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City of Slums: self-organisation across scales

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1.1. Introduction

The city is certainly a fine example of a complex system, where the parts can only be understood through the whole, and the whole is more than the simple sum of the parts. In the present paper we explore the idea that some of these parts are themselves complex systems and the interrelation between complex subsystems with the overall system is a necessary issue to the understanding of the urban complex system.

Spontaneous settlements are clear examples of complex subsystems within a complex urban system. Their morphological characteristics combined with their development process are traditionally understood as chaotic and unorganised. And so are Third World cities, traditionally known for their inherent chaotic and discontinuous spatial patterns and rapid and unorganioii de.5(i)ve.5(i)lo6.7()pminni
spontaneous settlements play in the global dynamics of the city? We explore this issue by analysing experiments of 'City-of-slums', an agent-based model that focuses on the process of consolidation of inner-city squatter settlements within a peripherisation process.

The paper also includes two previous studies on these topics where the dynamics of these two urban processes are examined as two isolated complex systems and an analysis of the morphological fragmentation of the distribution of spontaneous settlements within the overall city and within the spontaneous settlements themselves. Based on these analyses, we conclude with a brief discussion on the role of self-organisation in the socio-spatial dynamics of Third World cities.

1.2. Latin American cities: growth and fragmentation

The urbanization process in cities of developing countries is often insufficiently planned and poorly coordinated. The morphological result is a fragmented set of patches, with different morphological patterns often disconnected from each other. This fragmented pattern has its origins in the successive superposition of different urban typologies, including planned areas, spontaneous settlements, housing tracts, slums, vacant sites, institutional areas, shopping malls, informal town centres and so on. The Third World city

boundaries" (streets of the existent city, which bound the site). Following this logic, the model's rules are based on the idea that the spatial development of spontaneous settlements is both constrained and stimulated by the boundaries. The built structure is developed prior to any network and rough foot tracks arise in between built structures and often consolidate, connecting houses to local services situated on the site's borders (Sobreira, 2002).

In the favela project the agent's rules resemble the u-0.9(l)cni6 TDn.9(e)-0.8()6.1(ho5ur')10.3 o-0.8((f)12.4 Dn.9(eco)0.2
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residential areas within high-income zones, and vice-versa, what is caused by the accelerated and discontinuous process of development.

Figure 2. Variations of step and consolidation threshold parameters, time = 2000.

It is important to mention that in this kind of model the 'time' can only be measured through the number of iterations of the agents within the model. This condition opens up new possibilities of analysis of the model considering that, at the same number of iterations (t), the spatial development of the system will present variations depending on the parameters. This can be observed in the figure 2, where the variation of parameters at t = 2000 were tested.

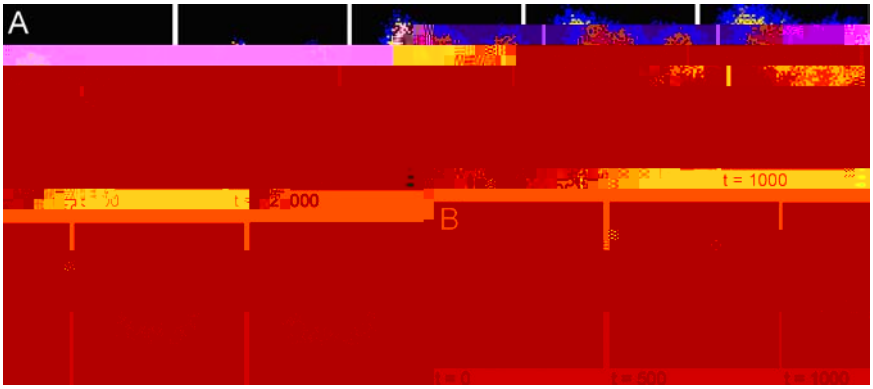
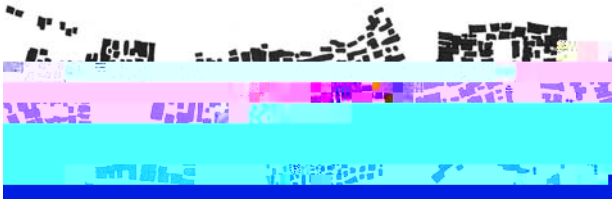


Figure 3.

1.5. Fragmentation: statistical properties of spatial complexity

In recent years a great deal of effort in pure and applied science has been devoted to the study of nontrivial spatial and temporal scaling laws which are robust, i.e. independent of the details of particular systems (Bak, P. 1997; Batty, M. and Longley, P. 1994; Gomes, M. et all, 1999). Spontaneous settlements tend to follow these scaling laws in both scales, local and global (Sobreira & Gomes, 2001; Sobreira, 2002). This multiscaling order is analysed here by a fragmentation measure which is related to the diversity of sizes of 'fragments' (built units) in these systems. Diversity is understood here as a measure of complexity (Gomes et all, 1999) and an expression of universal dynamics.

In the settlement scale the fragmentation pattern refers to the diversity of size of islands (cluster of connected dwellings) while in the global scale it concerns the size distribution of patches of spontaneous settlements within the city.



In figure 6 the fragmentation pattern is analysed through the size distribution of settlements in three Third World cities and compared to the size distribution of settlements in the *City of Slums* simulations in figure 7. In particular, the settlements in each city were grouped according to their area, and the relation between number of settlements ($N_{(a)}$) and respective size interval (a) were plotted in a log-log graph. As one can observe from the graph of figure 6, the scaling law which describe the settlements size distribution in the real cities falls in the same statistical fluctuation of the scaling law which describe the size distribution of the *city of slums* simulations. The graphs in figure 6 and figure 7 describe the same scaling relation $N(a) \sim a^{-\alpha}$., where $\alpha = 1{,}4 \pm 0{,}2$.

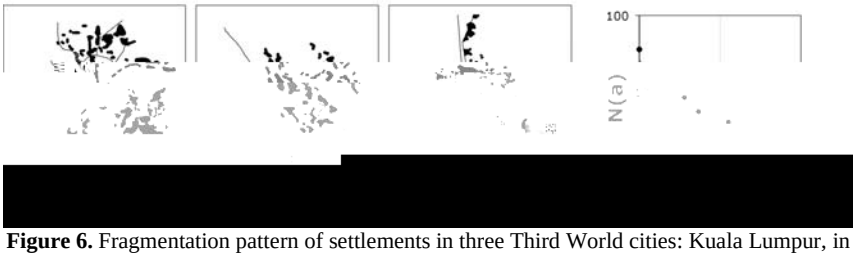


Figure 6. Fragmentation pattern of settlements in three Third World cities: Kuala Lumpur, in Malaysia; Manila, in Philippines; and Lima, in Peru.

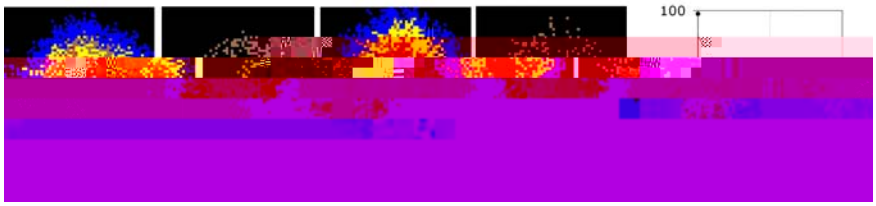


Figure 7. Distribution of settlements in the City of Slums model with fragmentation graph

Both global scale fragmentation patterns (real and simulated) are statistically the same, found for the local scale internal morphologies of the settlements. The negative exponents (α and τ) indicate a non-linear scaling order, in which there is a great number of small units (islands, at the local scale, and settlements at the global scale), a small number of big units, and a consistent distribution between them. In this aspect, we argue that such similarity of patterns is clearly an empirical evidence of a multiscaling relation between local and global urban systems and it is a suggestive indication that the agent-based models generate simulations which truly describe the fragmented features of these self-organised systems.

1.6. Conclusions

Third World cities have been traditionaiudie0016 ..2( )-6.a.4(ge)1c1 h9e0016 ..2( )-6r2(irdf6 ..2( )el)-6.5 irdfrdTD 0.

development. We understand that spontaneous settlements are constantly shaping and being shaped by a self-organised process which drives the system to a fragmented pattern that can be verified across scales. Therefore, they are key elements to understand the spatial pattern of Third World cities.

From a socio-spatial point of view, the existence of spontaneous settlements can be understood as instability pockets which are necessary for the structural stability of the global system (Portugali, 2000). If we consider that spontaneous settlements actually absorb part of the existent social instability - translated here as housing deficit - in unstable pockets within the city, one could say that they are necessary for the structural stability of the global system. Viewed as such, spontaneous settlements are fragments that keep the system away from what otherwise would be a breakdown of the already fragile and unstable equilibrium of Third World cities socio-spatial structure. This idea comes to reinforce Turner's (1988) argument that spontaneous settlements can be seen as an alternative solution, rather than a problem for the housing deficit. In the Third World urban context, spontaneous settlements play a paramount role within a system in which the parts do explain the whole, but only when seen in the light of a self-organised process.

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