SIMULATION OF ANTANANARIVO URBAN TRAFFIC

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Abstract

The agglomeration of Antananarivo is the first administrative, industrial and commercial area of Madagascar. It plays an important role in the economic development of Madagascar. Furthermore, this development is largely dependent on transport. The purpose of this study is to model the travel speed through the existing road network, while taking into account the perturbations.
During peak hours, the average speed of the Antananarivo traffic is 4km/h. This traffic can be improved based on future road construction and by improving the organization of our trip.

Keywords: Antananarivo, simulation, speed, traffic

1- INTRODUCTION

In the capital of Madagascar, road transport has a preponderant role in economic life. In addition to the transport of passengers, the transport of goods is usually done by the various roads, plays a starting and arrival center role of various products of the major ports of the coastal cities.

The car is the main means of transport for a large number of Antananarivo dwellers. However, most of the roads are in poor condition, and there are congestions in the city, especially during peak hours. Apart from the loss of time, is the economy not menaced by this problem of transportation?

In considering the agglomeration road network and the number of vehicles in different areas, would we be able to assess the speed of traffic? The goal would be to quantify the speed of displacement through the existing road network while taking into account the disturbances.

In this study, the various calculations and estimation correspond to the peak hours. To estimate the traffic speed, we should consider:

- the plan of the conurbation
- The emission and attraction trip zones
- The way/ road interconnections
- The district plan

2- METHODS

It is about the simulation of Antananarivo urban traffic.

3.1 – Description of the model

This model is based on [8]:

- A mathematical representation of the transport supply (road network).
- The demand (number of trips within the agglomeration area).
- Allocation of these movements on the road network to determine the agglomeration traffic flows.

The goal is to determine the traffic during rush hour (the worst case) in order to determine more rationally the necessary projects for Antananarivo.

Hence, we have chosen to simulate urban traffic between 7 and 9 am since school children, college students and high school students start between 7am and 8am, and most offices begin between 8 and 9am. Moreover, according to the count in the Louis Berger study in 2004, it is during the peak hours of the morning, from 7 to 9am that most vehicles are circulating.

3.2 - The transport supply/offer representation

3.2.1- The network arcs

The following map shows the network arcs of Antananarivo (Figure 1).

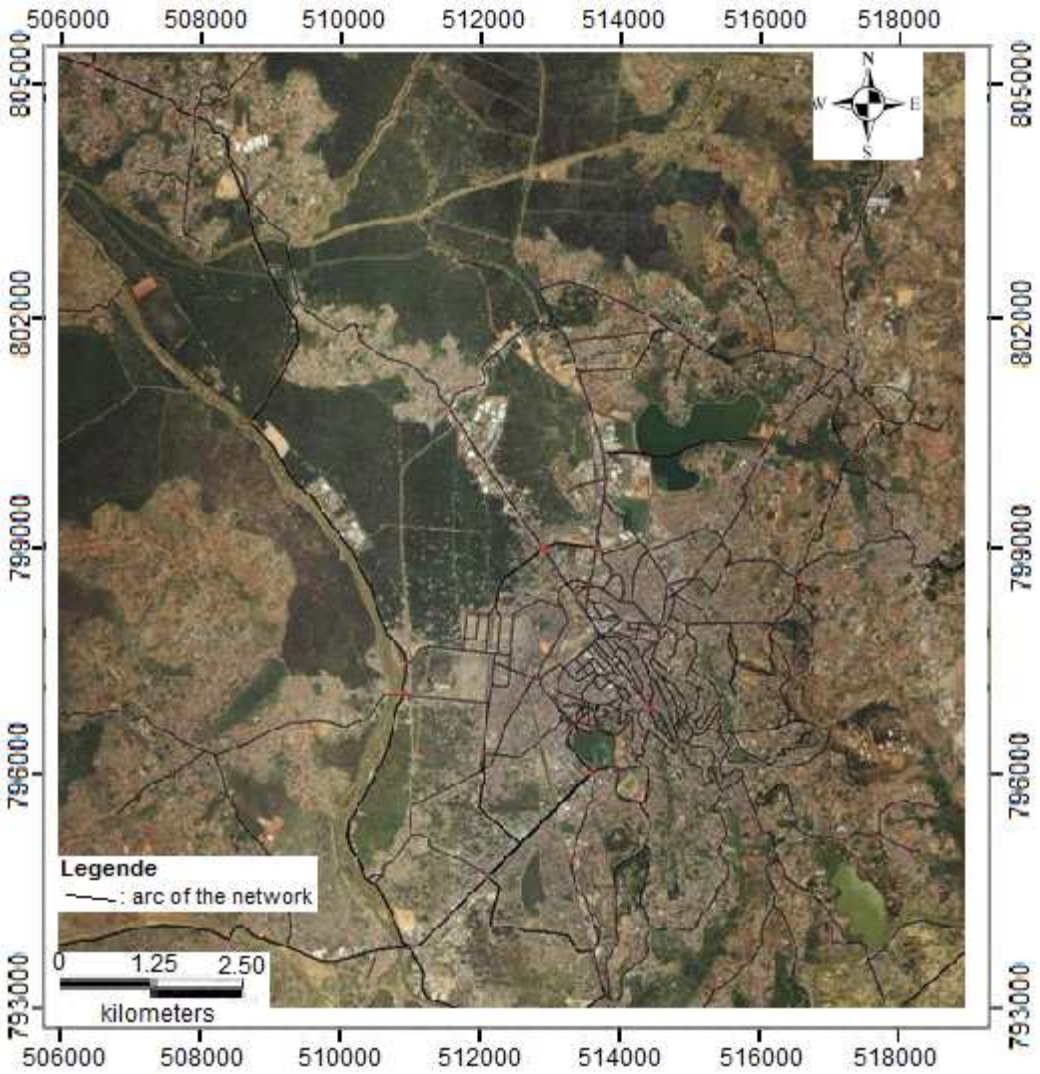

Figure 1 - network arcs of Antananarivo

3.2.2- The necessary databases for the modeling

An arc is a section of track between 2 nodes (crossroad, junction). The databases associated with each arc are:

- The length of the arc
- The number of traffic direction
- The number of lanes in each direction
- The origin node
- The end node
- The numbers of the Taxi-be taking the arc in each direction load speed and track capacity

3.3 - The transportation demand: the number of displacement in Antananarivo

3.3.1- Travel estimate issued by area

The number of issued travel is closely tied to the number of the population of the area.
Table 1 is an excerpt of a displacement number table issued by the boroughs and towns between 7 and 9 am (the peak times studied) [8]:

Table 1 – The emission of displacement in Antananarivo

Commune	Population 2010	Emission's percentage	Movement's number
Bemasoandro	44 209	11.52	5 093
Ambohidrapeto	24 733	5.78	1 430
Ambohitrimanjaka	32 644	6.67	2 177
Itaosy	17 925	11.00	1 972
1er Arrondissement	282 694	19.4	54 842
2eme Arrondissement	214 583	17.00	36 479
3eme Arrondissement	145 178	17.61	25 742
4eme Arrondissement	212 411	13.06	27 740
5eme Arrondissement	342 091	18.90	64 655
6eme Arrondissement	132 854	10.49	13 936

(Calculated from the socio-professional class and adjusted with field surveys).

3.3.2- Estimated trips attracted by area

The number of attracted displacement is related to the number of:

- Economic and / or industrial activities of the zone
- Commercial activities that will attract barges (markets, shopping malls, stores)
- Schools that will attract students

Here (Table 2) is an excerpt of the table with the number of attraction in the boroughs and towns between 7 and 9 am (peak time studied):

Table 2 – The attracted displacement in Antananarivo

Commune	Population 2010	Attracion's percentage	Attraction's number
Bemasoandro	44 209	7.78	5 093
Ambohidrapeto	24 733	11.89	2 941
1er Arrondissement	282 694	25.25	71 380
2eme Arrondissement	214 583	17.16	36 822
3eme Arrondissement	145 178	33.15	48 458
4eme Arrondissement	212 411	15.11	32 095

5eme Arrondissement	342 091	9.26	31 677
6eme Arrondissement	132 854	8.76	11 638

3.3.3- Distribution of travel

After Louis Berger study in 2004, here (Table 3) is the breakdown (in percent) of displacement of the agglomeration [11]:

Table3 – The breakdown of displacement in Antananarivo

Origin / Destination	Home	work	studies	shoppings	others	Total
Home	0.09	13.99	21.47	4.13	7.85	47.48
work	13.14	0.17	0.01	0.28	1.22	14.82
studies	21.51	0.02	0.07	0.07	0.46	22.14
shoppings	4.29	0.07	0.02	0.14	0.33	4.86
others	7.42	1.06	0.36	0.42	1.43	10.70
Total	46.45	15.27	21.94	5.05	11.29	100

3.3.4- Distribution of travel

This is the number of trips between each pair of zones. It has the shape of a gravity model and is expressed by the following relationship [7]:

$$D_{ij} = E_i \times A_j \times f(d_{ij})$$

D_{ij} is the number of deplacements between zones "i" and "j"

E_i is the issuing of the zone "i"

A_j is the attraction of the zone "j"

$f(d_{ij})$ $a \times b^{distance}$ with $a>0$ et $0<b<1$

Using regression methode, we find:

$$D_{ij} \equiv E_i \times A_j \times 25134 \times \left(\frac{3}{4}\right)^{d_{ij}}$$

3.3.5 - Distribution of travel modes

According to Pudi 2004, the following table (Table 4) is the distribution of travel modes in Antananarivo:

Table 4 – The distribution of the mode of transport in Antananarivo

Mode of transport	percentage

Two wheels	6.50
Utility vehicles	22.90
Public transport	66.66
Taxis	2.20
Others	1.90
Total	100

3.4- Allocation of travel on the network

This is the Determination of the rate for each arc [5]:

$$\text{speed} = 60\ \text{Coef}_{\text{speed}} \left(\frac{\text{arc length}}{\text{no load speed}}\right)\left(1+\left(\frac{\text{load capacity}}{\text{road capacity} \times \text{number of lanes}}\right)^4\right)$$

Avec: speed (km/h)
$\text{Coef}_{\text{speed}}$ (no unit)
arc length (km)
no load speed (km/h)
load capacity (veh/h)
road capacity (veh/h)

3- FINDINGS

The Figure 2 shows the result of modeling:

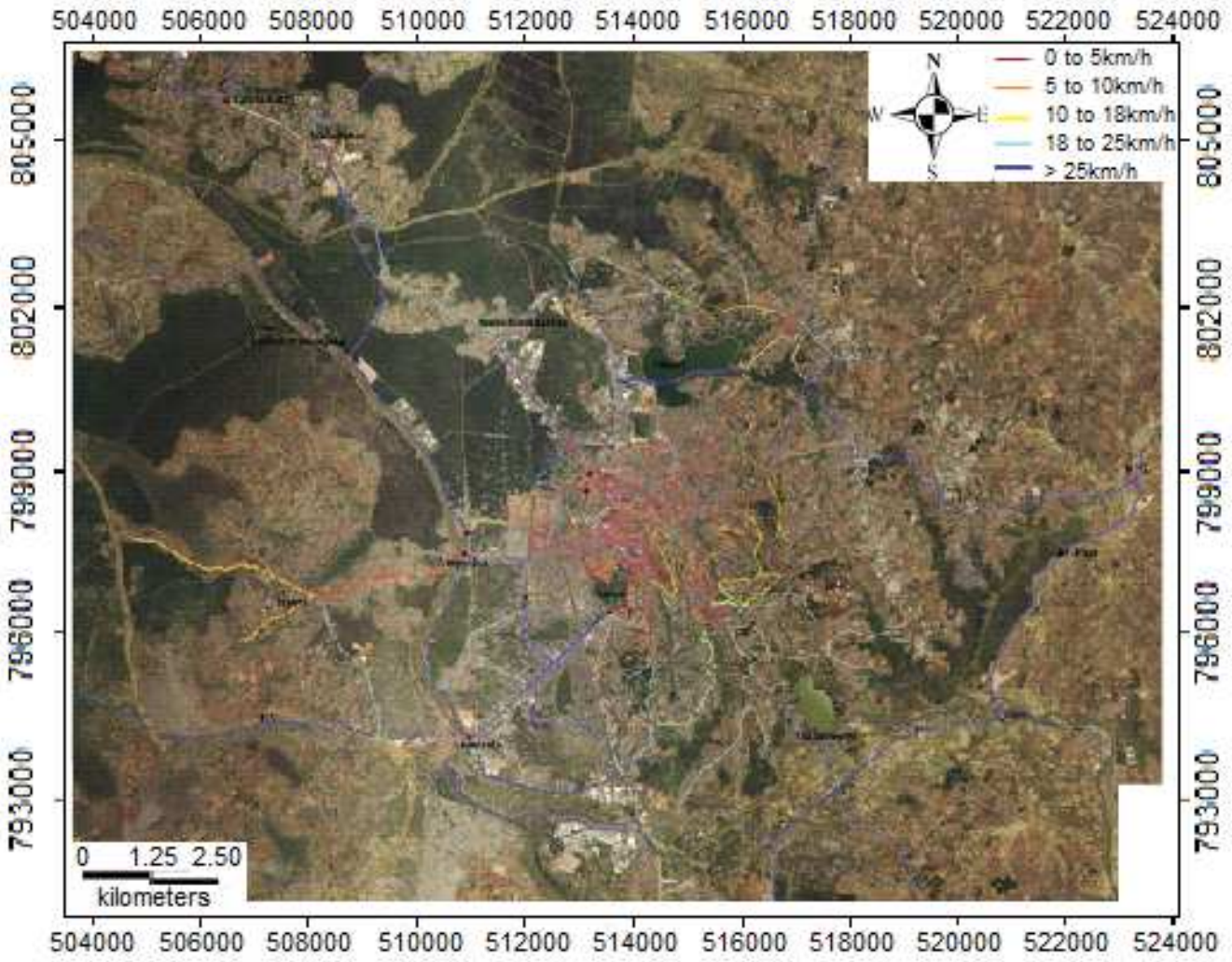

Figure 2 – The speed in each arc in Antananarivo

4.1- Estimated average speeds during time intervals

The traffic is studied during the following hours: [9h, 11h]; [11h, 13h]; [13h, 15h]; [15h-17h]. The average speed evaluation method is the same as the speed evaluation method during rush hour from 7am to 9am.

4.1.1- Travel allotment

According by Louis Berger study in 2004, here (Table 3) is the breakdown (in percent) of the agglomeration displacement [11]:

Table3 – The breakdown of displacement in Antananarivo

Origin / Destination	Home	work	studies	shoppings	others	Total
Home	0.09	13.99	21.47	4.13	7.85	47.48
work	13.14	0.17	0.01	0.28	1.22	14.82
studies	21.51	0.02	0.07	0.07	0.46	22.14
shoppings	4.29	0.07	0.02	0.14	0.33	4.86
others	7.42	1.06	0.36	0.42	1.43	10.70
Total	46.45	15.27	21.94	5.05	11.29	100

The calculation results will not be presented on map. However, the CUA and the outskirts traffic of Antananarivo average speed is written during the time intervals (Table 5, Table 6):

Table 5 - The average speed of traffic in the CUA

Times	[7h,9h]	[9h,11h]	[11h,13h]	[13h,15h]	[15h-17h]
Speed	4,6km/h	13,3km/h	6,2km/h	15,6km/h	11,4km/h

Table 6 - The average speed of traffic in the outskirts of Antananarivo

Times	[7h,9h]	[9h,11h]	[11h,13h]	[13h,15h]	[15h-17h]
Speed	12,5km/h	24,7km/h	16,3km/h	29,2km/h	21,1km/h

4.2- Necessary pathway projects and traffic simulation

The scenarios of pathway projects below are studied from the worst case: the rush hour from 7 am-9am.

4.2.1- The track project taken into account in modeling

- A fast-track road projects linking Iavoloha to the airport Ivato
- A continuity of Masay project:
    - A link road between the RN4 and the new route of the Digue;
    - A link road between RN3 and RN2
- A road between the RN4 and RN7, which is parallel to the dike road.
- Doubling the bridge between the RN4 and Route des Hydrocarbures
- A creation of a bypass road between NR2 and NR3
- A creation of a bypass road between RN3 and Ivato airport
- A creation of a bypass road between RN1 and the RN7

- A creation of a highway between Route des Hydrocarbures and Ivato airport

4.2.2- Traffic Simulation

The Figure 3 shows the Traffic on the project road network:

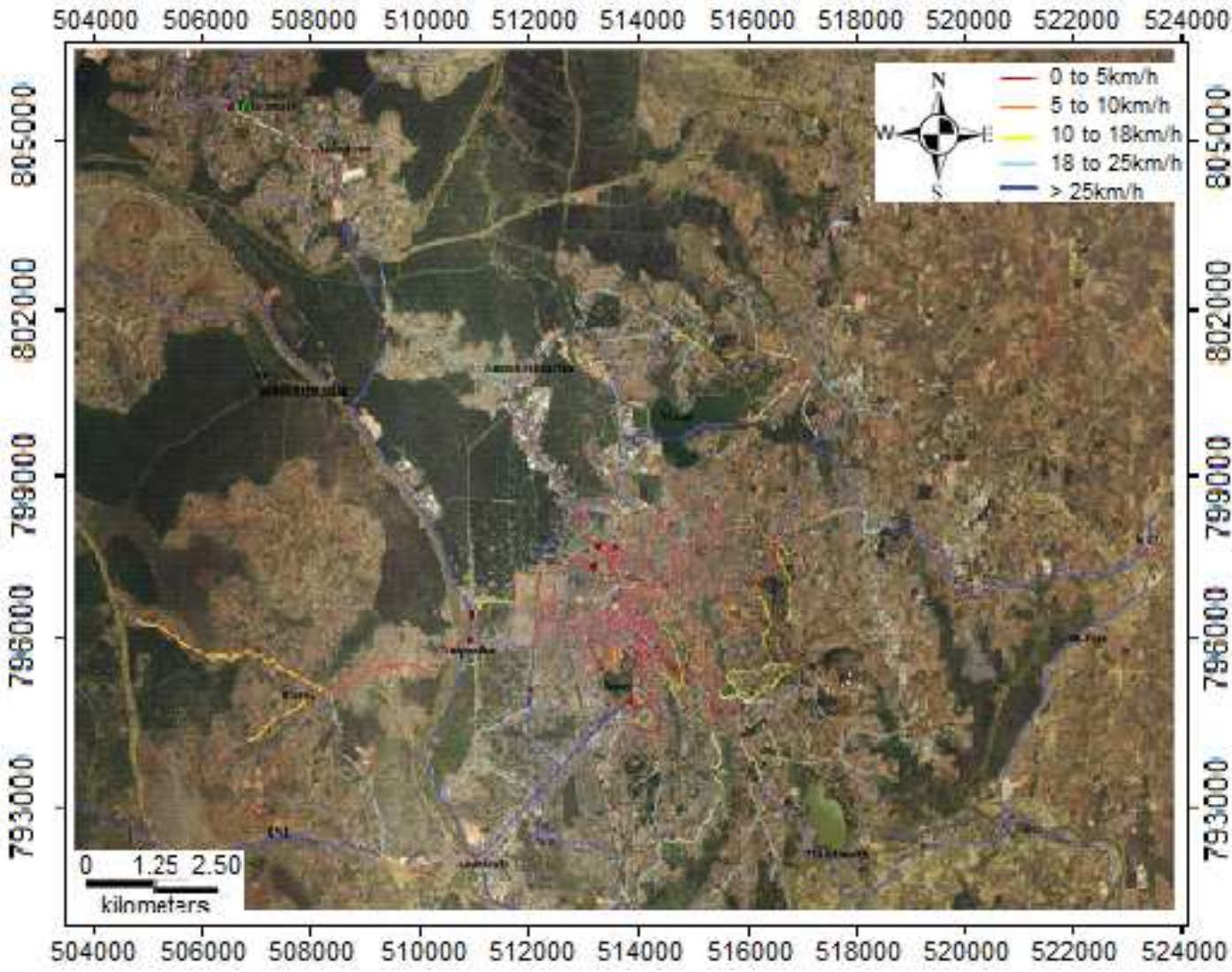

Figure 3 - the Traffic on the project road network

4- DISCUSSIONS

- The limit of modeling: illegal parking, illegal vendors ... who obstruct spontaneously the lanes and cannot considered in this modeling.
- Data collection: to be as accurate as possible, this study requires manual counts of displacement and socio-economic surveys that is relatively expensive.

- This study constitutes an introduction to research. It can and must be deepened in order to approach, as much as possible, the reality and to become a very effective tool in decision making. For example, in order to better control the problem of the crossroad conflict: it is necessary to study the theory of game conflict and the drivers 'behavior.

5- CONCLUSION

The congestion in the agglomeration of Antananarivo is intensifying by the day. The habits and behaviors of Antananarivo inhabitants worsen this situation. The various studies of this publication determine the moving speeds in different areas of Antananarivo.

This bottling problem becomes a blocking factor in the development of the City of Thousands. In terms of comparative advantages, the annual cost of lost opportunity in the traffic jam is significantly higher than the cost of the infrastructure congestion investment.

This raises the question: "How does one assess the economic loss of Antananarivo in traffic congestion?"

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