

MODELING THE HOUSEHOLDS LOCATION AND THE LAND USE OF ANTANANARIVO IN 2023

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Abstract

This study provides the size of the newly occupied and built area by Antananarivo dwellers between 2015 and 2023. According to the calculation, the size of the newly occupied area is 331ha on this time interval, include: 11 hectares for the CUA, 146ha for Avaradrano and 166ha for Atsimondrano. This study does not take into account the problems of administration, or the land value. Prediction is very difficult due to lack of data. This forecast serves as a decision support tool for authorities.

Keywords: Antananarivo, household, location, modeling, urban sprawl.

1- INTRODUCTION

The “artificialisation” of soils, the urbanization and the urban sprawl are generally perceived as a tendency to fight to avoid the waste of land. However, that has not always been the case: the perception has changed drastically since the royal period when the city was considered the place of civilization; in addition, it brings real security to its inhabitants. Until the nineteenth century, when the hygienists theories about benefits from nature emerged, as opposed to the unhealthy condition and insecurity of cities.

In the case of Antananarivo, sprawl is not manageable. Embankment and illegal constructions become non-negligible. The purpose of this study is to calculate and locate the size of urbanized areas in the agglomeration of Antananarivo, in 2023.

2- METHODS

3.1 - The context of Antananarivo about household locations and firms

This modeling study the intra-urban location of Antananarivo households, with a focus on the impact of income level.

The agglomeration of Antananarivo is a monocentric city: many of the activities (including shops, services ...) are located in the city center. Industries (zones, secondary sector ...) of processing which are localized in the periphery (Tanjombato, Andranomena, etc.) close to their workforce.

Regarding residential areas, wealthy households are grouped on residential neighborhoods that are accessible, well equipped and fairly close to their activities. The middle-income households live quite far from their places of business or close, but in places inaccessible by car and with insufficient VRD equipment. The low-income households live quite far from the city, they work in industries and practice at the same time suburban agriculture. Poor households live in slums, they live and squat risk areas (floodplains, dykes, ...) near markets and some areas with high densities (Isotry, Manjakaray, 67ha, ...) that welcome immigrants.

First, the proposed modeling explains the current location of households. In a second step, the modeling calculates the future preferred locations by households, businesses and industries.

Regarding inconstructible areas that have the potential (the flood Vals ...), the modeling evaluates this potential and lists the equivalent areas in terms of location.

Several explanations can be advanced to explain these differences, including the amenities offered respectively by the center and the periphery of cities. The urban formalized economy allows to provide some explanatory elements to these different city profiles. Obviously, it does not explain all situations, including the impact of amenities or polycentric urban development, but it has the advantage of to describe the household arbitrage in their choice of location.

3.2 - Presentation of the location model

We can explain the location of households in a city based on their income level by focusing primarily on the demand for housing, and assuming to simplify that we are dealing with a "monocentric city" where all jobs are grouped in the center and where transport monetary costs depend only on the distance to the center.

We consider a monocentric city (all jobs and services are in the city center). There are N identical individuals. Each individual lives in an area of housing q which market price at a distance x from the town center is $R(x)$, uses a non-spatial composite good z sold at a unit price, supports a monetary cost of transportation from home to work at a distance x from the town center given by $T(x) = tx$ and earns a wage W downtown. Consequently, its budget constraint is [3]:

$$W - tx = R(x)q + z \quad (1)$$

Each worker chooses q and z that maximize $U(z,q)$ under the budget constraint (1) or, equivalently, it solves the following equation: $\text{Max}(q, x) = U(W - tx, R(x)q + z)$.

It is assumed that landowners allocate land to those who offer the highest price at each point of the city. The utility of individuals should be the same at any point of the city, we have [3]:

$$T(x) + q \frac{dR(x)}{dx} = 0$$

Thus, in the basic formulation of the model, with the urban balance, each worker arbitrate between transport costs and housing prices, that is to say, the marginal cost of housing must be equal to its marginal cost of transportation. If the individual lives near the city center, he will pay a high housing

price, but will have a low transport cost. If he lives near the periphery, housing prices will be low but the transportation cost will be important.

We can then show that the land value decreases with the distance to the center. Thus, in the hypothesis (simplified), where the marginal cost of transport is the same for all individuals, the richest workers reside on the outskirts of the city while the less wealthy live near the city center. Qualitatively, this theory is true for the case of Antananarivo household location.

3.3 - Other parameters included in the model: the income, the value of time and the amenities

We must also consider the travel time in the individuals location, in the city. Particularly, wealthy households are expected to assign a higher value to the time spent in transport than low-income households. Hence, the salary allows to measure, in arbitration models leisure / work, the value of time spent in transport. The generalized transport costs (both monetary and time) must be used instead of only the monetary cost of transport [4].

In taking into account the time value, it is shown that there is an attraction force in the center for wealthier households because of the cost of travel time, which counterbalance the repulsive force in the determined center by the housing area. So, if we take into account the transport time, the richest workers are located in the periphery if and only if the elasticity of the marginal cost of transport compared to the salary is lower than the surface area compared to salary. Otherwise, they live near the city center.

One can interpret the above result as follows: if individuals are not very sensitive to housing size, the richest live near the city center to avoid losing too much time on transportation. However, if the desire for a spacious home is important, the rich will accept long trips to take advantage of larger housing. This theory is verified for the case of Antananarivo.

In practice, if the travel time is very low in relation to monetary costs, higher income households are located in the periphery. However, if the transport time is a very important part of the generalized cost, high-income households are located in the center.

In the same vein, we can say that families with the largest share of inactive tend to be located in the periphery if the income elasticity of housing demand is less than 1, and in the center if the elasticity is greater than 1 [2].

The presence of amenities (parks, pollution ...) plays a key role in urban areas. The model hardly reflects the influence of these amenities. However, these amenities have intrinsic value related to the preferences of different categories of households. In the case of Antananarivo, only privileged families are sensitive to these parks, pollution ... Thus, one can map the issue of amenities in the approach of the "monocentric" city. Therefore, we retain that the amenities grow according to the distance to the center (green areas, air quality and calm).

The formalization of the above model then shows arbitration between three forces in urban balance: the effect of transport costs, that of the housing demand and that of the amenities.

The model then shows that if the amenities are increasing with distance, high-income households are still localized in the periphery if the income elasticity of the marginal value given to amenities exceeds the income elasticity of demand for housing.

In other cases, one cannot draw a general conclusion without formally solving the model. Thus, one can say that the model reflects the reality of the location of Antananarivo households.

3.4 - The location of Antananarivo inhabitants land uses

We apply the model to explain the current situation of Antananarivo in terms of household location. The need for housing is a response to the population growth, knowing that in Antananarivo, a household includes about 4 to 7 persons and the annual growth rate of the population is 2, 8%. This increase in housing need is reflected in the densification and the urban sprawl. The individuals who cannot bear transport costs, have to stay in the city center, leading to a densification of the city. The households that can afford transportation can build on the periphery.

Preferably, the new constructions in Antananarivo follow small access roads, occupying more and more non-constructible plains by backfilling. The other possibility is to build on the edge of new roads and national roads, located quite far from the city center.

Our approach is to highlight the evolution of land use in Antananarivo, then, to predict future locations for Antananarivo households, based on projections of roads.

3.4.1 - Highlighting the evolution of land use in Antananarivo

If the area is saturated, there is very little evolution in terms of occupation. However, if there are still empty spaces, they are easily constructed and / or squatted. Thus, changes in Antananarivo land use strongly depends on the population density (Figure 1).

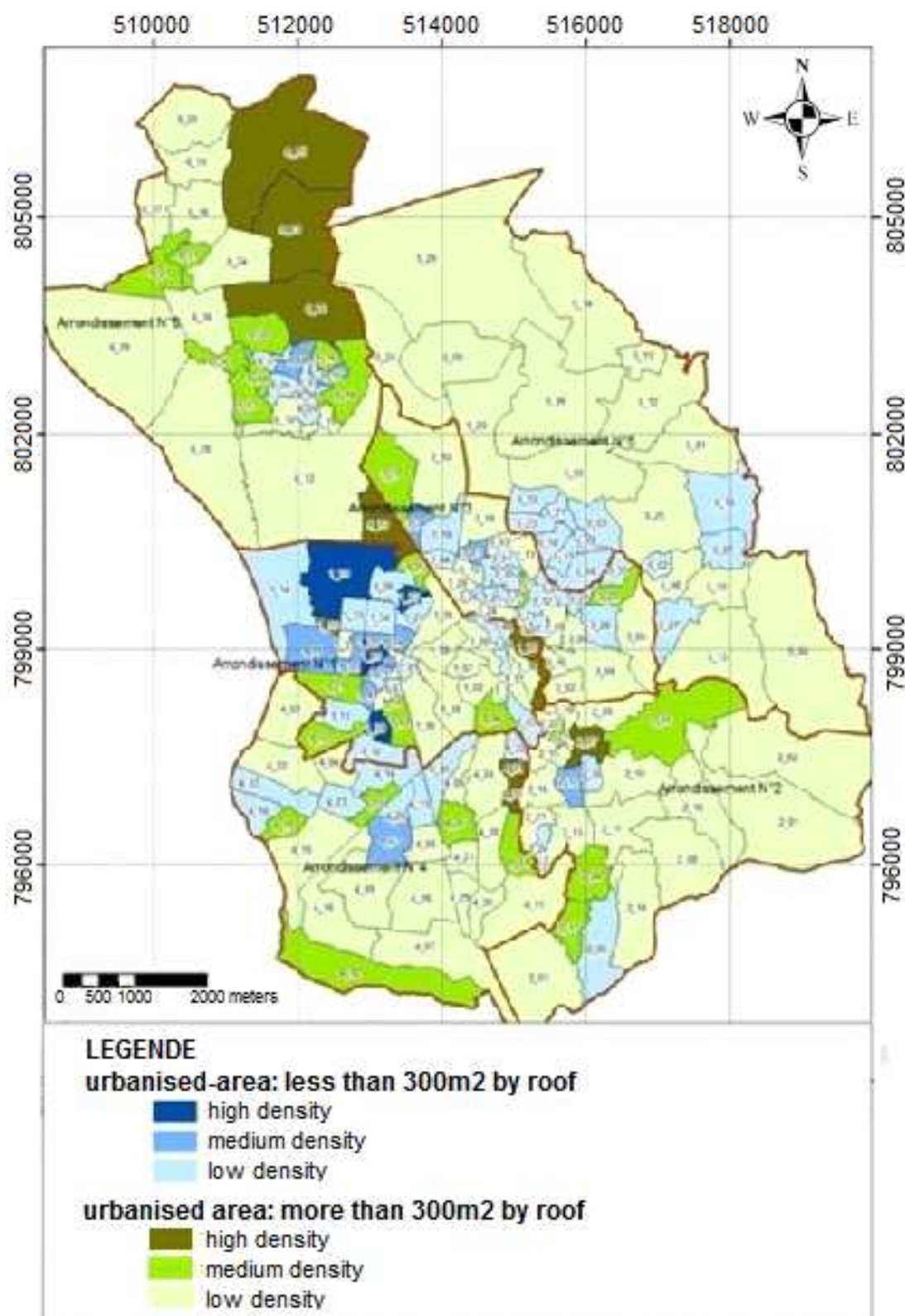


Figure 1 – The antananarivian density of the population in 2012

Here (Figure 2; Figure 3 ; Figure 4; Figure 5; Figure 6) is the comparison of soil occupations in Antananarivo:



Figure 2 – The neighbourhood of Andohatapenaka – medium density



Figure 3 – Mandrangombato Anosibe – medium density



Figure 4 – Neighbourhood of Ambatobe – low density



Figure 5 – Neighbourhood of Andohatapenaka – low density



Figure 6 – City of Ambodin'Isotry – High density

Interpretation of the evolution cards:

In these evolution cards, we note that the high density and saturated neighborhoods know little change in terms of land use. While low and medium density neighborhoods are changing: inconstructible and floodplains become more and more occupied.

The creation of new road is followed by occupation of its sides.

3.4.2 - Chronology of the land use in Antananarivo

Before 1945: occupation of the hill. The low lands were reserved to agriculture.

1950: The hills are occupied. Installation of Antananarivo inhabitants in Ambodin'Isotry neighborhood.

1960: Construction of the Cité of 67ha.

1970: gradual occupation of the plains. At that time, Antananarivo dwellers began to occupy the plains however they prefer the high areas.

1980: Antananarivo dwellers become numerous and difficult to control. The carelessness and the uncontrolled occupation of the plains and the slums begin.

1990: the rural exodus and slums were intensified, the sloppiness/scruffiness continues, the risk areas are occupied. Urban segregation takes place in downtown that becomes saturated. Slums become places of welcome of the rural exodus. The population begins to occupy the peripheral zones lying along the most important routes (roads, airport, ..). Wealthy households settle towards Ambohibao and Ivato. Sabotsy Namehana and Itaosy begin to be occupied. Tanjombato begins to accommodate industries.

2000: the urban segregation is increasing: the low land becomes "Low neighborhood» and even the middle-income households avoid it. Antananarivo dwellers are looking to occupy the city that become very saturated. The influence of capitalism gives rise to attraction of some areas compared to others for commercial use, at the beginning of the reconstruction of the city on itself, and the importance of the land added-value. The downtown land becomes inaccessible in terms of cost. Unserviced land and risks are built. The Ambohibao, Ivato, Sabotsy Namehana, Itaosy, Tanjombato, Andoharanofotsy and Mahazo axes are occupied until the access roads. The Western lifestyle become the tendency in Antananarivo.

2005: the establishment of the By-Pass, which is a ring road and much of the surrounding area, is not buildable, has highlighted Alasora, Ambohimanambola and Ambohimangakely axes. The lands on the outskirts of Boulevard de l'Europe and the ramp of Ankadimbahoaka are declared inconstructible. The reconstruction of the city on itself continues, the downtown lands are becoming more valuable, and the demand for land increases in the town center. Houses are illegally built even on land inferior to 100m².

2010-2016: nonexistence of new track construction. The city center is fully occupied. The axes of the outskirts of Antananarivo become increasingly saturated. The land offer decreases in, and however, the demand increases. Hence, the exponential increase of land prices and the construction on unconstructible areas of Antananarivo city.

3- FINDINGS

Land use and location of Antananarivo buildings 2023:

The land occupation depends on the development plan, the road manager plan and their strict application. The latter depends largely on the willingness and the great political decision of a strong government and a rule of law.

With the development of territorial marketing and commercial planning, the city center is becoming more and more interesting for trade. This phenomenon tends to increase the price of land in the city center and promotes the city's rebuilding on itself. The floodplains of the conurbation of Antananarivo, with a large attractive force, will be occupied by the highest bidders, that is to say investors [5].

Middle-income households and wealthy families will find their comforts and amenities in the periphery. Low-income households, constrained by transport costs tend to live near their work (free zone workers, industrial workers ...).

The Low land districts of Antananarivo continue to host the rural exodus. Here is the table (Table 1) showing the newly occupied areas, resulting from the comparison of orthophoto 1996, 2002, 2007 and 2016 (Figure 7):

Table 1 – The areas occupied in Antananarivo

Zones	1996 – 2006	2002-2006	2006 - 2016
CUA	155ha	80ha	35ha
Atsimondrano	55ha	40ha	130ha
Avaradrano	20ha	15ha	80ha
Total	230ha	135ha	245ha

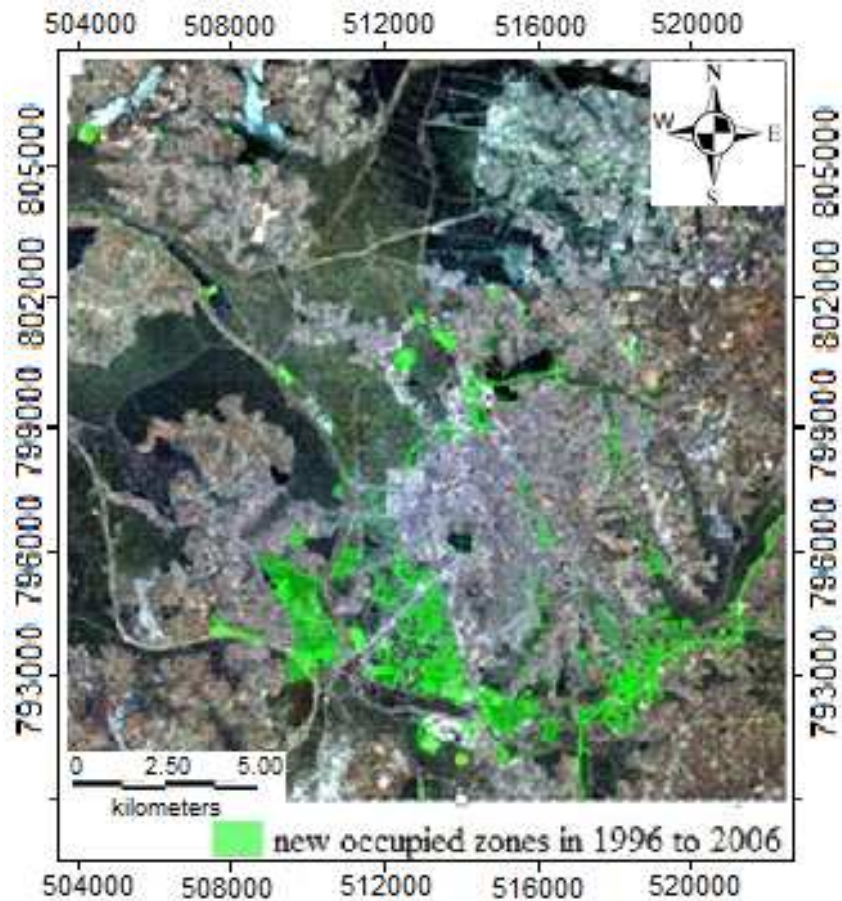


Figure 7 – the occupied zones in Antananarivo in 1996 to 2006

According to this table, the new downtown occupations (CUA) decreases from year to year because it is saturated. The new occupations of Atsimondrano and Avaradrano are increasing year by year because there are still some vacant land, even if they are sometimes unsuitable for construction. According to the linear regression, taking 1996 as the base year, the following table shows the area of the newly built areas from 2018 to 2023 (table 2):

Table 2 - the area of the newly built areas from 2018 to 2023

Zones	CUA	Avaradrano	Atsimondrano	Total
Occupied space	11ha	146ha	166ha	331ha

4- DISCUSSION

In Antananarivo, the economy is dual: the "modern" sector that creates few jobs, while the "informal" sector that creates many low productive jobs. We must take care of the "informal sector" for what it is: a *parallel economy of pre-industrial type*, which productivity depends on the physical environment that is

provided (fixed capital) and the tax is imposed and not as illegal activities to "formalize". *However, the basic needs of the informal population cannot be met by informal activities - starting with housing. Seeking to produce normative housing for the poor is an aberration.*

5- CONCLUSION

Land is an asset which offers remains unchangeable or even decreases and demand increases with the population. Any town becomes increasingly dense. Business and service sector tend to occupy the city center, where attractiveness exist for the case of a monocentric city like Antananarivo.

This city becomes increasingly saturated. This phenomenon leads to the implementation of the new construction on non occupied areas yet, which are inconstructible floodplains.

To secure investment and population, the state should realize Malagasy hydraulic solutions and urbanization conditions of the plains that have strong economic and urban potential.

BIBLIOGRAPHICAL REFERENCES

- [1] AEE (2006), The urban sprawl in Europe – an ignored environmental challenge (publied in 4/11/2006, consulted in 2016-03-22)
- [2] Guilluy Christophe, Noyé Christophe, Atlas des nouvelles fractures sociales en France, éd. Autrement, 2006.
- [3] Éric Hamelin et Olivier Razemon, The bitumen temptation, where will end the urban sprawl? éd. Rue de l'échiquier, 2012. (ISBN 2917770325).
- [4] « Les déterminants économiques de l'étalement urbain », Piron Olivier, in Études foncières, no 129, septembre-octobre 2007.
- [5] « Urban sprawl and climate changes”, Réseau Action Climat-France, juillet 2011.

LITERATURE REVIEW

- « Should we fight urban sprawl ? », Charmes Eric, with Stéphane Fuzesséry and Nathalie Roseau, Lavedesidees.fr, juin 2010.
- “The urban sprawl in developed countries. Disurbanisation or post-urbanisation?”. Ferrier Jean-Paul, Guieysse Jean-Albert, Rebour Thierry, Saarbrücken : Éditions Universitaires Européennes Editions, 2010.

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