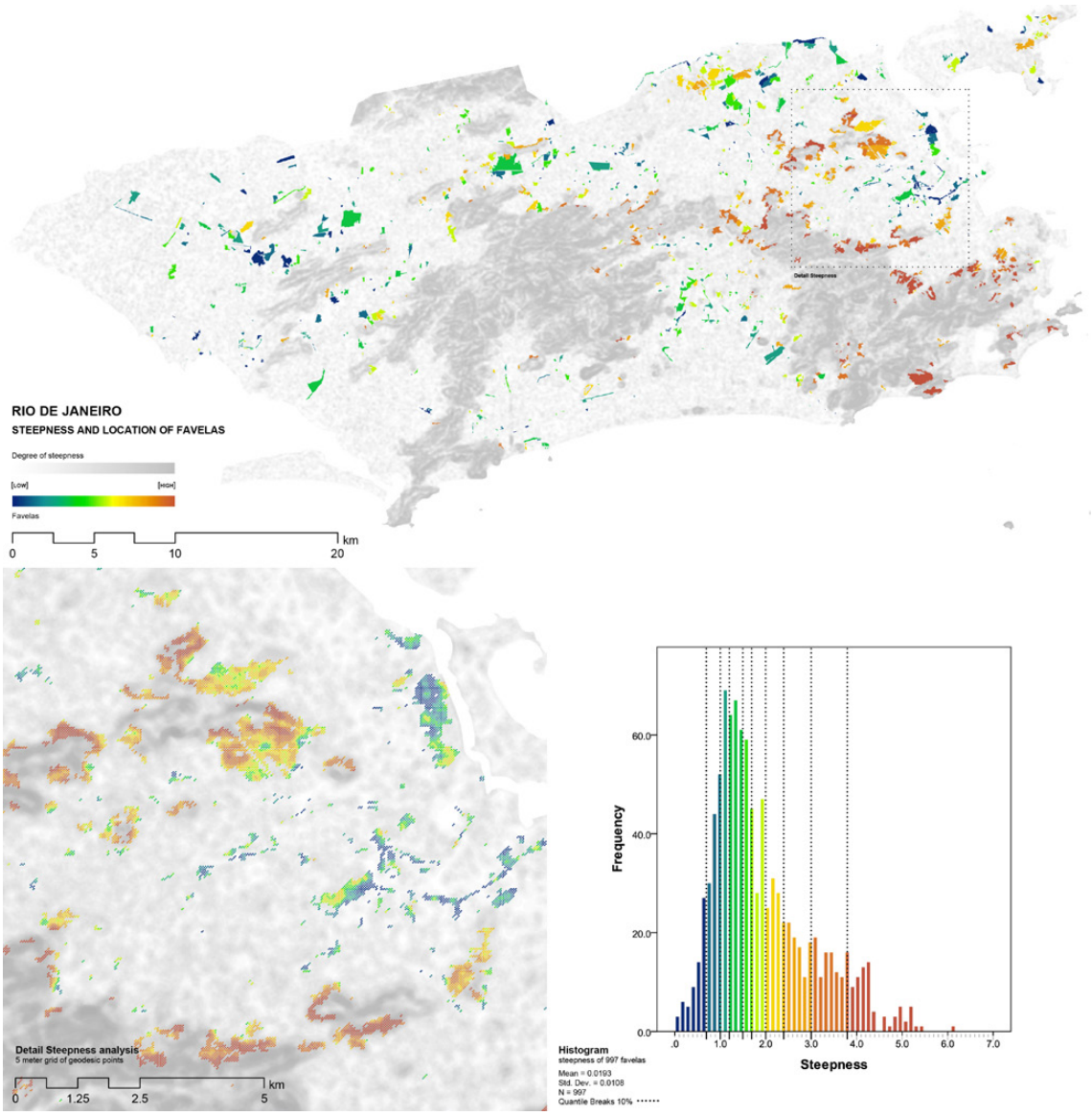


Figure 3. Topographic analysis of Rio de Janeiro. At the top: Showing the mean degree of incline for each favela within Rio de Janeiro (The colour gradient shows roughly the degree of incline from blue, yellow sloped and red steep sloped areas). At the bottom left: Detailed section of the analysis underlying the region map, showing a 5 meter grid of geodesic points for each favela. At the bottom right: Histogram of the mean degree of slope for the 997 sample areas, a dotted line shows 10% quantile breaks clustering equal numbers of favelas with the same value.



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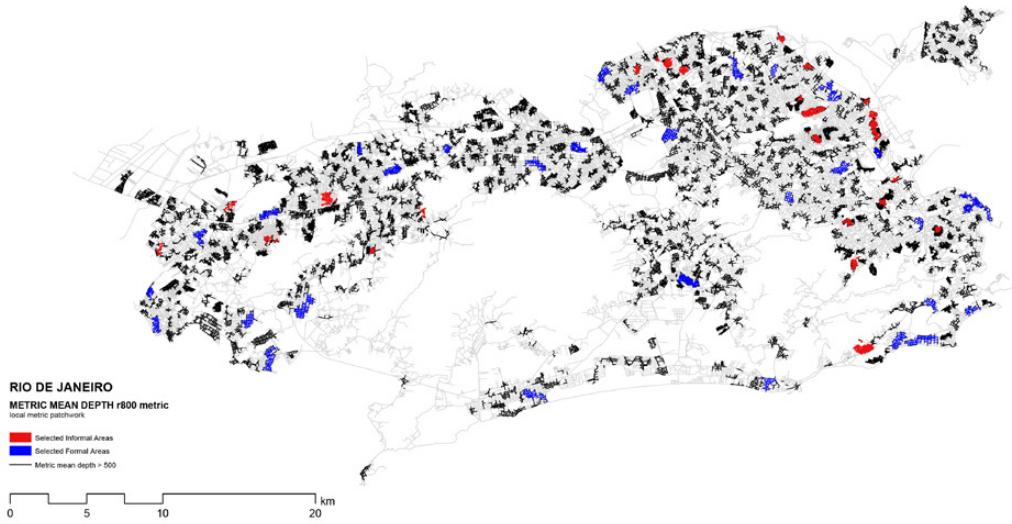
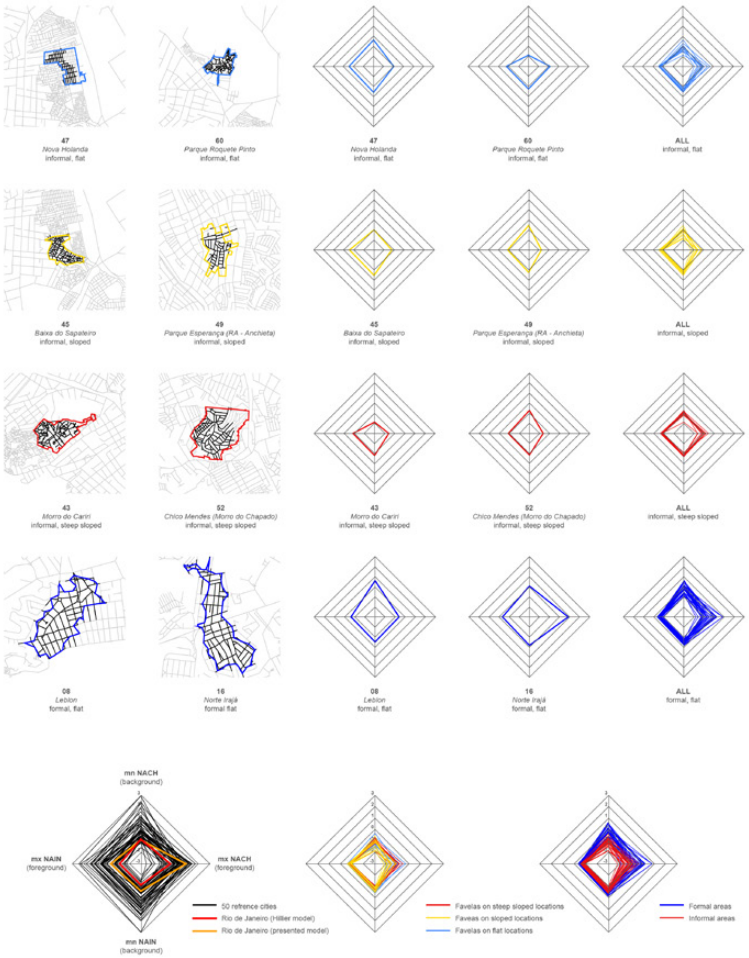
las and formal areas are drawn. The first two highlight statistical outliers next to their corresponding spatial structure and the third one contains the entire sample picturing the tendency of the specific type. Looking at the form of the entire city overlaid with Hillier's (2012) database of 50 world cities and the former star model for the whole city of Rio de Janeiro (Figure 4), the new model – including favelas – is significantly different to Hillier's original one. According to Hillier (2012, 185), Rio de Janeiro has a rather weak foreground network – in comparison to other cities – limited to a few 'single lines running east-west in the northern part of the city' and few more 'linking relatively discontinuous parts of the city together' in a tree-like form. The presented model however, which includes a higher degree of detailed street network, shows a more structured foreground network depicted by a high maximum of NACH. Then, a view on the comparison of formal and informal

Figure 4. At the top: Metric mean depth analysis for Rio de Janeiro on a radius of metric 800. Black indicates cluster and patches of areas with distinctive spatial patterns, depicting favelas as well as formal areas. Red and blue shows the 60 selected informal and formal areas. In the middle: Radar charts of the 60 selected areas, divided in subcategories. Light blue, flat informal areas; orange, sloped informal areas; red, steep sloped informal areas and dark blue, flat formal areas. On the left selected statistical outliers of each category and their spatial configuration. At the bottom: Three radar charts showing (left) 50 sample cities in comparison with Hillier's and the presented model of Rio, (middle) 30 selected favelas divided in to topographic categories and (right) 30 formal and 30 informal areas.





areas reveals strong differences between them. On the whole, formal areas perform with higher values in the mean and maximum of NACH, while informal areas perform slightly better in both the mean and max NAIN values. The comparison in all cases is relational, nevertheless it demonstrates that formal local areas have better 'structure' and 'order' than informal streets, whose complex internal geometry imply a rather fragmented system which grew incrementally without an 'all-at-once' conceptualisation.

A more diverse picture emerges when comparing the 30 favelas throughout the different topological conditions. With only very little variation in the dataset, steep sloped favelas perform very equally and create perfect diamond shapes, with a tendency to slightly higher max NACH values. This means equality in terms of both 'order' and 'structure', yet weak movement potential in both networks. Equality in values means that background and foreground, integration and choice tend to evenly match, making all-to-all destinations invariable to area-to-area relations. The diamond shapes are especially the case for favelas that are in close proximity to the city centre.

Favelas in sloped areas on the other hand present surprisingly the highest difference in 'order' and 'structure' of the three topographical types. They have the lowest values as well as the highest variation between mean and max NACH. This could be because those areas tend to be more often closer to the urban fringe and much more distant from strong global arteries than flat or steeply sloped favelas. Favelas on flat locations feature a value distribution similar to formal areas. Although the values are on average lower, than in the other two cases, their steady mean and max NAIN values and a tendency to either higher mean or higher maximum NACH values, makes them still very comparable. This could be an indicator that topography has indeed an impact on the spatial production, but that the particularity of informal settlements in general creates a much stronger variation does not lead to a clear pattern.

In the formal areas, the background tends to be stronger than the foreground network, which translates into more 'order' and less 'structure', that is an uninterrupted grid-like background and a foreground network that connects with disruptions. This pattern indicates that movement in the global structure is distributed equally to both background and foreground networks. This can be explained by the fact that city growth may have been led through the years by the background structure of residential use rather than a comprehensive urban planning which accommodates economic activity in certain parts of the city and connects disconnected pieces into a whole. This one-sided understanding of the formal city-creation may be sufficient to explain its informal counterpart as both are possibly underlined by the same logic: a 'rapidly developing residential process' of creation (Hillier, 2012, 187). This can be explained by the fact that while formal areas have stronger 'order' than 'structure', neither they nor the informal areas have strong foreground structures that connects the parts into a whole.

Conclusion

Due to length limitations, no socio-economic data are presented in this paper. Therefore, the confidence is placed on the syntactic performance of the global metropolitan region of Rio de Janeiro and a sample of local areas across it. The objective is to understand in a comprehensive way the spatial characteristics of the systems: their location and their degree of 'accessibility', 'order' and 'structure' in order to overcome any existing perceptions of Rio being a divided city. To conclude, the paper forms a contribution in understanding favelas in an integrated way, analysing the spatial structure of favelas in a regional context. The paper showed that favelas are indeed different in their spatial structure, but form an integral part of Rio's spatial structure. Moreover in a regional spatial context favelas are far from being segregated islands. However, they are characterised by very weak internal structures, particularly when compared to formal areas. Light was shed on the role of topography in the location of favelas highlighting that favelas in Rio de Janeiro form a more complex phenomenon that being considered as always developing on steep slopes. This paper stresses the need of additional research in field and the importance to understand the phenomenon of informal settlements in a comprehensive way.

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