The challenges of urban expansion in developing countries: the case study of Maputo-KaTembe

Albertina Soares Give

albertina.give@tecnico.ulisboa.pt

Instituto Superior Técnico, Lisboa, Portugal

October, 2016

1. Introduction

We have witnessed an increasing urbanisation globally in recent years, and the cities of the developing countries are growing at a faster pace, crossing into the territory of huge socio-economic disparities that mark (Melo, 2015). Such is the situation in Mozambique in 2007 the urban population was 35% rural and 65% (UN-HABITAT, 2007). In the metropolitan area of Maputo (MMA) had about 2,500,000 inhabitants, representing just over 12% of the Mozambican population and just over 35% of its urban population. Maputo, the country's capital, contributes more than half of the national GDP (Macucule, 2015). Financial management and the country's resources are centralised in Maputo. This city is the epicentre of the MMA (CMM, 2008), traditionally taking the largest urban concentration in the country with about 1,094,315 inhabitants. About 70% of inhabitants live in slums (UN-Habitat 2010, p. 16), concentrated in areas inhabited by a population low-income and level of education, whose territory and experiences are forged in the "interaction between two bipolar worlds". That is the urban model resulting from the mirrored western town in the centre and rural references that mark the history of its inhabitants (Raposo & Salvador, 2007, p. 136).

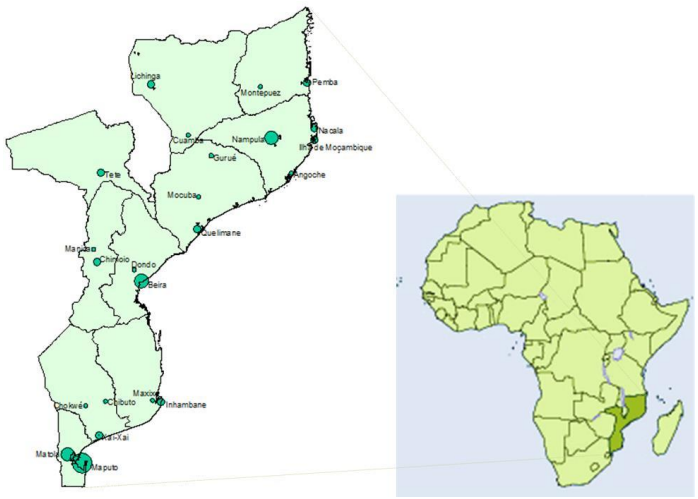

Figure 1: Mozambique location map and its cities.

The urban peripheries of the major African cities correspond to the most extreme definition of the periphery. In other words, areas in the geographical periphery of the city centre, areas with high concentration of families and their corresponding housing (the image of urban areas) but without the corresponding level of essential services and infrastructure or food self-sufficiency that the countryside offers and regions of different of urban and rural life.

2. The urban planning and environmental management

In Mozambique, the Land Management System (LMS) was inspired by the Portuguese model. The Spatial Planning Policy 2007, which leads the territorial order of the country, inspired by the Basic Law of Land Management Policy and the Portuguese 1998 Urbanism (Sicola, 2014). This LMS is directly related to the administrative and political structure of the country. The implementation of regional plans and policies focused on the distribution of powers on spatial planning by different ministries and other government agencies. Regarding spatial division (see Fig. 2), Mozambique has eleven provinces (including the city of Maputo province status), 152 districts and 405 administrative posts (INE, Mozambique 2015). According to the Decree 23/2008 Regulation of the Territorial Planning Act, the Mozambican territorial organisation comprises the following levels of intervention in the territory, namely: a) National; b) Provincial; c) District; and d) Municipal.

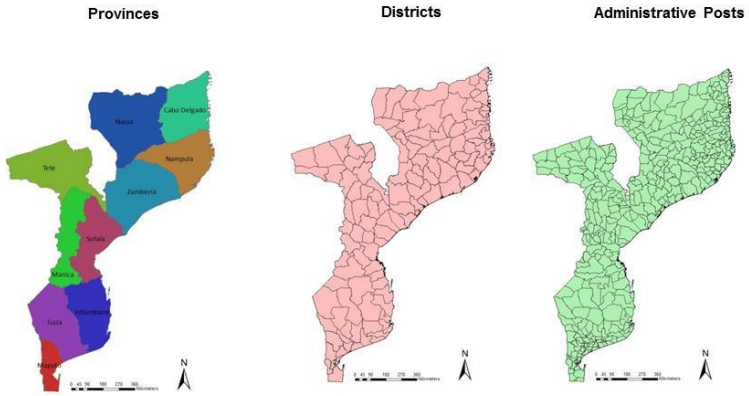

Figure 2: Territorial division of Mozambique. Source: Adapted based on the administrative division of the country, available in http://www.gadm.org/

The LMS in Mozambique operates on three levels namely: Central Government, Provincial Government and District Government. In addition to these levels, Law No 8/2003 (RA 2003) highlights the organs of administration / local territorial organisation of the State following levels: provincial, district, administrative posts, localities and villages.

Regarding environmental framework in the MMA, the issue of water resources is one of the most critical aspects of all the environmental context of the MMA. For many years the central government to local authorities has been looking for solutions to minimise the damage associated with this problem but without apparent success. Due to increasing demand welfare in the city and also by rapid population growth, urban areas of AMM have been consecutive times the scene of the main unsuitable occupations and the local government has not been able to control this emerging phenomenon. In this context, we identified three (3) main problems (see Fig. 3) as a result of this inadequate occupation in the territory, including floods, runoff and saline intrusion. Moreover, the obvious examples of these problems can be observed in Fig. 4.

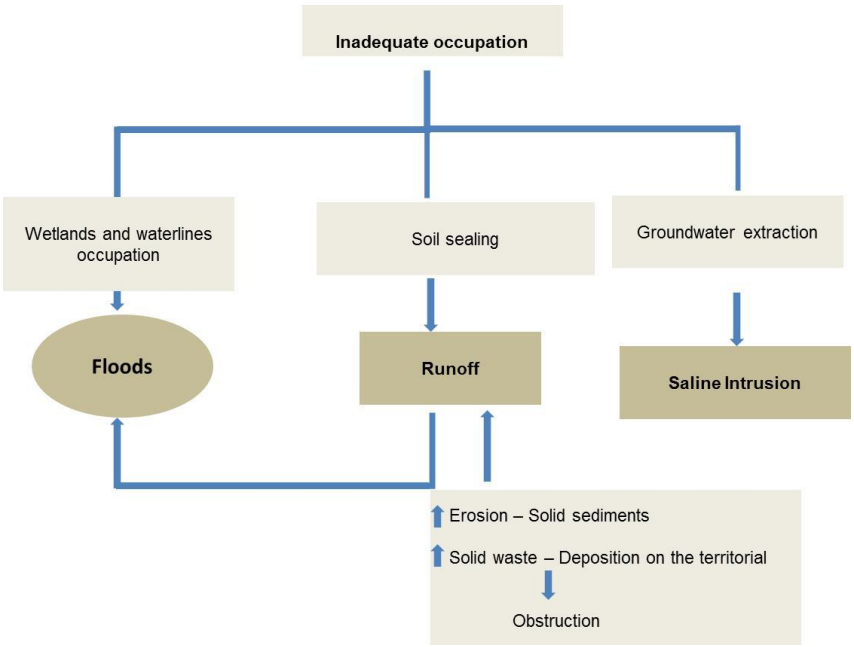

Figure 3: Presentation of the problems of water resources.

Figure 4: Problems of water resources in the AMM. Source: http://www.mmo.co.mz/maputo-e-lixo-casados-para-sempre. http://www.moz.life/familias-perigo-erosao-na-julius-nyerere/; http://www.jornaldomingo.co.mz/index.php/reportagem/4655-municipes-e-edilidade-lutam-contra-inundacoes; http://impactoerosao.blogspot.pt/

3. Occupation structure and dynamics of urban growth in MMA

The structure of the occupation and dynamics of urban growth in the MMA had in mind the perception of the environment in the study area (the KaTembe) which is inserted starting from a macro look at the MMA (see Fig. 5 the geographical location). This realisation has been taken through a physiography characterization of the MMA (Fig. 6), generated and analysed in ArcGIS environment. The physical characterization of a territory largely conditions and power occupying a given space. For a description of urban occupation considered the use of satellite images for the production form of information that would allow us to obtain the area with urban settlement in the MMA due to non-availability of data on the subject. The selected images were based on years in which images had some quality resolution capable of reducing the level of errors in processing and spatial analysis. In this sequence, the established periodization was 1986 (marked by the period shortly after the country's independence), 2006 and 2016.

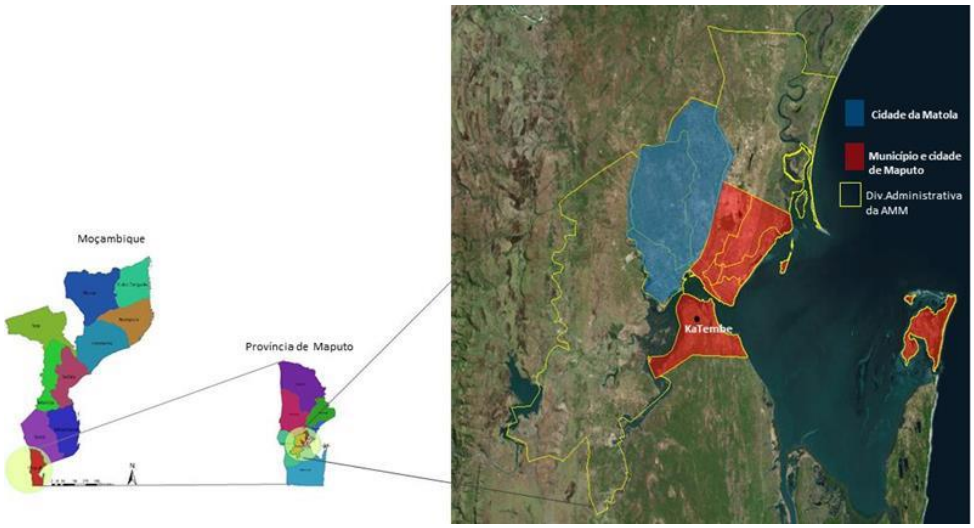

Figure 5: Framework of the study area.

The DEM has generated from the hardware the characteristics of the territory that compose MMA and its altitude and the topography of the area. The altitudes range from 0 to 785m. The surfaces flattened ranging from 5 to 120m; the city of Maputo territory east of the MMA is dominated by surface areas of less than 100 meters. Further south, specifically in the district KaTembe presents low altitudes below 60 m, with all its waterfront and downtown alluvial water line across the territory with North-South orientation altimetry below 10 m. On the other hand the area over accentuated elevation there is west of the MMA (belonging to the province of Matola) and zones with a little sharp rise in Maputo. This substrate has an influence on the territorial model of Maputo.

About sun exposure (see photo 2 in Fig. 6), given the different geographical directions that the territory has to be noted that the slopes are given a greater or lesser amount of solar radiation, which influences the comfort of buildings. Maputo is moister than Matola. The levation is higher in Matola raised area. The fact that the Maputo area was a swamp which was later buried to make way for the city did contribute to a zone that is wetter than Matola.

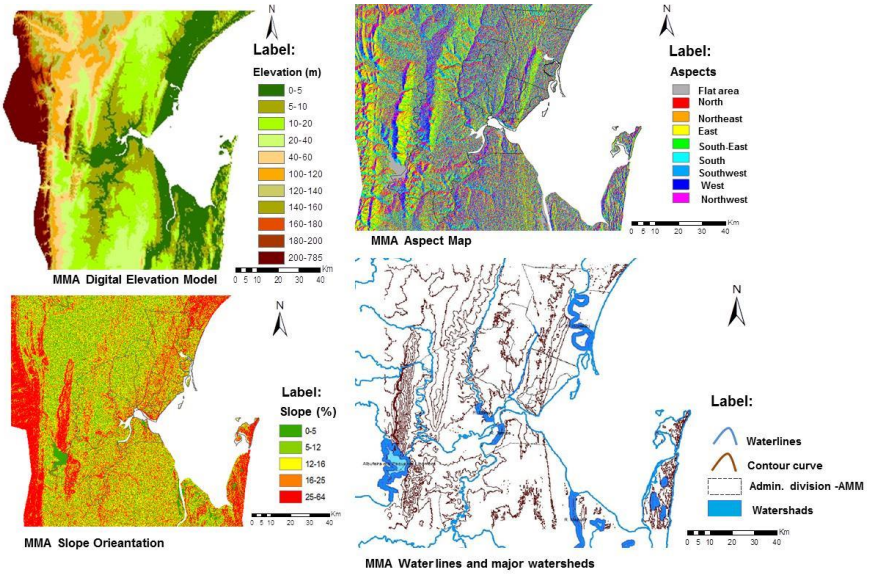

Figure 6: Physical characterization of the AMM. Source: Letters generated from data available in http://www.cgiar-csi.org/data/srtm-90m-digital-elevation-database-v4-1.

Looking to the altimetry (see photo 3 of Fig. 6) which has revealed the distribution of classes established for the slope in terms proportional throughout the metropolitan area of Maputo, observing large flat areas with slopes up to 5%. In the area of KaTembe, there are sloping areas from 5% to 16% with the steepest areas. Also, there is susceptibility to the occurrence of strand mass movements, in particular, overturning landslide soils and debris. Finally, see the photo 4, in the letter we highlight the main basins that drain the AMM are Matola, Tembe, Maputo, and Umbeluzi and the valley of Influence barrage of small Lebombo west of Matola. This is due to configuration relief most of the rivers in southern Mozambique run from west to east, flowing into the Indian Ocean. In addition to the relief soil, nature influences the flow, structure and pattern of the river system. On the plains form meanders and deposit their alluvium or form lagoons and marshes.

• Urban occupation and influences its growth

Based on the above-identified satellite images, applied to the production techniques of Remote Sensing data, this technique allows extracting information from an object, area, or phenomenon (urban occupation, growth of crops, flooding, erosion, etcetera); through the analysis of data acquired by a device that is not in contact with the object, area, or phenomenon under study (in classes I-SIG 2014/2015-IST). However, the results of applying these techniques are not absolute, on the one hand, it depends on how the data were treated and on the contrary the quality of the images obtained, so it is necessary to consider some errors and logically any change in the results. The second step was the processing and analyses of data in ArcMap environments; these processes have eliminated and made the choice of images that showed better visual quality, then geometric, radiometric and atmospheric corrections, a projection of the UTM coordinate system WGS-1984 tete-36S corresponding to the system used in Mozambique for the South zone. Then, we proceeded with the image classification, supervised and unsupervised (see fig. 7). In unsupervised classification, the pixels were grouped into classes according to their characteristics (3 colours, RGB). Since the study area is known, was carried out with the supervised classification.

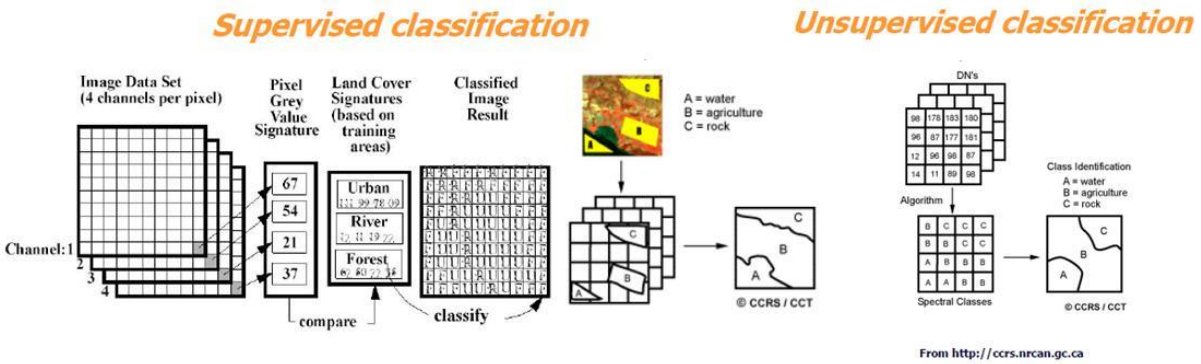

Figure 7: Image classification method. Source: GIS I Lessons 2014/2015-IST.

We obtained the desired area in the matrix format, and undertook calculations in the ArcMap environment geoprocessing tools and geometry calculator, which gave the result of land use index as can glimpse in Fig. 8 for the year 2016. For the other years the results were not satisfactory due to image quality, for that only consider the occupation obtained the images for the year 2016. We used the following formula to determine the occupancy level of the area under study:

$$\mathrm{Io}(\%) = \sum \frac{\mathbf{Ia}}{\mathbf{Sa}} \quad \text{Where:} \begin{cases} \mathbf{Io}\text{: Soil Occupation Index} \\ \mathbf{Ia}\text{: The implantation area} \\ \mathbf{Sa}\text{: Soil Area} \end{cases}$$

The soil load factor concerns the space consumed by the implementation and corresponds to the ratio between the total area of deployment and the ground area that the index is concerned and expressed as a percentage. The results of this processing and data analysis are presented in the form of a matrix raster and vector then makes up the intersection of these two entities so as to give a single result which is (see Fig. 8). According to the results of the calculation of the occupancy rate of urban areas shown in Fig. 8, it is found that is within the urban areas with is high occupation density have values between 76% and reaches up to 100 % occupancy. Also, it appears that the more we move away from the urban core the informal occupation densities are decreasing, going from 0% to 49%. This is because there is in these cities the highest concentration of goods and services, thereby attracting the population living far, and the phenomenon of rural exodus to urban centres. Furthermore, another curious fact is the low occupancy density within these cities, from 9% to 27%. Melo (2015) states that the centres of these inherited cities in the colonial period expand to adjacent areas, makeup and redox, decay and renew themselves, suffer from overcrowding or empty themselves, given the emergence of new centralities, it should be the reason of low density within this nucleus.

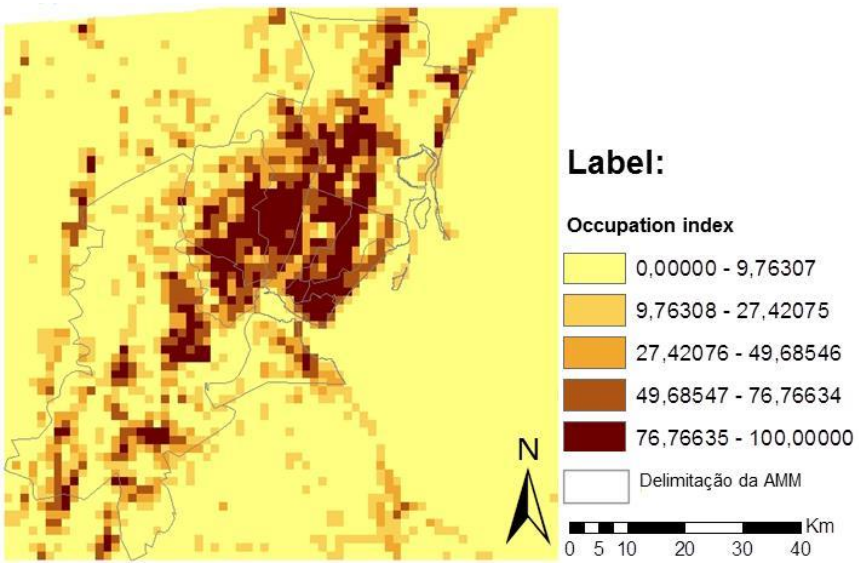

Figure 8: Soil occupancy index in MMA-year 2016. Source: The author.

To analyse why this model of occupation became a data overlay on the structural elements of the AMM with the profession and concluded that the concentration of the population tends to be along the structural elements of the MMA. However, it is strongly marked by the search facility the movement of people, goods and services (see fig. 9).

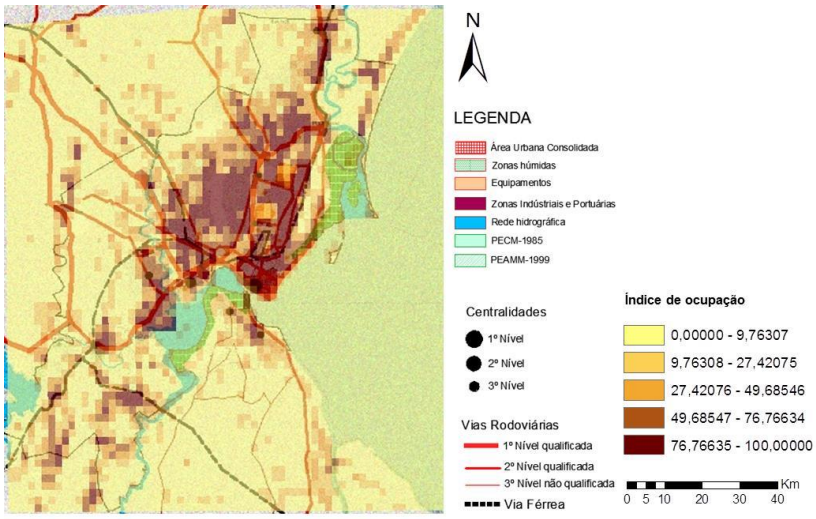

Figure 9: Structural elements vs land use rate in the MMA. Source: The author.

4. KaTembe

The Municipal District of KaTembe belongs to the municipality of Maputo and the province of Maputo. The district is located on the south bank of the Maputo Bay (see Fig. 10) in front of the central area of Maputo. It borders with Tembe River to the west, Espirito Santo Estuary to the North, Bay of Maputo to the east, and the dividing line to the south. The access to KaTembe is possible through a ferry-boat and small boats, and land passing through the district of Boane.

Figure 10: Location of the municipal district of KaTembe. Source: Adapted by the author based on street view of ArGIS images, in 2016.

In the context of urban interventions provided for in PEUMM-2008, the township of KaTembe is a potential area for urbanisation. In sequence, the project for its implementation was approved, which presents a root urbanisation model (see Fig. 11) integrated into the same district Urbanization Plan (Lopes, 2005). The inclusion of this project is to respond to the current social problems in Maputo, given the growth and increase in population in the Mozambican capital. The search for new areas would be met mainly by the extent of the urban area towards Boane, Moamba, Marracuene and KaTembe, allowing better management of land use. Also, it is paramount to open new areas which would relieve some overly dense areas and meet the demand of land for urbanisation of sectors, particularly along the roads.

Figure 11: Urbanization Plan Images of the new centrality of KaTembe. Source: Maputo-South, EP (2012).

5. Contribution to an urban occupation model to Maputo-KaTembe

According to the analysed data, there is a need for a regional-level planning model. This is our particular contribution to an urban occupation model for Maputo KaTembe based on three top priorities. The key priorities include Metropolitan Qualification fulfilled through the containment of urban expansion that aims to develop new centres and Firth of Articulation of the Espirito Santo with the Maputo Bay safeguarding water resources and wetlands, environmental sustainability. The objective is to frame the expansion of the urban area to the Katembe the township according to the maintenance of environmental values in particular water resources. In this perspective, we adopt a systemic vision of environmental sustainability based on the protection of water areas through ecological corridors, and definition of defence zones in coastal regions. Therefore, we proposed an urban ecological structure that can subsequently be developed on a different scale of territorial intervention plans of MMA; and Structuring the municipal transport system. The MMA has a network of infrastructure and poor transport facilities to contribute to solving this problem. Therefore, we propose the extension of roads in some axes of urban connection, and the closure of the coastal arc to increase connectivity between Maputo, Matola and KaTembe through the estuary and the Maputo Bay.

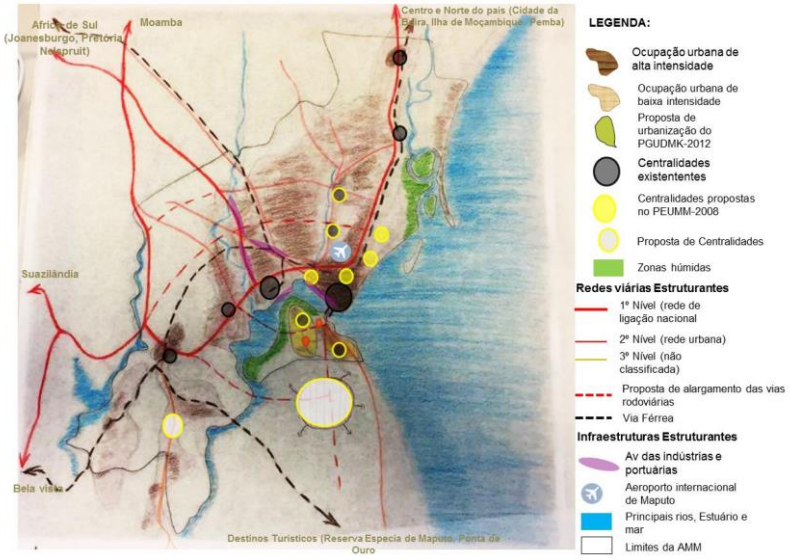

Figure 12: Contribution to a proposed land-use model in Maputo KaTembe. Source: Adapted by the author based on the current model of occupation.

This framework (see Fig. 12) suggests that the PGUDMK alone not be sufficient to ensure the dynamic that Katembe with the construction of the bridge will experience. Since the new bridge in Katembe must be accompanied by a plan to give support regarding spatial planning at the regional level to allow at least defends:

- Main road network infrastructure (road and rail)
- Network of Green Infrastructure, through an official classification of areas to safeguard and protect the urban occupation (which the government will hardly be able to control)

We recommend the encouragement of mixed use and promotion of proximity equipment with the introduction of new centres in Matutuíne, reducing the need for travel of the population of KaTembe to Maputo. Other intervention occurs in defining protected areas across the riverfront of KaTembe to qualify and value that environmentally sensitive area and also prevents the uncontrolled growth (urban sprawl). Regarding accessibility and mobility, we propose the extension of Maputo Circular completed later this year to the axis that goes toward Muamba and the enlargement of the Lurdes Mutola Avenue to the trucking between the axis of Moamba and Swaziland. This scheme will allow efficient mobility of people by the riverine arc that makes the connection Matola, Maputo and KaTembe.

The preparation of the contribution to a proposed Metropolitan Ecological Structure of the need for protection and maintenance of environmental values in particular water resources has been one of the most critical issues around the environmental framework context. Therefore, we propose in the public ecological structure special attention the inclusion of the broad outlines of water/river basins are filled beds, areas at risk of erosion, riverside, natural and urban vegetation. It is crucial to self-respect the recovery and maintenance of environmental and social values in KaTembe, lest resale in conflicts such as the inadequate occupation. The integration of these elements should be articulated on a structure which allows connectivity, and there is continuity of urban containment zones as seen in FIG. 13.

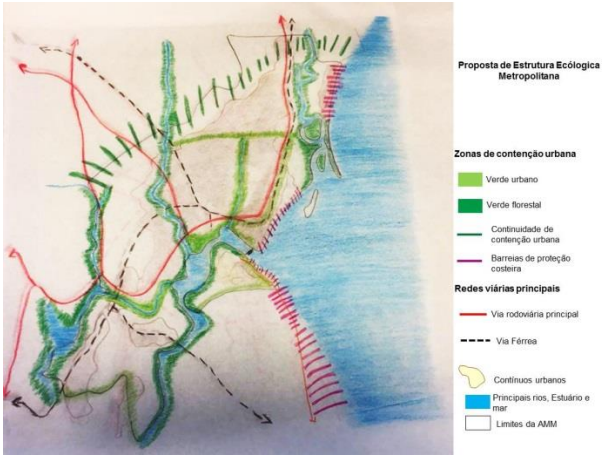

Figure 13: Contribution for a proposal of a Metropolitan Ecological Structure. Source: The author based on the physical characteristics of MMA.

The urban containment zones consist of urban vegetation to heavily urbanised areas, and the planned urban occupation and forest green should be green environmental protection and enhancement of water resources, this area is proposed as an area of protection of groundwater Linens and inhibit people construes these areas. We also propose a continuation of the northernmost

urban containment of the MMA, and this contention can be better defined concerning other planning scales, but the important thing is that this area should be considered in the urban ecological structure. Coastal areas have also proven fragile and are considered here so that they are not forgotten, since the range of Marginal Maputo Avenue to the southern margin KaTembe which has constituted a strong point of interest from ecological and landscape framework.

6. Conclusions

The main findings we draw from the work is that the non-imposition and legalisation of a metropolitan plan in Maputo conditions the proper planning and integrated call Grande Maputo region. This is due to the currently regional dynamics are an emergency in the urban intervention of a scale metropolitan, although the notion of inter-municipal cooperation is not meaningful. Maputo urban expansion for KaTembe requires planning and a more regional approach. The Regional Plan should serve as a reference for a development model of the MMA and will safeguard a network of essential key infrastructure (road and rail access and spaces green not artificialized) of urban occupation, even though they may not realise all at once. It also requires the establishment of a Plan of Metropolitan Ecological structure to frame the expansion of the urban area to the KaTembe the township inconsistent with the maintenance of environmental values, in particular, the water resources.

7. References

1. AR, A. da R., 2003. Lei no 8/2003. Lei dos Órgãos Locais do Estado.
2. Araújo, M.G.M. de, n.d. Espaço urbano demograficamente multifacetado: As cidades de Maputo e da Matola.
3. Betar, C., Beta, 2012. Estudo de pré-viabilidade ambiental e definição do âmbito e dos termos de referência do estudo de impacto ambiental. Avaliação de impacto ambiental do plano geral de urbanização do distrito municipal da KaTembe.
4. Betar Consultores, Promontório Planning, 2012. Plano geral de urbanização do distrito municipal KaTembe. Empresa de desenvolvimento de Maputo sul, e.p.
5. CMM, C.M. de M., 2008. Plano de estrutura urbana do município de Maputo.
6. Lopes, L.V.T., 2005. Ordenamento do território no distrito municipal da catembe. (Bacharel monography). Eduardo Mondlane University, Maputo-Mozambique.
7. Macucule, D.A., 2015. Processo-forma urbana restruturação urbana e governança no grande Maputo. (PhD thesis). Faculty of Social Sciences and Humanities-NOVA University of Lisbon, Lisbon-Portugal.
8. Melo, V. de P., 2015. A produção recente de periferias urbanas africanas. (PhD thesis). Faculty of Architecture–Lisbon University, Lisbon-Portugal.
9. Sicola, R.F., 2014. Ordenamento territorial e planificação estratégica no âmbito local: os sistemas de gestão do território.
10. UN-HABITAT, 2007. Programa das nações unidas para assentamentos humanos escritório regional para África e estados árabes perfil do sector urbano em Moçambique.