

HABITAT TYPOLOGY IN THE AFRICAN CITY

Contribution for the Characterization of the Residential Land Use in Maputo Using Multidimensional Analysis

Cristina HENRIQUES^(1,2) and Jorge RIBEIRO^(1,3)

⁽¹⁾Faculdade de Arquitectura – Universidade Técnica de Lisboa

⁽²⁾e-Geo Centro de Estudos de Geografia e Planeamento Regional

⁽³⁾CVRM – Centro de Geo-Sistemas do IST

The landscape of the African city with colonial inheritance, like Maputo, is deeply marked by the transformations on the social-economic structure and on its spatial form.

This paper aims to characterize the residential land use of Maputo municipality through a set of variables within the different neighbourhoods, namely in respect to the building materials used and to the habitable conditions.

In order to process data, specifically large data sets of different nature, available in a “formless” way, and without an *a priori* obvious structure, one can use descriptive methods of Multidimensional Analysis, namely Principal Components Analysis and Automatic Classification through clustering. These methods allow the definition of sample sets (individuals or objects) or variables (properties or attributes), which incorporate the mutual influence of one in the others using similitude and dissimilitude criteria. In this way it will be possible to contribute to typify some aspects of the spatial organization of the city concerning the residential areas.

KEYWORDS

Maputo, Habitat typology, Principal Component Analysis, Clustering, African city

INTRODUCTION

The contemporary African city has already been described and characterized by several authors, having always been made references to its accelerated demographic growth occurring in the last decades and to the precarious housing conditions of the majority of its population.

“One outstanding feature of most African cities is their current rate of growth. Tropical Africa’s total urban population is rising by over 5 per cent per year, and that of many individual cities by over 7 per cent to produce a doubling within ten years” (O’Conner, 1983);

“The rapid growth of urban population has obvious implications for the infrastructure and service needs of cities. The failure to expand water supplies, sanitation systems, housing supply and transportation to match the growth of population has been prime cause of misery in the cities of the developing world.” (Devas *et al.*, 1992).

The social-economic poverty and inequality are patent in the image of these cities and are reflected in their housing conditions by means of indicators such as, among others, the building materials used (in detached houses, flats, precarious housing, thatched huts) and the level of infrastructures (water supply, sanitation, electricity...)

The city of Maputo which lies between the River Infulene, the Espirito Santo Estuary and the Indian Ocean (Figure 1) in the southern part of Mozambique, fits in such a frame and the 52 districts (“bairros”) it consists of (Annex 1) show heterogeneous habitat characteristics which are the target in the present paper. If by means of a brief survey of the land of this municipality the existence of two distinct cities seems obvious,

namely the formal city (“cement city”) of colonial roots and the spontaneous city (“caniço city” of native origin, a more profound analysis suggests other diversities.

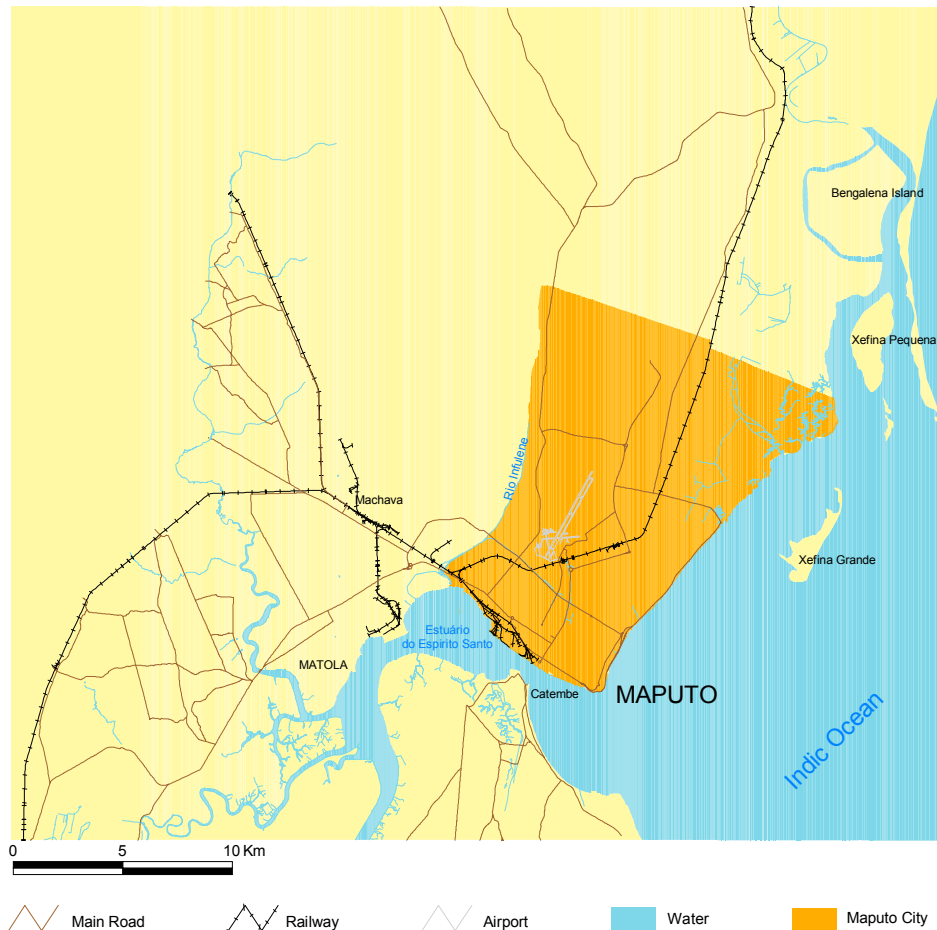


Figure 1 – Maputo city location

Do the suburban “bairros” which are contemporary to the colonial period have the same habitat patterns as the districts which emerged during and after the Seventies of the 20th century? Are the form and density of the residential land use of the “bairros” closest to the center identical to the farthest ones?

METHODOLOGY

In order to understand and characterize the diversities which presumably exist in the “bairros” of Maputo as far as housing conditions are concerned we had recourse to data published by the 1997 Census regarding housing, to data regarding residential land use land classes (Annex 2) and to the processing thereof by means of descriptive and classificative methods of multivariate data analysis.

Using as an exploratory technique the Principal Components Analysis (PCA) enabled us, in a first step, to establish links between the various variables involved, integrating their mutual influence, showing the resemblances and unlikenesses between “bairros” by means of their typological description. The “bairros” were classified in groups using a hierarchical method of Automatic Classification, subjacent to which were the similitude and dissimilitude of the variables relating to housing.

Through this methodology a typification of the “bairros” was obtained with regard to habitat questions, achieving thus a better understanding of the typology of the residential areas.

Exploratory Analysis Using PCA

PCA developed by Hotelling (1933) during the Thirties of the 20th Century is a Multivariate Data Statistical Analysis (MDSA) applicable to two dimensional tables which cross individuals and quantitative variables (Escofier and Pagès, 1998, 2002). The table lines represent the individuals (which correspond in this case study to the “bairros” of Maputo – Annex 1), and the variables are given by columns (corresponding to housing and Maputo “bairros” characteristics in this case – Annex 2).

The first problem consists therefore in treating the set of available data, which takes the form of a data file as shown in Table 1. At the intersection of line i and column k the variable k for the individual i is found.

| | BDU | MDU | ADU | BDUP | ... | PMP | PMG | PC | PMT | PAD | ... | HOUT | HRET | HLAT | HSRL |
|------|---------|----------|---------|------|-----|--------|------|--------|------|------|-----|------|--------|--------|-------|
| AMa | 0.0 | 0.0 | 0.0 | 0.0 | ... | 1592.0 | 21.0 | 436.0 | 15.0 | 0.0 | ... | 26.0 | 1999.0 | 20.0 | 52.0 |
| AMb | 0.0 | 0.0 | 0.0 | 0.0 | ... | 2190.0 | 18.0 | 719.0 | 41.0 | 1.0 | ... | 18.0 | 2786.0 | 85.0 | 131.0 |
| . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 25Jb | 9606.8 | 10794.4 | 11719.9 | 0.0 | ... | 118.0 | 8.0 | 2511.0 | 16.0 | 29.0 | ... | 3.0 | 532.0 | 2340.0 | 50.0 |
| ZPT | 79150.8 | 607098.6 | 0.0 | 0.0 | ... | 9.0 | 2.0 | 1728.0 | 4.0 | 41.0 | ... | 8.0 | 127.0 | 2069.0 | 158.0 |

Table 1 – Example of Maputo data matrix

Applying PCA to this kind of tables has as a general aim an exploratory study. This analysis can be carried out in two main ways:

Set of links between variables – by trying to answer this kind of questions: Which variables correlate positively? Which of them are in opposition (negatively correlated)? Are there groups of variables correlated to one another? Is a typology of variables evident?

Set of similitudes between individuals – the questions are such as: Which individuals are alike? Which are different? Are there homogeneous groups of individuals? Is a typology of individuals evident?

After having initially carried out an univariate and bivariate study of the available variables, the set of data is treated by the PCA algorithm (CVRM, 1989, 2002), considering all the “bairros” as active lines. The first 17 variables regarding the type of residential areas and residential city blocks (“quarteirões”) were considered as supplementary columns due to the scarcity of data and the high dispersion values obtained, while the remaining 35 variables were used as active columns. It could be seen that the first four components contain about 75 % of the variance included in the initial data set (Table 2). The screeplot of Figure 2 also enabled us to reach the conclusion that the first four components should be analysed.

| Components | Eigenvalues | Variance (%) | Cumulative Variance (%) |
|------------|-------------|--------------|-------------------------|
| 1 | 12.34562 | 35.27319 | 35.27319 |
| 2 | 7.072803 | 20.20801 | 55.48119 |
| 3 | 4.817098 | 13.76314 | 69.244331 |
| 4 | 2.023813 | 5.782324 | 75.026657 |
| 5 | 1.576458 | 4.504165 | 79.530823 |
| 6 | 1.310139 | 3.743255 | 83.274078 |
| 7 | 1.116509 | 3.190025 | 86.464104 |
| 8 | 0.868968 | 2.482765 | 88.946869 |
| 9 | 0.569661 | 1.627603 | 90.574471 |

Table 2 – PCA Results

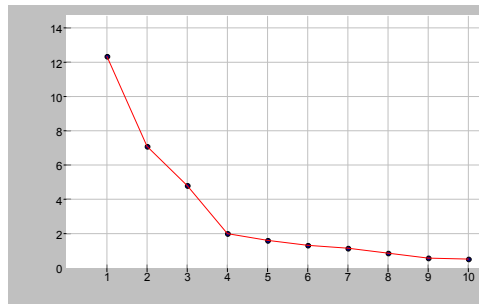


Figure 2 – Eigenvalues screeplot

The first component plane (factors 1 and 2 bearing respectively 35.3 % and 20.2 % of explanation) shown in Figure 3 answers some of the questions related to the variables.

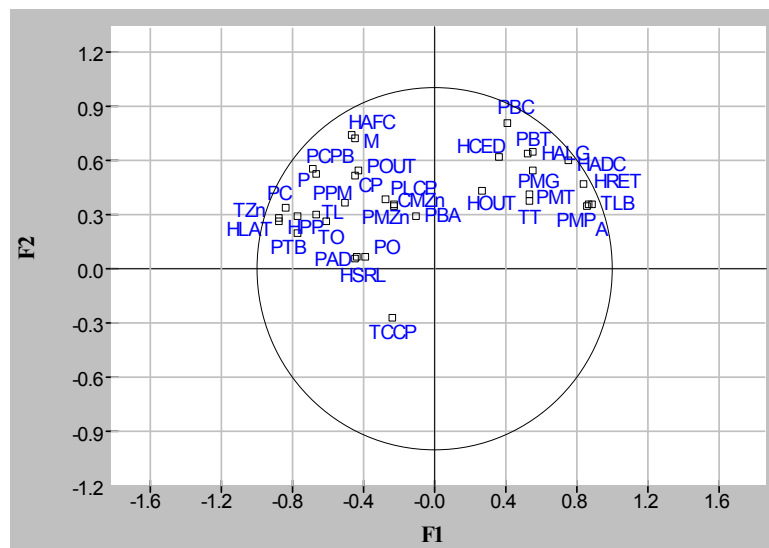


Figure 3 – Active variables projection on plane F1, F2

Component 1 indicates the quality of the houses in the city of Maputo in terms of building materials used, type of housing and basic infrastructures, showing the opposition of variables PMP, TLB, A, HRET, HADC, PMG, HALG, PMT, TT e PBT to variables HLT, TZn, PC, PTB, HPP, PCPB, TL, P, TO and PPM. Component 2 seems to distinguish between what is built with longer lasting materials and what seem to be houses built with thatched roofs and with roofs made of “capim” or straw which need constant keeping, thus opposing variables TCCP to all other variables (in particular variables PBC, HAFC, M, HCEd, POUT, CP). By projecting the supplementary variables on this first component plane (Figure 4) it may be seen that the residential areas and the city blocks QRUP, QPRP, QPRU include houses of a better quality while areas such as MDU, NMDU, NADU and ADU include houses of a lesser quality. On the other hand, one can see that in the areas NBDU, ARPE and BDU more vulnerable houses are predominant, while all the other areas and city blocks show houses built with better materials.

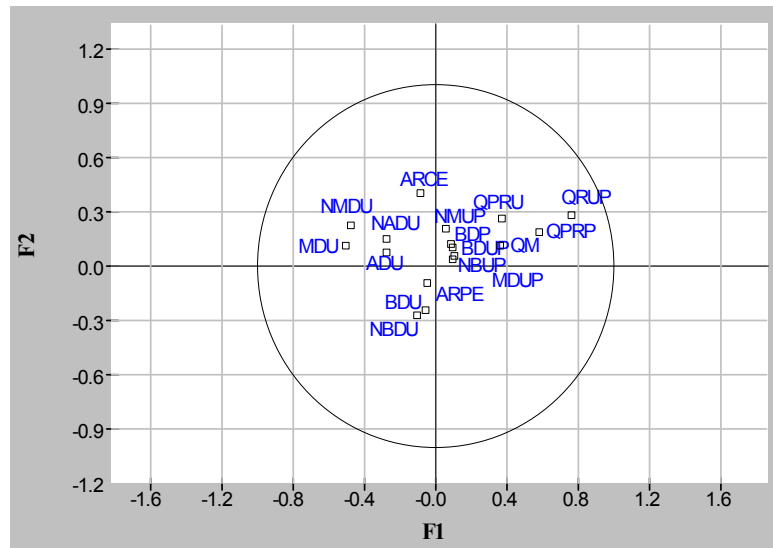


Figure 4 – Supplementary variables projection on plane F1, F2

As far as individuals (“bairros”) are concerned, Figure 5 shows us that the “bairros” Sommershield (Somm), Central B (Ctb), Alto Mae B (AMb), Central A (Cta), Polana Cimento A (PCTa), Polana Cimento B (PCTb), Central C (Ctc), Alto Mae A (AMa), Malhangalene B (MHGb), Malanga (MLG), Jardim (Jard), Chamanculo A (CHMa), Malhangalene A (MHGa) e Coop (Coop) include lodgings with better housing conditions while “bairros” Luis Cabral (LC), Polana Caniço A (PCNa), George Dimitrov (GD), Ferroviário (Ferr), Polana Caniço B (PCNb), Maxaquene B (MXQb), Maxaquene A (MXQa), Hulene B (HLb), Chamanculo C (CHMc) e Inhagoia A (IGa) include the lodgings of lesser quality. It should also be taken into account that the “bairros” Albazine (ABZ), Malhazine (MLHZ), Mavalane (MVb), Magoanine (MGNN), Zimpeto (ZPT), Nsalene (NSL), FPLM (FPLM), Maxaquene D (MXQd), Mavalane A (MVA), Hulene A (HLA), 3 de Fevereiro (3F), Laulane (Lla), Mahotas (MHT), 25 de Junho A (25Ja), 25 Junho B (25Jb), Mikadjuine (MKD), Unidade 7 (U7), Bagamoio (BGM), Maxaquene C (MXQc), Chamanculo B (CHMb), Costa do Sol (CS), Inhagoia B (IGb) have a considerable number of houses with hatched roofs and with roofs made of “capim” or straw.

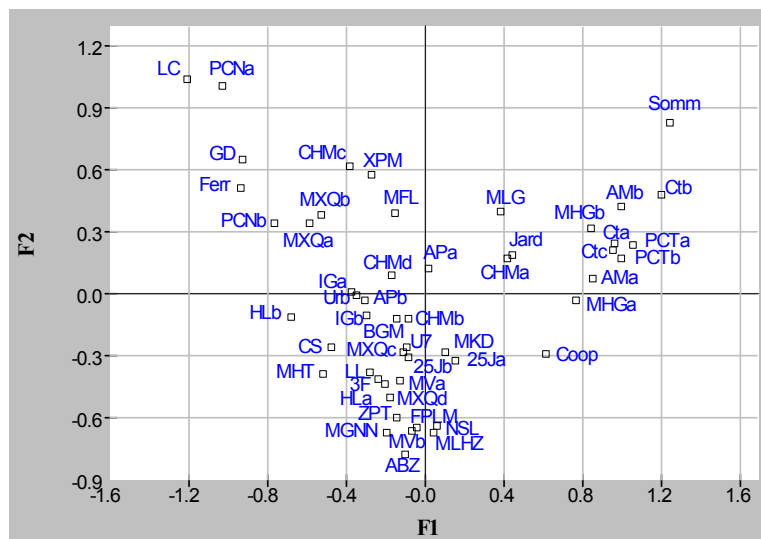


Figure 5 – « Bairros » projection on plane F1, F2

Complementing the analysis with the third component it may be seen in Figure 6 (plane of the components 1 and 3 with respectively 35.3 % and 13.8 % of variance) that variables PMZn, CMZn, PLCP and PBA are in opposition to variables HSLR and PAD, thus revealing the quality between some particular kinds of materials used on the walls and floors of the houses.

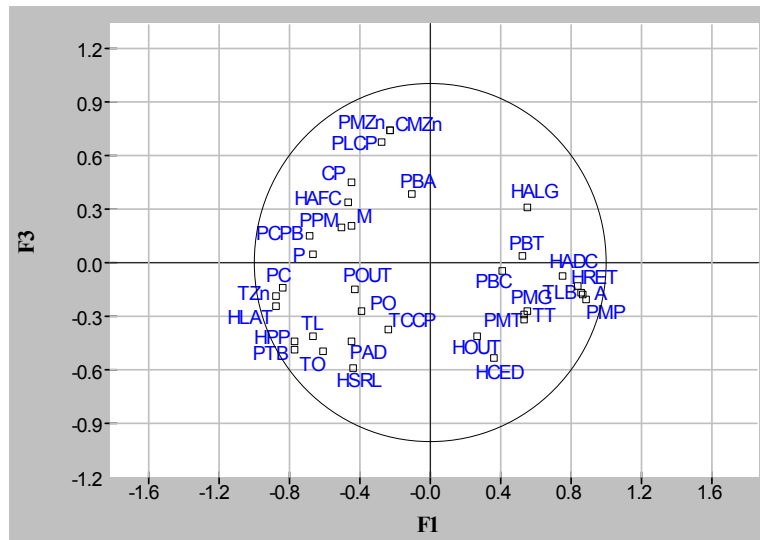


Figure 6 – Active variables projection on plane F1, F3

The projection of the supplementary variables on this plane formed by components 1 and 3 (see Figure 7) enables one to conclude that the residential areas and city blocks NMUP, NADU include houses with walls made of zinc and of other precarious materials, while areas ARPE and ARCE consist of adobe floor houses without WCs or latrines.

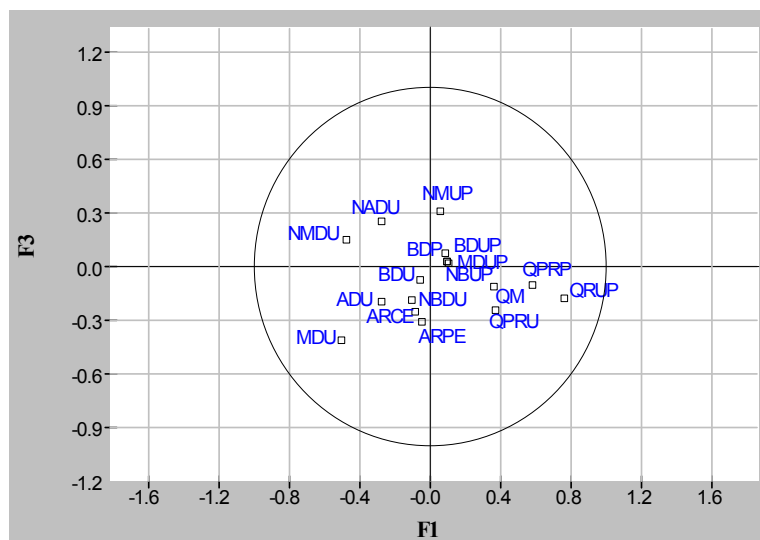


Figure 7 – Supplementary variables projection on plane F1, F3

As far as the “bairros” are concerned it can be seen in Figure 8 that Xipamanine (XPM), Chamanculo C

(CHMc), Mafalala (MFL), Chamanculo B (CHMb), Chamanculo D (CHMd), Mikadjuie (MKD), Aeroporto B (APb) are “bairros” with houses the walls of which are predominately made of zinc and other low cost materials, while “bairros” Hulene B (HLb), Costa do Sol (CS), Ferroviário (Ferr) have many houses with adobe floors, no WCs or latrines.

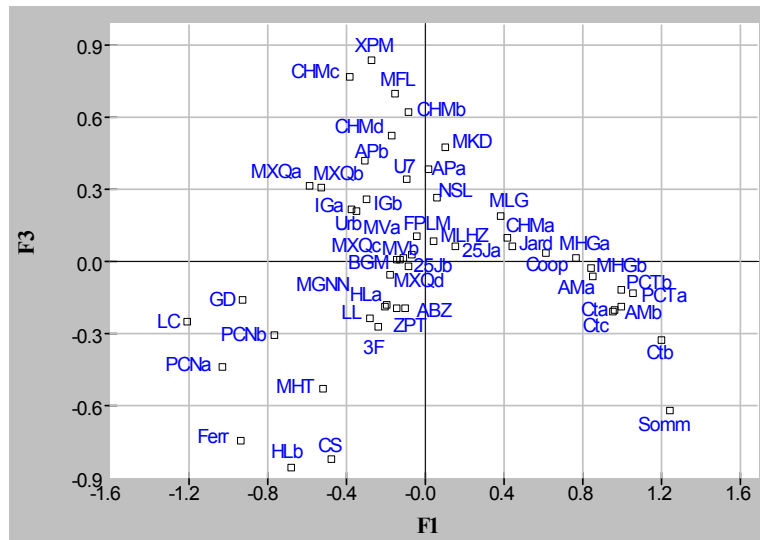


Figure 8 – « Bairros » projection on plane F1, F3

The fourth component (Fig. 9 – plane of components 1 and 4 with respectively 35.3 % and 5.8 % of variance) merely expresses the link between variables TCCP and PAD.

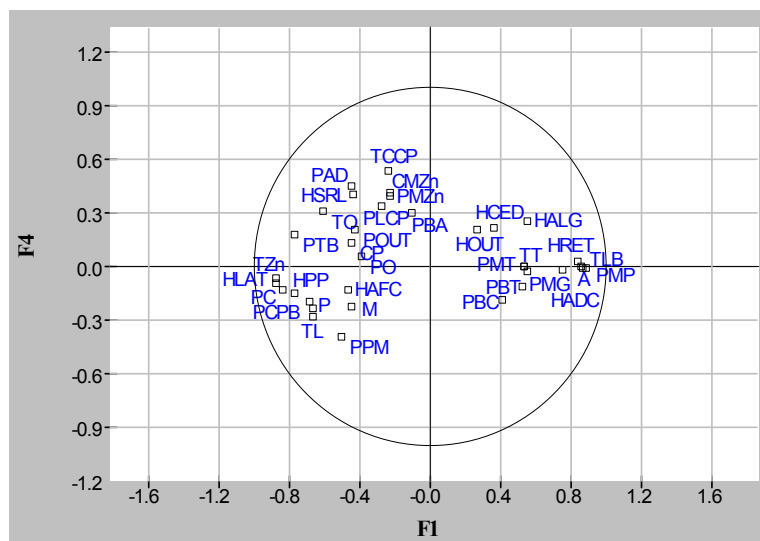


Figure 9 – Active variables projection on plane F1, F4

In this fourth component (Figure 10) the residential areas and city blocks associated to variables TCCP and PAD are: NBDU, ARPE and NMUP.

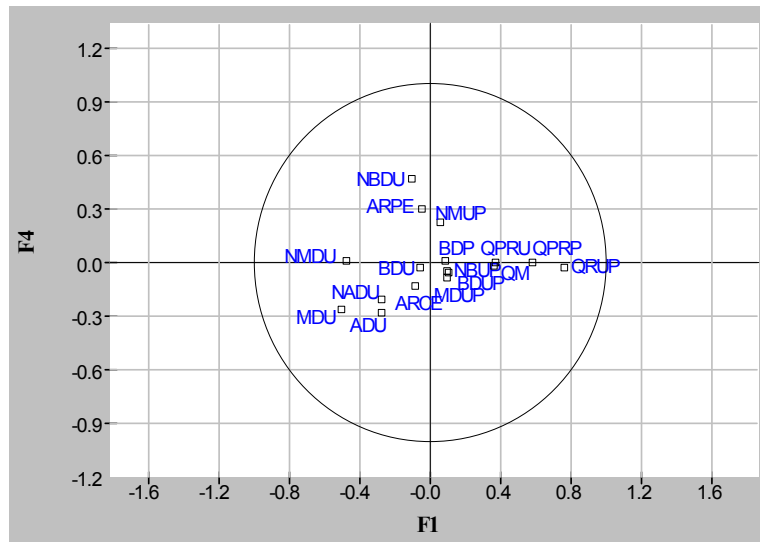


Figure 10 – Supplementary variables projection on plane F1, F4

The “bairros” which display these characteristics are, according to Figure 11, Costa do Sol (CS), Xipamanine (XPM), Abazine (ABZ), Mafalala (MFL) and Mahotas (MHT).

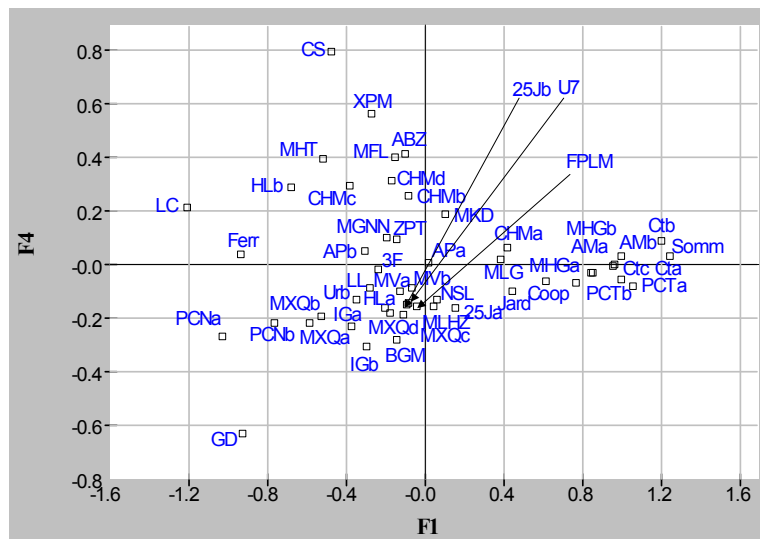


Figure 11 – « Bairros » projection on plane F1, F4

The joint analysis of the four main components enables one furthermore to define some groups of variables and of “bairros” as synthesized in Table 3 and in Figure 12.

| | Active Variables | Supplementary Variables | “Bairros” |
|----------------|--|-----------------------------|---|
| Group I | PMP, TLB, A, HRET, HADC, PMG, PMT, TT, PBC, HCED, HOUT | QRUP, QPRP, QPRU, QM | Somm, Ctb, PCTa, Amb, PCTb, Cta, Ctc, Ama, MHGb, MHGa, Coop, Jard |
| Group II | HALG, PBT | NBUP, MDUP, BDUP, NMUP, BDP | CHMa, MLG, APa |
| Group III | | | 25Ja, MKD, NSL, MLHZ |
| Group IV | PBA, CMZn, PMZn, PLCP, CP, M, HAFC, PPM, P, PCPB | NADU, NMDU | MFL, CHMd, XPM, IGa, CHMc, MXQb, MXQa, |
| Group V | PO, POUT, HSRL, PAD, TO, TL, HPP, PTB, PC, TZn, HLAT | ARCE, ADU, MDU | PCNb, GD, Ferr, PCNa, LC |
| Group VI | TCCP | ARPE, BDU, NBDU | 25Jb, ABZ, ZPT, MXQd, MGNN, HLa, 3F, LL, CS, MHT, HLb |
| Non Classified | | | FPLM, MVb, CHMb, U7, MXQc, MVa, BGM, IGb, APb, Urb |

Table 3 – Groups of variables and « Bairros » as a result of PCA algorithm

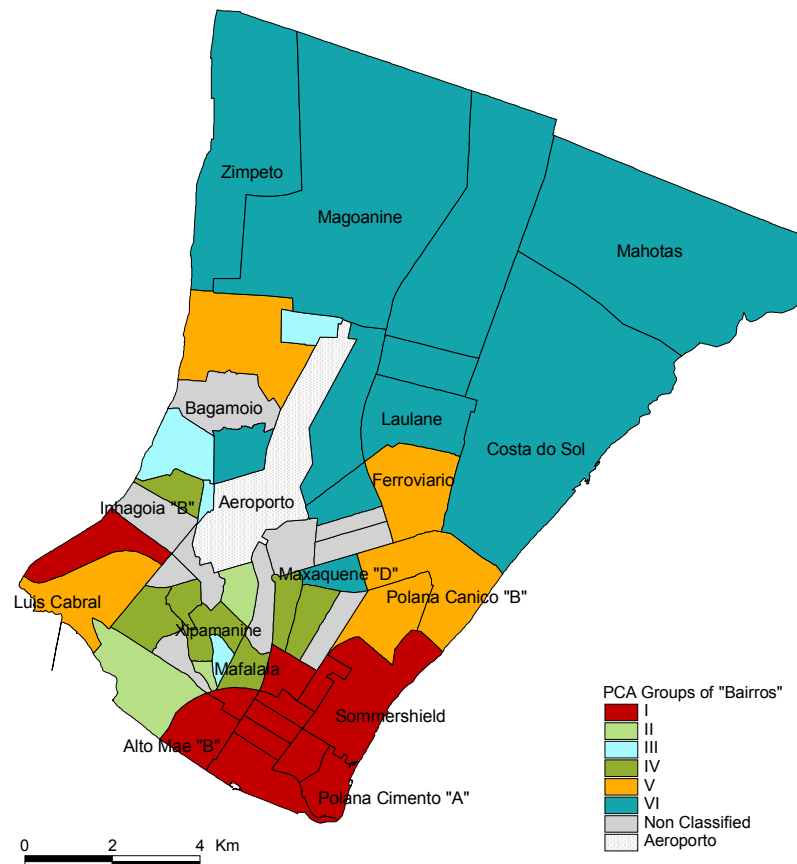


Figure 12 – Goups of “Bairros as a result of PCA

Figure 12 resulting from the spatial representation of PCA groups shows three different situations regarding the process of forming groups of “bairros”. The first situation relates to Group I which corresponds to the so-called “cement city”, with the exception of “bairro” Jardim. The second one relates to the “bairros” of the peri-

urban area which is most far-off the center (Group VI) with the exception of the “bairros” Maxaquene D and 25 de Junho B. These two “aggregates” show an homogeneous behaviour of the variables which is expressed by the spatial contiguity of the units analysed. The third situation corresponds to Groups II, III, IV and V showing a very heterogeneous behaviour. The diversity of the habitat conditions is much greater in this group of “bairros” when compared to Groups I and VI. This analysis leads to a first conclusion: in Maputo there exists in fact a center (Group I) and two well defined peri-urban areas, namely a rural fringe (Group VI) and a dense and very diversified suburban area as far as housing conditions are concerned (remaining Groups). We may therefore assert that the latter (the suburban area contiguous to the “cement city”), corresponds to a city of suburban-urban transition considering the growing of its urbanity.

Cluster Analysis

In order to obtain a classification of all the “bairros” thereby reaching a definition of the habitat typologies of the city of Maputo, we resorted to an automatic classification technique – the Cluster Analysis – the generic aim of which is to identify and classify individuals or variables on the basis of the similarity of the characteristics they possess. It seeks to minimize within-group variance and maximize between-group variance. The specific aim of this case-study consists in the construction of groups of “bairros” similar to one another with respect to their housing conditions.

In order to avoid a partition of the initial table in several classes it was decided to use a method of hierarchic classification (ascending hierarchic classification – AHC), the main characteristic of which is the fact that the groups formed in each phase are being successfully imbricated in one another, forming a tree-like structure, so that the groups brought together in each phase of the algorithm will never dissociate. The deterministic characteristics of this technique enables us to classify all individuals.

Therefore, and bearing in mind the results obtained by using PCA algorithm, the 52 available variables were considered in this assay. The set of n individuals to be classified (consisting in the present case in the 52 “bairros” of Maputo) was submitted to an AHC algorithm, the criterion of distance between individuals designated by $\cos \theta$, and which is applicable above all when the data is not normally distributed, being then used. The analytical expression thereof for calculating the distance between two individuals a and b is given by:

$$d_{a,b} = \sqrt{1 - \sum_j \left(\frac{x_{aj} - m_j}{s_j} \cdot \frac{x_{bj} - m_j}{s_j} \right)}$$

wherein m_j is the average value of the variable and s_j is the respective standard deviation. The strategy that was used for clustering was the complete linkage (Sorensen, 1948) – the distance between two clusters is the maximum distance between an observation in one cluster and an observation in the other cluster, its analytical expression for calculating the distance between two groups K and L being given by:

$$d_{K,L} = \max_{a \in K} \max_{b \in L} d(x_a, x_b)$$

The result obtained by dendrogram (Figure 12) is a number of heterogeneous groups with homogeneous contents: there are substantial differences between the groups, but the individuals within a single group are similar.

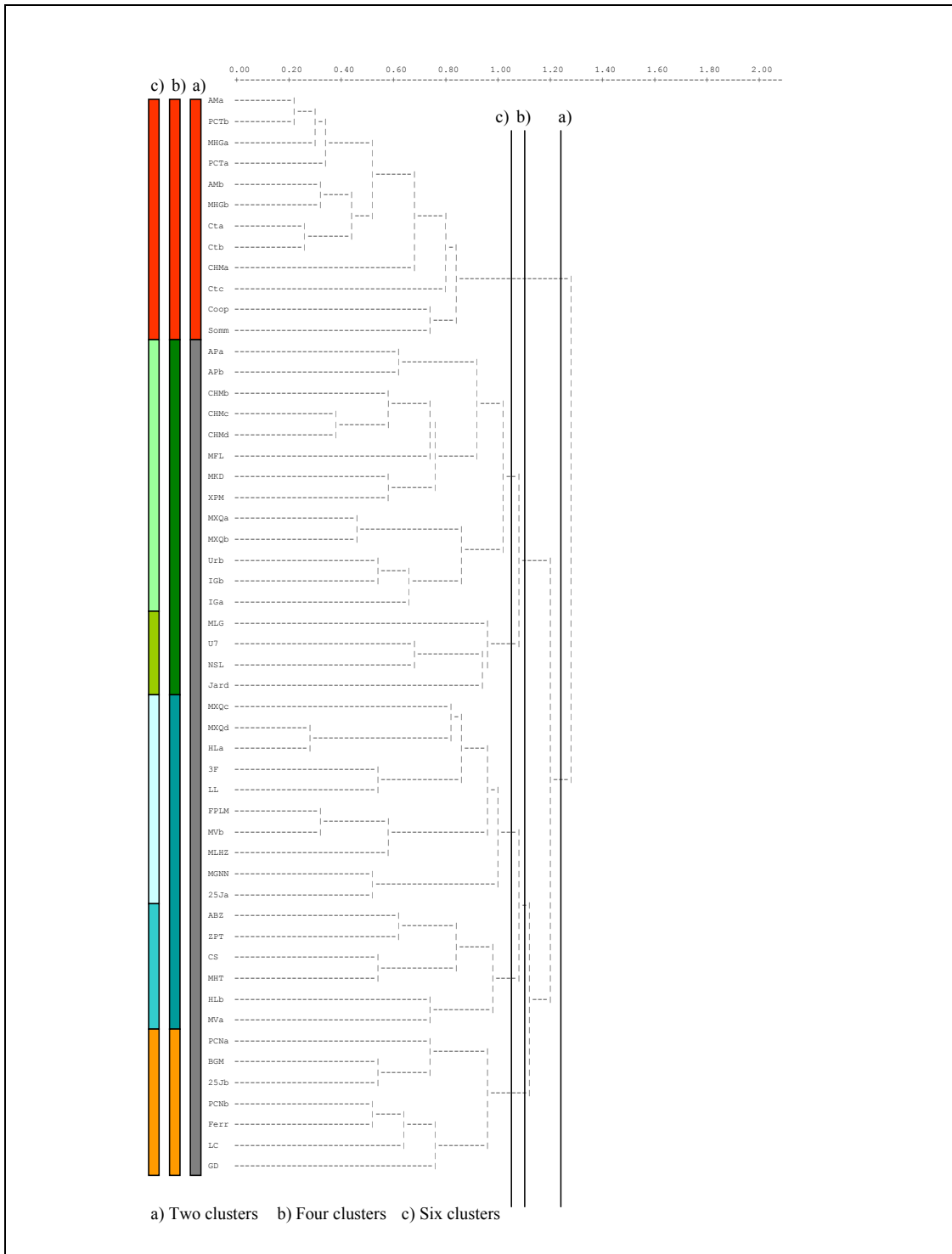


Figure 12 – Dendrogram

RESULTS

Characterization of the Habitat Clusters

The classification in 2 clusters shows the existence of the two aforementioned cities (Figure 13 A), namely the “cement city” and the “caniço city”.

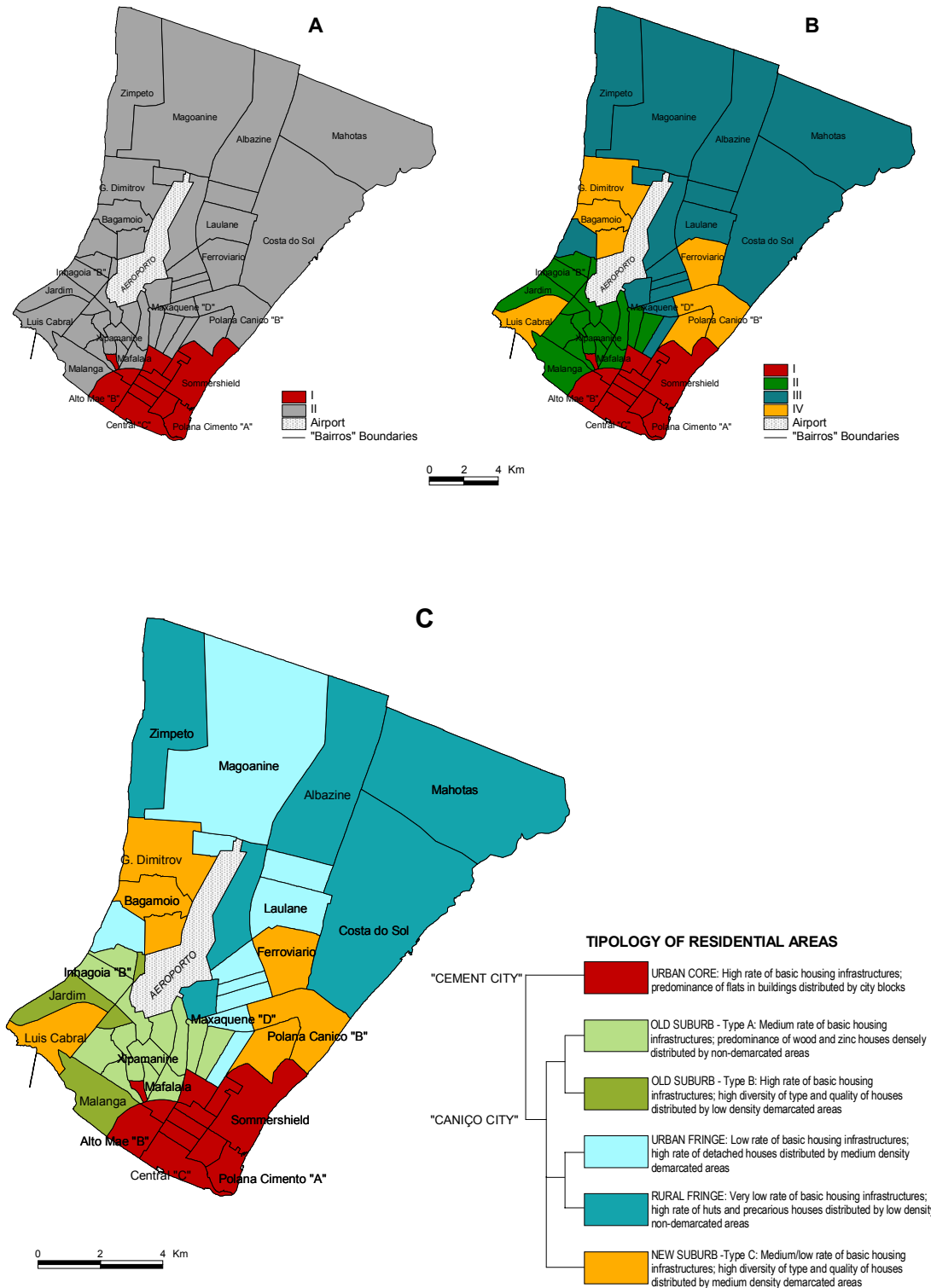


Figure 13 – “Bairros” classification in 2, 4 and 6 clusters

The “cement city” has relatively homogeneous characteristics with respect to the high habitat conditions which may be observed therein. It shows a predominance of apartment buildings interspersed with detached houses, the former as well as the latter being well equipped as far as basic infrastructures are concerned. In this area huts and precarious houses are almost inexistent.

In this two cluster classification the “caniço city” comprises all the other “bairros”. It includes the densely populated earliest suburbs of the colonial city, as well as the more recent expansion areas which are rather peripheral in respect to the “cement city”. As far as housing and housing conditions are concerned this vast area presents the most diverse situations. All types of habitat may be found therein, from huts to detached houses, often built side by side on the land, situations where the habitat is provided with good infrastructures as well as habitat with very precarious ones. Likewise, it is possible to see areas with unplanned occupation, alternating with areas submitted to a planning process and where the local government intervened by tracing the limits of the residential quarters (non-demarcated areas and demarcated areas). The density of the habitat may also largely vary from “bairro” to “bairro” within the big cluster, and there may be found “bairros” with densities of about 200 inhab/ha and “bairros” with less than 10 inhab/ha.

The classification in four clusters enabled us to verify the homogeneity of the “cement city” already referred to, as well as of making an attempt to show the heterogeneous character of the remaining “bairros” which form the “caniço city” (Figure 13 B). Cluster II seems to group the “bairros” corresponding to the already existing earliest suburbs of the colonial period and which have not undertaken any planning process, therefore revealing a disorganised form. On the other hand, cluster III consists of more recently created “bairros” where many residential areas were the result of an intervening process in the framework of an urbanization plan. Cluster IV also shows the more significant rural areas as well as those where a recent suburb expansion took place.

By classifying the “bairros” in 6 clusters (Figure 13 C) we were able to ascertain the existing diversity at the old suburban level and at the more remote “bairros”, and consequently to more objectively typify the residential areas of the Maputo city. The “cement city” remains in this case perfectly delimited by cluster I, as well as the more recent suburb which had been already individualized in the four cluster classification. This suburb is designated here by cluster VI. As far as the old suburb (clusters II and III) is concerned, the “bairros” where there exists a formal demarcation of the building plots and a greater percentage of habitat with basic infrastructure stood out in relation to others, thus forming cluster III. In the case of the more rural areas it was again possible to separate “bairros” corresponding to expansion areas of the suburb from areas preserving a more rural character.

Another look upon this typification of the city in 6 homogeneous areas in terms of housing characteristics shows us that half of the city’s population lives in areas defined by clusters II and IV, that is, in a mere 21.9 % of the total city area. We also reached the conclusion that in all those areas the number of households is greater than the number of houses, but it is in cluster II (43170 families for 38059 houses) where such a difference greater and where the number of houses made of wood and zinc is very expressive. If in cluster I almost all the houses have water, in cluster V a mere 7.3 % profit from this basic infrastructure. It is also in this area that huts and precarious houses are predominant.

TYPOLOGY OF THE RESIDENTIAL AREAS

The built housing area of the **Urban Core** is distributed amongst city blocks of a well defined orthogonal tracing, bordered by large avenues and tarred roads. The “cement city” represents a mere 9.1 % of the total area of the municipality and before the independence of the former colony it was essentially inhabited by the Portuguese settlers. After the revolution many inhabitants of the suburbs and of the peripheral area occupied the flats and detached houses abandoned by the former residents when they left the country. A process of degradation of the buildings took then place due to the lack of a local government intervening policy in this area, and to the very low affordability level of the people who came to live there which prevented them of carrying out significant repair work on the buildings. Only after the end of the war and after the political changes conducing to the privatization of the housing stock did the rehabilitation of buildings in some parts of the “cement city” take place. In the course of such a process the inhabitants with lesser means were once again pushed away and forced to live in the suburbs and peri-urban areas. In 1997 only 148178 individuals lived in this area, that is, a mere 15.7 % of the population of the Maputo city.

The urban core concentrates almost all formal business activities and services of the city of Maputo. During the colonial period such activities were located downtown and the remaining “bairros” were used almost exclusively as residential areas. Nowadays it is possible to find numerous company offices occupying many detached houses of these peaceful “bairros”.

Although at a first glance, the “cement city” is similar to many of the so-called eastern cities, it conceals in between its many storied buildings and in the flats countless situations of absolute poverty, which the statistics survey do not collect.

The **Old Suburb Type A and B** comprises areas of the city which were inhabited by the African population during the colonial period. The population density of these areas increased dramatically and the “subúrbios” grew in an anarchic and precarious way due to the successive waves of migrations which occurred in the course of time: “In the 1940’s a limited industrial sector was established, processing raw materials for local consumption. This gave rise to a rapid growth of occupation in the “subúrbios” in between the new industrial zones. The city government treated these areas as temporary without any construction rights and adopted a “laissez faire” attitude to their occupation. Hence buildings were of non-permanent materials (corrugated iron sheet and reeds) and most often rented.” (Jenkins, 2000).

The “bairros” of the Old Suburb Type A show a high population density (an average of 200 inhab/ha) while compared to those of the urban core (104 inhab/ha). In this case the habitat is distributed in a dense and unplanned way with scarce open spaces, even in terms of traffic (people and cars) which runs through narrow and sinuous paths. The quality of the equipment of these “bairros” is poor, although there are schools, markets and playing grounds, unfortunately far too few for the demand. These “bairros” are practically “monofunctional” ones, though there is a frenzy of informal open-air markets in the small squares and narrow streets crossing them.

The Old Suburb Type B has lower population densities and a more heterogeneous type of land occupation. In the words of the Chief Officer of a “Grupo Dinamizador” (a kind of a Social Welfare Group) of one of the “bairros”: “Bairro Jardim is a mixed “bairro” consisting of a cement area and a “caniço” area where poverty, I can even say “absolute poverty”, is more deeply felt”. (in Oppenheimer, 2002). In these “bairros” some factories and warehouses may also be found between the houses, thus contributing to the heterogeneity of the old suburb’s aspect.

The **Urban Fringe** corresponds to the “bairros” of the city which have recently expanded. The population thereof consists of newly-arrived people and of individuals which have been “pushed”, due to the expansion of the “cement city”, towards the old suburb. Although their infrastructures are poor, several good houses may be found. The rural features of many areas of this cluster are however visible when looking at the “machambas” (small vegetable gardens) scattered among the houses.

The **Rural Fringe** is characterized by the low density of the housing and by the use of the land for agricultural purposes. The huts with rural characteristics are here more noticeable, but one may also find here and there big detached houses surrounded by walls which are locally designated as “quintas” (small farms). The landscape of the rural fringe is marked by vegetable gardens, aviaries, green houses and by some residential areas (along the few roads and at the Costa do Sol, by the sea).

In the late 1970s the Local Government carried out an urbanization programme that lead to the planned occupation of the **New Suburb**. It consists of vast residential areas geometrically divided in plots, interrupted here and there by social amenities (school, church, playground). The housing heterogeneity reflects the basic self-help construction programme promoted for these “bairros” as well as the affordability level of each household. Polana Caniço A and B “bairros” are the most representative of this type of land occupation.

ACKNOWLEDGMENTS

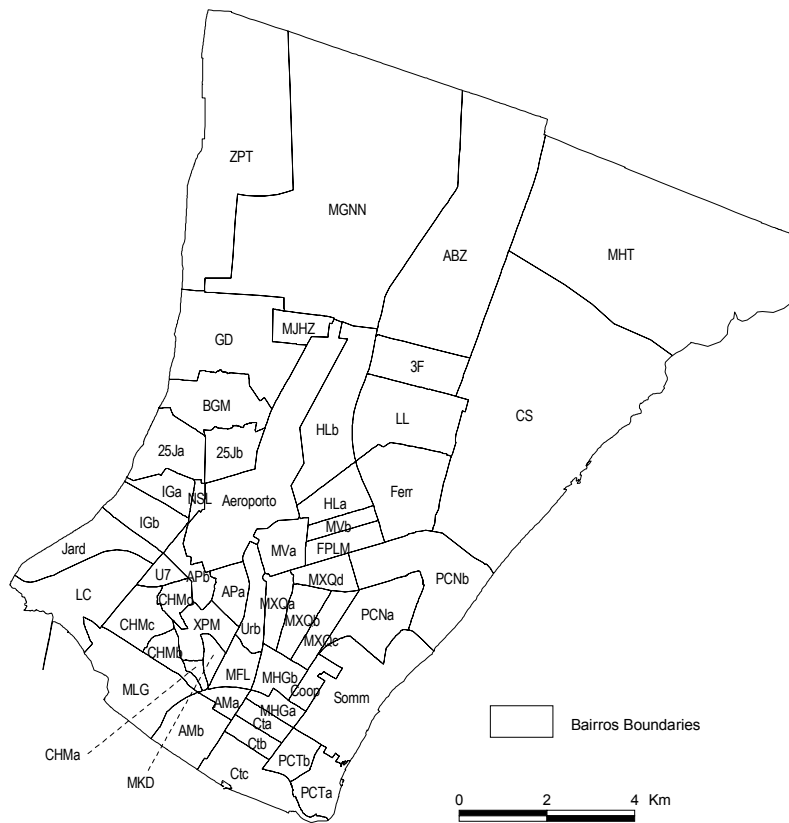
The authors would like to acknowledge the contribution of Elisa Henriques.

REFERENCES

1. **CVRM – Centro de GeoSistemas do IST**, software AnDad, Lisbon, 1989 and 2002.

2. **Devas, N. and Rakodi, C.**, (Eds.) *Managing Fast Growing Cities. New Approaches to Urban Planning and Management in the Developing World*, Essex, 1992, p.337.
3. **Escofier, B. and Pagès, J.**, *Analyses factorielles simples et multiples. Objectifs, méthodes et interpretation*, 3^e édition, Dunod, 284 p.
4. **Henriques, C.**, "Problemas E Oportunidades Da Habitação Urbana Na África Ao Sul Do Sara: A Perspectiva De A. Graham Tiplle E O Caso De Cabo Verde", Garcia de Orta - Série de Geografia, Revista do Instituto de Investigação Científica Tropical, 1998, 16 (1-2).
5. **Hotelling, H.**, Analysis of a complex of statistical variables into principal components. *Journal of Educational Psychology*, Nr. 24, 1933, pp. 417-441 and 498-520.
6. **Jenkins, P.**, City Profile Maputo, *Cities*, Vol. 17 Nr. 3, 2000, pp. 207-218.
7. **Luís, J.; Ribeiro, J.; Patinha, P.; Luís, A.; Dias, M. and Pereira, H. G.**, Para uma Tipologia da Utilização dos Solos Agrícolas". *Geo sistemas*, Nr. 1, Lisboa ,1992, pp. 63-88.
8. **Mendes, C.**, Maputo Antes da Independência. *Geografia De Uma Cidade Colonial. Memórias do Instituto de Investigação Científica Tropical*, Nr. 68, Lisboa ,1985, pp. 366-382.
9. **O'Conner, A.**, *The African City*, London, 1983, p. 359.
10. **Oppenheimer, J. and Raposo, I.**, A Pobreza em Maputo, Departamento de Cooperação do Ministério do Trabalho e da Solidariedade, Colecção Cooperação, Lisboa, 2002, p. 200.
11. **Pereira, H. G. and Ribeiro, J.**, Combining Correspondance Analysis and Spatial Statistics for River Water Quality Assessment and Prediction". CD-ROM ASMDA 2005 Proceedings of the XIth International Symposium on Applied Stochastic Model and Data Analysis, Brest, France, 2005. p. 764 – 771.
12. **Raposo, I. and Henriques, C.**, (Sub)Urbanidade e Transformação do Uso do Solo na Periferia de Maputo, *Cadernos de Arquitectura* Nr. 5 2005, Faculdade de Arquitectura-UTL, pp. 114-123
13. **Sorensen, T.**, A Method of Establishing Groups of Equal Amplitude in Plant Sociology Based on Similarity of Species Content and Its Application to Analyses of the Vegetation on Danish Commons, *Biologiske Skrifter*, Nr. 5, 1948, pp. 1 –34

ANNEX 1



| “Bairros” and codes | | | | | |
|---------------------|------|-----------------|------|----------------|------|
| Alto Mae A | AMa | Malanga | MLG | Mahotas | MHT |
| Alto Mae B | AMb | Minkadjuine | MKD | Mavalane A | MVa |
| Central A | Cta | Unidade 7 | U7 | Mavalane B | MVb |
| Central B | Ctb | Xipamanine | XPM | 3 de Fevereiro | 3F |
| Central C | Ctc | Mafalala | MFL | Laulane | LL |
| Coop | Coop | Maxaquene A | MXQa | Bagamoio | BGM |
| Malhangalene A | MHGa | Maxaquene B | MXQb | G. Dimitrov | GD |
| Malhangalene B | MHGb | Maxaquene C | MXQc | Inhagoia A | IGa |
| Polana Cimento A | PCTa | Maxaquene D | MXQd | Inhagoia B | IGb |
| Polana Cimento B | PCTb | Polana Canico A | PCNa | Jardim | Jard |
| Sommersfield | Somm | Polana Canico B | PCNb | Luis Cabral | LC |
| Aeroporto A | APa | Urbanizacao | Urb | Magoanine | MGNN |
| Aeroporto B | APb | Albazine | ABZ | Malhazine | MLHZ |
| Chamanculo A | CHMa | Costa do Sol | CS | Nsalene | NSL |
| Chamanculo B | CHMb | Ferrovuario | Ferr | 25 de Junho A | 25Ja |
| Chamanculo C | CHMc | FPLM | FPLM | 25 de Junho B | 25Jb |
| Chamanculo D | CHMd | Hulene A | HLa | Zimpeto | ZPT |
| | | Hulene B | HLb | | |

ANNEX 2

| Variables and Codes | | | |
|--|------|---|------|
| Área Residencial Consolidada Formalmente Demarcada de Baixa Densidade de Habitação Unifamiliar | BDU | Nº de Habitações com Laje de Betão no Tecto | TLB |
| Área Residencial Consolidada Formalmente Demarcada de Média Densidade de Habitação Unifamiliar | MDU | Nº de Habitações com Telha no Tecto | TT |
| Área Residencial Consolidada Formalmente Demarcada de Alta Densidade de Habitação Unifamiliar | ADU | Nº de Habitações com Lusalite no Tecto | TL |
| Área Residencial Consolidada Formalmente Demarcada de Baixa Densidade de Habitação Uni e Plurifamiliar | BDUP | Nº de Habitações com Zinco no Tecto | TZn |
| Área Residencial Consolidada Formalmente Demarcada de Média Densidade de Habitação Uni e Plurifamiliar | MDUP | Nº de Habitações com Capim/Colmo/Palmeira | TCCP |
| Área Residencial Consolidada Formalmente Demarcada de Baixa Densidade de Habitação Plurifamiliar | BDP | Nº de Habitações com Outro Material no Tecto | TO |
| Área Residencial Consolidada não Demarcada Formalmente de Baixa Densidade de Habitação Unifamiliar | NBDU | Nº de Habitações com Água dentro de casa | HADC |
| Área Residencial Consolidada não Demarcada Formalmente de Média Densidade de Habitação Unifamiliar | NMDU | Nº de Habitações com Água fora de casa | HAFC |
| Área Residencial Consolidada não Demarcada Formalmente de Alta Densidade de Habitação Unifamiliar | NADU | Nº de Habitações de tipo Moradia | M |
| Área Residencial Consolidada não Demarcada Formalmente de Baixa Densidade de Habitação Uni e Plurifamiliar | NBUP | Nº de Habitações de tipo Apartamento | A |
| Área Residencial Consolidada não Demarcada Formalmente de Média Densidade de Habitação Uni e Plurifamiliar | NMUP | Nº de habitações de tipo Palhota | P |
| Área Residencial da Periferia em Expansão | ARPE | Nº de Habitações de tipo Casa Precária | CP |
| Quarteirão Predominantemente Residencial Plurifamiliar | QPRP | Nº de Habitações de tipo Casa de Madeira e Zinco | CMZn |
| Quarteirão Predominantemente Residencial Uni e Plurifamiliar | QRUP | Nº de Habitações com Bloco de Cimento nas Paredes | PBC |
| Quarteirão Predominantemente Residencial Unifamiliar | QPRU | Nº de Habitações com Bloco de Tijolo nas Paredes | PBT |
| Área Residencial Central em Expansão | ARCE | Nº de Habitações com Madeira e Zinco nas Paredes | PMZn |
| Quarteirão Multifuncional | QM | Nº de Habitações com Bloco de Adobe nas Paredes | PBA |
| Nº de Habitações com Madeira/Parquet no Pavimento | PMP | Nº de Habitações com Caniço/Paus/Bambu/Palmeira nas Paredes | PCPB |
| Nº de Habitações com Mármore/Granulito no Pavimento | PMG | Nº de Habitações com Paus Maticados nas Paredes | PPM |
| Nº de Habitações com Cimento no Pavimento | PC | Nº de Habitações com Lata/Carlão/Papel/Saco/Casca nas Paredes | PLCP |
| Nº de Habitações com Mosaico/Tijoleira no Pavimento | PMT | Nº de Habitações com Outro Material nas Paredes | POUT |
| Nº de Habitações com Adobe no Pavimento | PAD | Nº de Habitações Alugadas | HALG |
| Nº de Habitações com Sem nada/Terra batida no Pavimento | PTB | Nº de Habitações Próprias | HPP |
| Nº de Habitações com Outro Material no Pavimento | PO | Nº de Habitações Cedidas | HCED |
| | | Nº de Habitações com Outro Regime de Propriedade | HOUT |
| | | Nº de Habitações com Retrete | HRET |
| | | Nº de Habitações com Latrina | HLAT |
| | | Nº de Habitações sem Retrete/Latrina | HSRL |

AUTHORS INFORMATION

Cristina HENRIQUES

cdh@fa.utl.pt
Fac. de Arquitectura da UTL
R. Sá Nogueira – Alto da Ajuda 1349-055 Lisboa
e-Geo, Centro de Estudos de Geografia e
Planeamento Regional, UNL
Av. de Berna, 26 C – 1069-061 Lisboa

Jorge RIBEIRO

jribeiro@fa.utl.pt
Fac. de Arquitectura da UTL
R. Sá Nogueira – Alto da Ajuda 1349-055 Lisboa
CVRM-Centro de Geo-Sistemas do IST
Av. Rovisco Pais 1049-001 Lisboa