DEMONSTRATING ANTANANARIVO CITY DYSFUNCTION IN TERMS OF DENSITY AND URBAN SPRAWL

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Abstract

Initially, the goal of this research is to model the density of Antananarivo city in terms of population, as well as to assess its urban sprawl. By applying the formulas of modeling, research has given its result via linear regression. However, the value of the determination coefficient is very low, 0.38, which shows a lack of performance in modeling, and expresses Antananarivo city dysfunction in terms of urban density of population. The latter demonstrates accessibility dysfunction which measures urban sprawl, which no longer needs to be calculated.

Keywords: accessibility, Antananarivo, area density, modeling, urban sprawl.

1- INTRODUCTION

Antananarivo conurbation suffers from a non-controlled sprawl which wastes its land. The goal is to be documented on the factors of urban sprawl which is ubiquitous and continuing, owing to the use of automobile, the development of transport and to household preferences in terms of life quality.

The purpose of this research is to calculate the density function of Antananarivo population in an exponential form; then the measure of accessibility, and finally the extent of urban sprawl by the gravitational method.

Once calculated, these functions will evaluate Antananarivo future land occupations. However, if the determination coefficient is significantly higher or lower than 1, then the model cannot be applied on Antananarivo.

2- METHODS

3.1 - A generality on urban sprawl

It is noted that the expansion of the city of Antananarivo follows an urban sprawl that is difficult to control. It is evident that urban sprawl is very much space consuming. Urban sprawl shows that urban space is under-utilized, and even wasted.

There is a strong correlation between decentralization of population (population percentage in the area compared with the conurbation) and that of employment (employment percentage in the area in relation to the conurbation). The areas differ widely in terms of job density. In the case of Antananarivo, outside of the city center, job centers are less dense.

The main factors of urban sprawl are:

- Commuting costs:
- Lower commuting costs promote urban sprawl ,
- There is a correlation between the cost of using private cars and urban sprawl. This correlation is determined by a logarithmic function regression
- Growing demand for space: Growing income entails growing demand in housing and can largely explain the periurbanization of Antananarivo (Ivato Andoharanofotsy ...). Thus, income growth and car possession are also explanations of the sprawl.
- Escape from social issues in town centers: as sprawl is very significant regardless of the poverty level downtown, escape from social issues encourages sprawl but is not the primary cause thereof.

3.2 - Models of density, of accessibility as an index of urban sprawl

3.2.1- Estimating the density function

Density functions, or dispersion, link the population or employment density at each point of an urban area and the distance to the center.

The functional form used is the negative exponential [5]:

$$, D(x) = D_0 \, e^{-\gamma x}$$

- D(x): residential density
- D_0 :density at the center of the city,
- x : distance to the center
- γ: the density gradient, that is to say the rate of change in the density according to the distance to the center.

The function D(x) will be sought from the linear regression for the case of Antananarivo.

As urban sprawl is generally regarded as an increase in city size accompanied by an increase in densities in the periphery (or their decrease in the center), the interpretation of this function is simple: urban sprawl corresponds to a decrease in the parameter over time, with or without reduction in the parameterD_0.

The counterpart of the simplicity in this functional form of the density is the observed differences from the urban setting. Hence the search for several functions D(x) defined by piece in order to obtain more accurate results.

3.2.2 - Accessibility as a measure of remoteness and the gravity model

The simplest approach to be implemented for measuring accessibility consists in considering it as the measure of remoteness to considered amenities.

Remoteness from amenities is defined as the average distance from the commune.
Measuring accessibility according to a gravity model relies on the definition of gravity models in the physical sense of the term. Such method measures a potential of opportunities that can be achieved in the urban area as a whole, weighted by a resistance function linked to the displacement between a home areai and a destination area j. Such resistance function reflects the effort required by individuals in commuting to reach an activity they need.

The gravity model is in the following form [3]:

$$A_i = \sum_j O_j \times d_{ij}^{-\alpha}$$

Avec : i as the individual (or individual group) location area;
j as the destination area of the commuting completed by an individual from i ;
O_j as the volume of opportunities located in the destination area j;
d_{ij} as the distance of the commuting by the individual between the origin i and the destination j;
α as a coefficient representing the resistance of commuting as a function of distances.

Accessibility A_i measures the O opportunities as a whole for all j areas of the urban space that an individual located in the zone i can potentially reach by commuting over the distance d_{ij}. The functions A_i will be obtained from linear regressions.
The gravity model is the most used for measuring the spatial mismatch of the location of inhabitants in relation to the location of amenities.
First, the results of the gravity model are highly dependent on the form of the resistance function. The measure of accessibility through the gravity model is strongly influenced by the commuting of individuals located in i whose destination is that same area i.
In this modeling, one must take into account community-based jobs, which can have an important role in the labor market. On the other hand, the resistance function reflects the effort felt by individuals commuting from an origin to a destination location, taking into account the commuting distance and / or time, or costs. However, the effort felt by an individual may come from factors exogenous from their social group, their geographical location to the location of activities, or specific to their subjectivity.

3.2.3 - Accessibility as a measure of urban sprawl

After calculating density functions D(x) and accessibilities Ai, we will build the indicators of urban sprawl from the results [2].
We will then construct the map for density, accessibility and urban sprawl of Antananarivo.

3- FINDINGS

Applying the model on the current situation of Antananarivo.

We apply the density and accessibility models to explain the current situation of Antananarivo in terms of urban sprawl. We will seek the coefficients of modeling formulas through the linear regression method.

Calculating the density function

The following table (table 1) and map (Figure 1) provides the number of Antananarivo population.

Table 1 – The population 2010 in Antananarivo

Commune	Population 2010 (monograph)
Bemasoandro	44,209
Ambohidrapeto	24,733
Ambohitrimanjaka	32,644
Itaosy	17,925
Ambavahaditokana	32,944
Andranonahoatra	49,395
Tanjombato	46,831
Talatamaty	44,082
Antehiroka	44,463
Ivato aéroport	22,906
IvatoFiraisana	22,686
Ampitatafika	55,512
Anosizato	19,546
Soavina/Soalandy	26,168
Andoharanofotsy	41,861
Ankaraobato	39,845
Alasora	13,482
Ambohimangakely	79,158
SabotsyNamehana	59,362
Ankadikely	85,610
1st Arrondissement	28,2694
2nd Arrondissement	21,4583
3rd Arrondissement	14,6178
4th Arrondissement	21,2411
5th Arrondissement	34,2091
6th Arrondissement	13,2854
Total	2 035 698

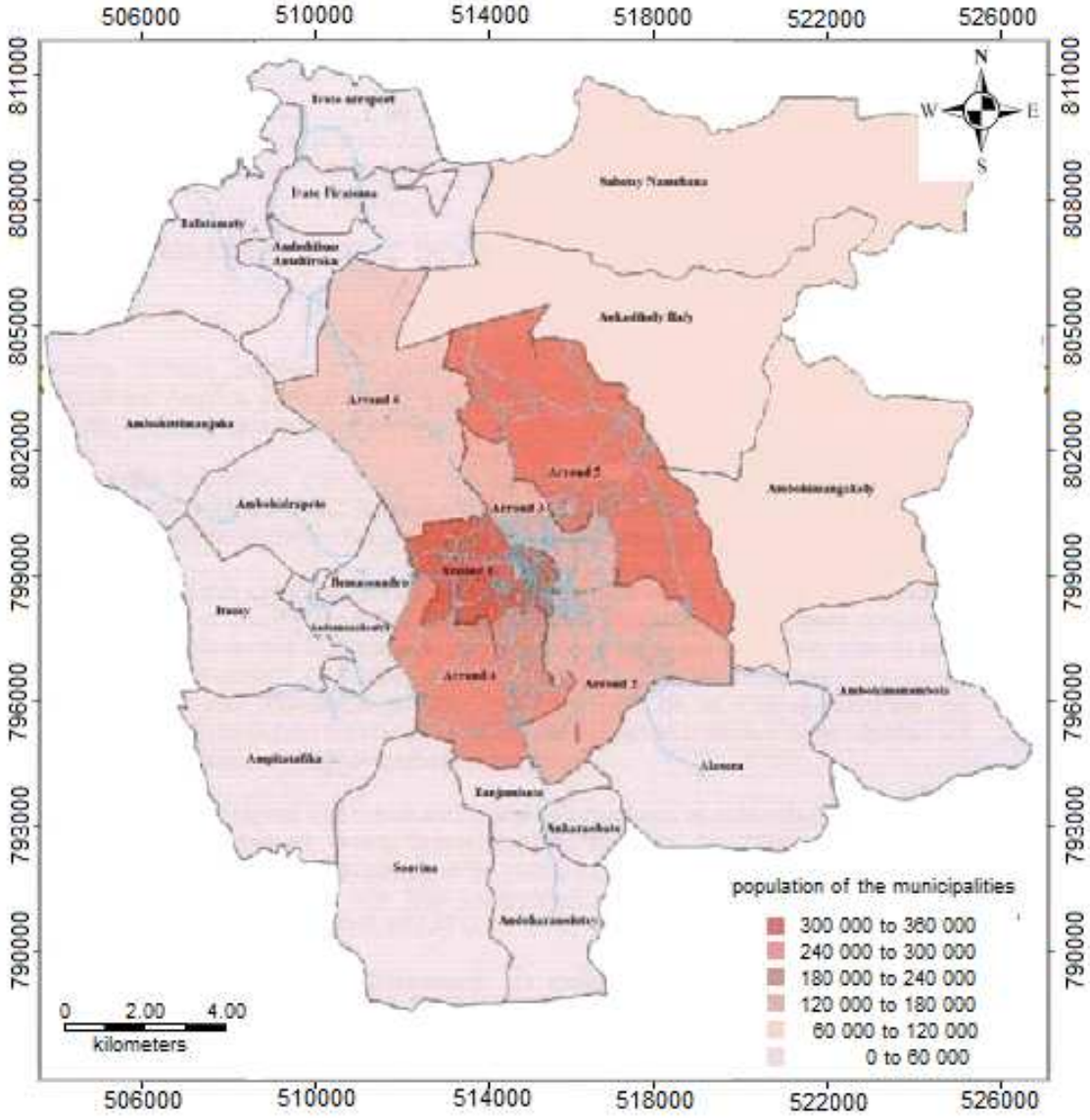

Figure 1 – The population 2010 in Antananarivo

We can notice that the population number decreases with distance to the center, and the same applies for the density.

By making the calculation, the best regression obtained from those that have been conducted is [5]:

$D(x) = D_0 \, e^{-\gamma x}$,

- $D(x)$: residential density
- D_0 density at the center of the city,
- x : distance to the center
- γ: the *density gradient*

$D(x) = 436 \, e^{-2.7x}$ with a determination coefficient $R^2 = 0.38$.

The low value of the determination coefficient which is 0.38 shows a lack of performance in modeling. Such lack of performance reflects the dysfunction in Antananarivo city in terms of density. The latter demonstrates accessibility dysfunction which measures urban sprawl, which no longer needs to be calculated.

4- DISCUSSION

- Data collection: to be as accurate as possible, this study requires the displacement of manual counts and socio-economic surveys that have relatively high costs.
- Further research should be made in order to be able to approach, as much as possible to reality and become a very effective tool in decision-making;
- The primary cause of irregular and precarious neighborhoods before the poverty is the exclusion by the imposed standards, the refusal of gradual improvement. The whole city is scalable. "Rome was not built in a day."

5- CONCLUSION

This research has shown that the function density of Antananarivo population, its measure of accessibility, and its measure of urban sprawl by gravitational method, cannot be calculated.

This demonstrates Antananarivo city dysfunction.

The only solution for this agglomeration is to design strict and applicable urban planning strategies. It should be noted that such solution requires a political will from the leaders and a strong state and a rule of law to be imposed on third parties.

The following question thus arises: "Is it possible to design decision support tools in urban planning that is effective for our leaders?".

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