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Changes in daily mobility patterns in Dakar (Senegal)

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Abstract

In sub-Saharan Africa, as in other regions of the South, rapid demographic and urban growth has deeply transformed the spatial organization of capitals and other large cities. Their central districts are more and more densely populated and urban areas are spreading out even further due to the expansion of peripheral settlements which are frequently unplanned and short of facilities. Rapid urbanization, insufficient service provision, the small number of jobs in the outskirts and their concentration in the central districts have increased daily travel needs. Our objective is to study changes in daily mobility in Dakar, the capital city of Senegal, which had 3 million inhabitants in 2013. In less than fifteen years the city's population has increased by one million and important changes in public transport provision have taken place since the year 2000, such as the creation of the new state-owned public transport enterprise and the reorganization of a number of small public transport operators to create a formal structure, under the name of AFTU. Nevertheless, many other operations remain outside the formalization process. This study is supported by the analysis of data collected in two household travel surveys. These were conducted in 2000 (2,301 households) and 2015 (3,176 households) with similar methodologies, in particular the collection of details about respondents' travel the day before the interview. Even though the average number of trips for the population aged 14 years and older remained much the same between 2000 and 2015, many changes have taken place. While the proportion of the "immobile" residents of the region of Dakar on an average weekday has increased slightly, the proportion of those who travel exclusively on foot has declined substantially. Conversely, there are many more public transport users, and this group is almost as large as the captive pedestrians. The precise nature of these changes varies according to gender, age, income and place of residence. The AFTU buses, which did not exist in 2000, are currently the most widely used mode of public transport, but the role of the small-scale transport operators is still significant. In a context of increasing and complex mobility needs it is necessary to rely on operators in all market segments and on a real transport network.

Keywords: daily mobility; modal share; walking; motorisation rate; public transport provision; urban growth; household travel survey; Dakar.

1. Introduction

In Africa, and particularly in sub-Saharan Africa, as in other regions of the South, rapid urban growth has deeply transformed the spatial organisation of capitals and other major cities. The peripheral zones where the majority of new housing is located are unplanned, short of facilities (Myers, 2005; Rakodi, 2005), and frequently inappropriate for residents due to recurrent landslides and floods (Cissé and Seye, 2015). In a context of prevailing poverty, the response capacity of public stakeholders is very limited and they cannot meet the population's social needs. The public sector is thus barely involved in the provision of housing which depends essentially on private initiatives. Neither the State nor the local authorities are able to provide local facilities and services such as schools, dispensaries, water and sanitation. They have difficulties maintaining the roads and regulating public transport which is provided by informal and/or small-scale operators, who often prefer to operate in districts with good accessibility. In addition, transport measures are often implemented in a patchy manner with no consideration of the interrelationships between spatial planning and transport (Dimitriou and Gakenheimer, 2011).

These changes are taking place in a context of marked disparities of access to motorized modes of transport, which is a major feature of the cities of the South (Vasconcellos, 2014; Diaz Olvera et al., 2015). The difficulty of travel is heightened by the increase in distances, the poor quality of service provided by public transport and the fact that fares are very high for low-income households (Nkurunziza, 2013; Venter, 2011), particularly in zones with low accessibility (Diaz Olvera et al., 2015). In spite of the difficulties involved in day-to-day travel, the inhabitants of large African cities do travel, but differently according to their means and their social position, income, gender, age, place of residence, etc. In particular, it is necessary for the poor to be able to move and reach the places where resources are

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available, whether for work or job-seeking, education, household provision, administrative formalities or to maintain social networks (Bryceson et al., 2003; Diaz Olvera et al., 2013 ; Langevang and Gough, 2009; Lucas, 2011; Mandel, 2004; Salon and Gulyani, 2010). In this context, the objective of this paper is to study how daily mobility is changing in a large sub-Saharan African city. The example we shall consider is Dakar, the capital of Senegal, which is experiencing marked population growth and where the transport sector has undergone major changes in recent years. Although surveys that cover mobility in African cities are scarce, in the case of Dakar we have the opportunity to undertake quantitative analyses of mobility across time. The reason for this is that, in the framework of the Program for the Improvement of Urban Mobility (*Programme d'Amélioration de la Mobilité Urbaine*, PAMU) and the Support Project for Transport and Urban Mobility (*Projet d'Appui au Transport et à la Mobilité Urbaine*, PATMUR), two household travel surveys were conducted in 2000 and 2015 in order to gain a better understanding of trips and mobility.

This paper is organized as follows. First, we shall describe the main urban changes that have taken place in Dakar (2) and then present public transport provision and how this has been modified (3) followed by a description of the data we used (4). The most significant changes in mobility that have taken place during the last 15 years are then presented using descriptive statistical analysis (5). We shall then focus on the changes in the distribution of the mobility profiles of individuals according to their use of personal transport modes (6) and public transport modes (7). Finally, we shall summarize the main results and highlight the need for public transport to be reorganized (8).

2. Urban growth under geographical constraints

The metropolitan area of Dakar consists of four departments which together make up the region of Dakar: Dakar, Guédiawaye, Pikine and Rufisque (Fig. 1), where 3.05 million inhabitants lived in 2013, more than one-fifth of the Senegalese population. For the sake of simplicity we will hereafter refer to the department of Dakar as “Dakar” and the region of Dakar as “the region”.

The population of the region increased rapidly during the second half of the 20th century: from only 132,000 inhabitants in 1945 to 375,000 in 1960, 1.3 million in 1988, 1.8 million in 1995 and 2.2 million in 2002 (Sakho, 2002; Syscom, 2001; ANSD, 2014). However, the average annual growth rate decreased markedly at the beginning of the 21st century, 3% in 2000-2013 compared with 4.2% in 1988-2000.

The majority of the region’s inhabitants live in urban areas and the average population density is 5,735 inhabitants/km² (ANSD, 2014). The percentage of the population living in Dakar and Guédiawaye fell slightly in 2002-2013 while it increased in Pikine and Rufisque (Table 1). Still, almost three-quarters of the population are concentrated in Dakar and Pikine while Rufisque contains most of the rural areas and land reserves.

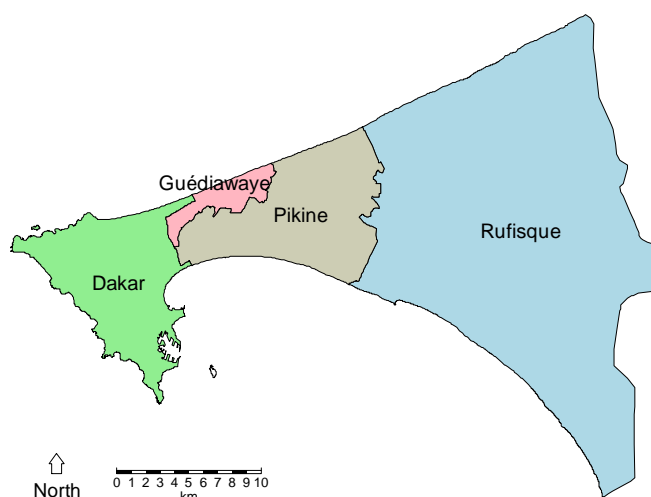


Fig. 1. The region of Dakar.

The geography of the Cap Vert peninsula, where the region of Dakar is located, has a crucial influence on the direction of urbanization and the configuration of the road network, which can only be extended from west to east (Sakho, 2014). A great number of administrative and economic activities and services are located in the peninsula's southern extremity. In 2000, 60% of the region's working population had their workplace in Dakar and 15 years later this proportion still remains high, 58%. In the case of Pikine, the proportion increased slightly, from 23% to 26%.

Table 1. Distribution of the population of the Region of Dakar in 2002 and 2013 (%).

	2002	2013
Dakar	40.3	36.5
Guediawaye	12.1	10.5
Pikine	35.2	37.3
Rufisque	12.3	15.6
Region of Dakar (million inhabitants)	2.19	3.05

Source: ANSD, 2014, population censuses. Calculations by the authors.

As in other cities in developing countries, urbanization rapidly spread to unplanned areas which were far from the centre and often insuitable. Urban settlements, both formal and informal, spread out progressively since the 1950's in Pikine, since the 1970's in Guediawaye, and the 1980's in Rufisque (Sakho, 2002). Because of the geographical characteristics of the site, the dissociation between home- and workplaces is particularly marked and the Dakar metropolitan area has the features of a "partitioned city" (Lombard et al., 2006:199) where "the divorce between functional centrality and geographical centrality constitutes one of the main constraints of mobility" (Sakho, 2002). Some evidence of centrality is also observed in Pikine, but it seems to take the form of centrality "by default", due to the fact that the cost of daily access to Dakar's city centre is too high for many inhabitants from the suburbs (Bertoncello, 2008).

Commuting is concentrated on just a few roads which are also used for internal trips, thus resulting in frequent congestion. Rapid urbanization and demographic growth, insufficient service provision, the small number of jobs in the peripheral zones and their concentration in the central districts, particularly in the southern tip of the peninsula, increase daily needs to travel inside Dakar and into it from the other three departments. Personal car and motorcycle ownership is very low and most of this travel can be provided only by public transport, which depends to a large extent on privately owned public transport in the form of microenterprises. During the last 15 years, several changes have been observed in the urban transport sector: the state-owned transport enterprise SOTRAC has been replaced by another, *Dakar Dem Dikk*; a number of small public transport operators have been formally reorganized; attempts have been made to reorganize the positioning and operating conditions of public transport stations; a toll road has been opened between Dakar and Diamniadio in the western part of the region (SCE-Safege, 2014), where the construction of a new economic hub is under way; in addition, the development of the activities of CETUD², the organizing transport authority.

3. Diversity of transport modes³

The Dakar region has a wide range of public transport modes, and diversity is present not only as regards the type and size of vehicles but also the characteristics of the operators (public/private, formal/informal, small scale/large fleet, etc.). Furthermore, the boundaries between the different categories are not clear-cut. Nevertheless, *car rapide* and *Ndiaga Ndiaye* minibuses, unlicensed shared taxis (*clandos*), and taxis can be classified as small-scale operators, while *Dakar Dem Dikk* and *Tata* buses can be classified as formal public transport modes.

² The Executive Board for Public Transport in Dakar (*Conseil Exécutif des Transports Urbains de Dakar*, CETUD) is a public agency created in 1997 in order to implement and monitor policy for the public transport sector in the region of Dakar. The Ministries of Transport and Finance are responsible for issuing licenses for transport operators while CETUD determines routes, signs and monitors contracts with the licensed operators, carries out studies and conducts vocational training for operators, and, last, formulates proposals for transport pricing, improving infrastructure, traffic management and road safety.

³ The following references have been consulted for this section: Kumar and Diouf, 2010; Diouf, 2002; Godard, 2002; Lammoglia, 2013; Lombard, 2015; Ndiaye S.A.S, 2012; Ndiaye I., 2015; Teurnier and Mandon, 1994.

3.1. Public transport modes

The *car rapide* minibuses (“rapid coaches”) are the oldest public transport mode in Dakar. They first appeared in 1947 and were at that time deemed to be faster than the other modes of transport, hence their name. The vehicles are light commercial vehicles made by Renault that have been converted for passenger transport, with a seating capacity of about 22. Their history has been marked by several phases, from a ban to tolerance and implicit acceptance, and it was not until the 1970s that their role in the public transport market was fully recognized. The public authorities then tried to regulate the *cars rapides* sector and to ensure its complementarity with the buses from the public enterprise by specifying the fares, schedules and routes, and providing incentives to encourage the vehicle owners to replace their vehicle(s). But few operators complied with the regulations and the informal character of *cars rapides* still prevails.

The *Ndiaga Ndiaye* minibuses first appeared in the 1980s. Like the *cars rapides*, they were light commercial vehicles (mainly made by Mercedes) which had been converted for passenger transport, with a capacity of around 45 seats. They were named after the operator who owned the largest number of vehicles, officially 250 in 2003 (Lombard, 2015:199). In the 1990s, the *Ndiaga Ndiaye* initially provided transport services for employees, notably for dockers commuting to and from the port. They then extended their activities to include public transport services between Dakar and its suburbs.

In the 1990s, in a context of fast urbanization and marked demographic growth, the state-owned bus company, SOTRAC, was unable to satisfy increasing demand for transport. The number of *cars rapides* and *Ndiaga Ndiaye* increased constantly reaching 2,500 to 3,000 vehicles, which represented about two-thirds of the transport market. Most of the *cars rapides* and *Ndiaga Ndiaye* belonged to small-scale operators, who usually owned only one vehicle and at the very most just a few vehicles.

At the beginning of the 1990s, the age and poor condition of the vehicles, together with the need for the public authorities to regulate the activity of the minibuses, led the authorities to initiate an ambitious program to professionalize the activity and renew the vehicle fleet. However, due to strong opposition from the small-scale operators, the project was not actually implemented until 2003 with funding from the World Bank. The renewal program was based on financial leasing over a 5 year-period, with the operator contributing 25% of the new vehicle’s purchase price. This amount was financed by a scrapping premium for the old vehicle (1-2.5 million CFA Francs). The operators are organized in economic interest groups (GIE) which grouped together form AFTU (*Association de Financement des professionnels du Transport Urbain*). AFTU monitors the credit-lease contracts and is the intermediary between the GIEs on the one hand, and the CETUD and the supplier of vehicles on the other. The operators undertake to follow the routes designated by CETUD, and comply with the departure frequency, pricing, ticketing and training requirements. The first new vehicles were Indian, manufactured by Tata, but this manufacturer was then replaced by the Chinese firm King Long. The vehicles are 40-seater buses, still known locally as *Tatas*. There are currently approximately 300 operators which are grouped together to form 14 GIEs and own 1,300 vehicles in running order that serve almost 60 routes. However, failures to comply with pre-defined routes and departure frequencies are still common (Orrico Filho et al., 2015). Vehicle overloading and the strenuousness of journeys are regularly mentioned by the press (e.g. La Gazette, 2014). Despite the very high patronage achieved by the *Tata*, many *car rapide* and *Ndiaga Ndiaye* operators have still not joined the vehicle renewal program and continue to work as before.

Clandos are private cars used, regularly or occasionally, as unlicensed shared taxis. They serve areas in the outskirts (Guediawaye, Pikine and Rufisque) that are usually well known to the drivers. Their routes are “recurrent and well structured” (Lammoglia, 2013:74), so that they may be identified easily by customers in the absence of any distinctive sign. Their number has considerably increased and they have replaced the former authorized suburban shared taxis, known locally as “green and white taxis”.

Metered taxis are usually yellow and black, but some are entirely yellow or blue. The latter operate by telephone reservation while yellow and black taxis cruise the streets of Dakar in search of clients.

Dakar Dem Dikk (“round-trip” in *wolof*, the local language), is the current state-owned bus company. It came into being in 2000, after SOTRAC was declared bankrupt, following a long period of management difficulties, financial losses and decline in its position in the public transport market. *Dakar Dem Dikk* began operating with second-hand buses and it was only in 2005 that 400 new 80-seater Tata and Volvo buses were purchased. Fourteen routes serve Dakar, six routes connect Dakar to the other departments and three routes connect two suburbs.

The PTB (*Petit Train de Banlieue*, “Small suburban train”) is an urban train that has been operating since 1987 with just one line between Dakar and Rufisque, in the south of the conurbation. The train

service runs only at peak hours (6:00-10:50 am, 4:30-8:00 pm) on working days so the number of customers is very small compared to the road public transport modes. In the 1990s, the PTB was perceived as “the backbone of the transport integration” (Sakho, 2104:55). But in line with the 2008 Dakar urban mobility plan, the Bus Rapid Transit (BRT) project is now considered as the main route on the future public transport network.

The other public transport modes in Dakar include horse-drawn carts. These operate mainly in Pikine and Rufisque, especially in areas with poor accessibility for motorized vehicles.

3.2. Personal vehicles

Sub-Saharan African cities are characterized by very low car ownership rates due to the high costs of vehicle purchase and use compared to the budget of the vast majority of households, and the region of Dakar is no exception (Diaz Olvera et al., 2013). Although the total number of private vehicles on the roads is increasing every year, household vehicle ownership is very low and in 2015 more than three-quarters of all households are without a vehicle of any type (Table 2). The ownership of personal vehicles, particularly cars, is restricted to the “well-off” population. In 2000, half the personal cars belonged to households living in residential areas while less than 3% of them were owned by households living in non-regulated precarious settlements (Syscom, 2001). Most of the residents thus have no personal vehicle (car, motorcycle or bicycle) at their disposal. In 2000, there were on average 17 cars/1,000 inhabitants and even though this proportion has increased by more than 50%, the motorization rate still remains very low in 2015, 26 cars/1,000 inhabitants⁴.

For the vast majority of the city’s residents, access to areas outside their neighborhood depends on their capacity to access public transport, whose level and quality of service and pricing may differ across areas, times of the day and day of the week.

Table 2. Rate of household personal vehicle ownership in the region of Dakar in 2000 and 2015 (percentage of households)*

	2000	2015
Horse-drawn carriage or bicycle	0.9	2.6
Motorcycle	2.1	4.5
Car	12.9	15.2
No vehicle	84.2	77.7

* Households owning at least one car may own other types of vehicles, such as motorcycles or non-motorised vehicles. Similarly, households owning at least a motorcycle may also own non-motorised vehicles.

4. Data: two household travel surveys

The two household travel surveys used in this study were conducted in 2000 (Syscom, 2001) and 2015 (Sitrass-Curem, 2015), and were funded by CETUD. In both cases the region of Dakar was covered and there are strong similarities in the survey methodology as well as in the type of information collected on trips and some of that concerning households and individuals. Their shared characteristics mean they can be used to make valid comparisons between daily mobility in 2000 and 2015.

4.1. Geographical stratification and sampling

The whole region was stratified on the basis of location within the region, type of housing environment, and residents’ standard of living. The survey census districts were selected randomly within the different types of stratified areas. Finally, the sample of households was selected randomly within each selected census district. Within each household, individuals aged 14 years and older were interviewed in 2000 while in 2015 the minimum age was lowered to 11 years.

The geographical stratification of the area covered by the 2015 survey employed a more fine-grained division than in 2000, and the number of surveyed census districts was also higher. This is due partially

⁴ By way of comparison, there were on average 474 cars/1000 inhabitants in 2014 in Spain and 482 cars/1000 inhabitants in 2011 in France.

to the inclusion in 2015 of the large number of zones that have been urbanized since 2000. The stratifications were not based on exactly the same principles and because of this they are not superimposable.

To ensure statistical representativeness of the survey samples, data weighting was performed on the basis of the 2002 census for the 2000 survey and the 2013 census for the 2015 survey. Table 3 shows the main characteristics of both surveys and the population in the region of Dakar at the time of the surveys.

Table 3. Main characteristics of the 2000 and 2015 household travel surveys.

	2000	2015
Number of geographical strata	15	41
Number of surveyed census districts	160	419
Number of surveyed households per census district	15	5 or 10
Sample of households	2,301	3,176
Sample of individuals	8,658	13,415
Minimum age of surveyed individuals	14	11
Total number of inhabitants (million)	2.1	3.3
Total number of inhabitants \geq 11 years (million)	--	2.4
Total number of inhabitants \geq 14 years (million)	1.0	2.3
Total number of households	287,632	494,664

Source: Syscom, 2001; Sitrass-Curem, 2015.

4.2. Data on households and individuals

Even though the questionnaires used for both surveys were not strictly identical, many sections were common to both. Information on the household and each household member was collected for both surveys. The head of the household provided general information such as the main socio-economic characteristics of all the members of the household, the characteristics of the dwelling, assets owned by the household (including vehicles) and access to basic services (education, health, markets). Each household member (over 13 years of age in 2000 and over 10 years of age in 2015), including the head of household, was interviewed separately and gave information on:

- his/her personal characteristics (education, job, place of education or work, customary transport modes for commuting, personal income, access to personal vehicles, etc.);
- his/her opinions on transport modes;
- each of his/her trips undertaken the day before the interview, whatever its distance, duration or the transport mode(s) used.

Trips were listed in chronological order and the following information was collected for each: origin and destination, departure and arrival time, purpose, number of segments, transport mode for each segment, public transport expenditure, and in the 2015 survey, parking expenditure and tolls.

To guarantee the comparability of the data between 2000 and 2015, the findings in the following sections refer to the population aged 14 years and older and for trips made during the day before the interview, from Monday to Friday.

5. Mobility changes in 2000-2015

5.1. Global mobility indicators

The average number of trips for the population aged 14 years and older remained stable between 2000 and 2015, as can be seen in Table 4. In contrast, some changes are observed in the distribution of trips according to purpose. In 2000, almost seven of every ten trips were generated by work/education or by personal business/household related activities and the rest by social/leisure activities. In 2015, the proportion of made trips for work/education has increased substantially (+12 percentage points) and this purpose accounts for almost half the trips. The proportion of trips made for social/leisure activities has decreased markedly (by 9 points) while only a slight decrease (2 points) is observed for personal business/household related activities. The reduction in the percentage of trips generated by social/leisure

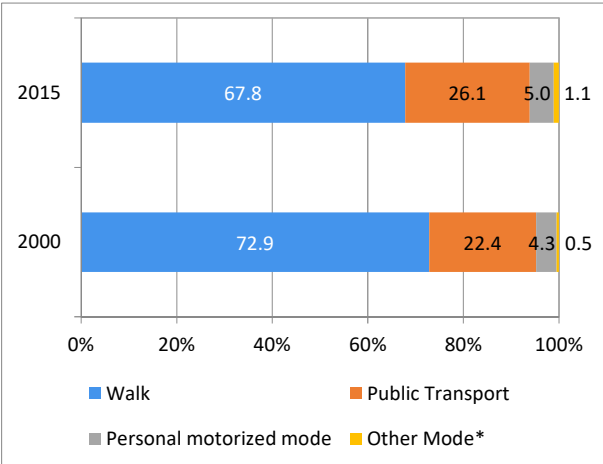
activities is particularly marked among the working population who seem to be more focused on their professional activities. In 2000, professional activities accounted for 50% of their trips and this proportion has increased to 61% in 2015.

A comparison between the modal splits in 2000 and 2015 shows a 5 point decrease in the percentage of pedestrian trips. All the same, walking still plays an essential role in daily mobility and two out of every three trips are pedestrian (Fig. 2). In line with this, while on the whole motorized modes play a greater role in 2015 than in 2000, public transport increased its share more than personal motorized vehicles (increasing by 3.7 points and 0.7 point respectively). The share of the “other modes” (non-motorized and more uncommon motorized transport modes) also increased (by 0.7 point) but are still very low. Cars and motorcycles are used for only 5% of trips due to the low motorization rate (see Section 3).

The average duration of each trip has remained quite stable but significant differences have appeared according to the transport mode (see Table 4). Public transport trips are still the longest even though the average duration has diminished (by 4 minutes). The second longest are car trips, which have on the contrary increased significantly in length (by 7 minutes). Pedestrian trips, which are the majority, currently take on average nearly 11 minutes, with a slight upward trend. In 2000, three-quarters of these trips had a duration of less than 13 minutes, which has risen to less than 15 minutes in 2015. As a consequence of changes in the use of transport modes and the duration of trips, the average travel budget time increased slightly between 2000 and 2015 to 62 minutes.

Table 4. Mobility indicators in Dakar for 2000 and 2015 (14 years and over, Monday to Friday).

	2000	2015
Number of trips per day per individual	3.21	3.28
Distribution of trips according to purpose (%)		
Work and education	35.2	48.0
Personal business and household related activities	34.1	31.8
Social and leisure activities	28.7	19.1
Average duration of trips by transport mode (min)		
Walking	10.3	10.9
Public transport	43.0	38.6
Motorcycle	22.0	21.4
Personal car	23.4	30.9
Other modes (non-motorized and motorized)	32.7	31.8
All	18.3	19.3
Average travel-time budget per day (min)	58.9	62.2



* Horse-drawn carriage, bicycle, boat, truck, bus services for employees and students, urban train.

Fig. 2. Modal split in 2000 and 2015 (percentage, population aged 14 and over, Monday to Friday).

5.2. Attractiveness of Dakar

The proportion of inter-departmental motorized trips has fallen from 32.6% to 28.5% over the 15 year period between the two surveys (Table 5). The proportion of internal trips has also fallen in Dakar while it has risen in Guediawaye, Rufisque and to an even greater extent in Pikine. Even though urban sprawl conveys the expansion of population from west to east more rapidly than that of jobs, it also generates greater internal attractiveness within each of the peripheral departments. These changes also provide evidence of the growing role of Pikine, which is confirmed by the percentage of the region's residents travelling to the different departments.

Table 5. Distribution of motorized trips according to origin-destination by department (percentage, population aged 14 and over, Monday to Friday).

	Intra-department				Inter-department	All
	Dakar	Guediawaye	Pikine	Rufisque		
2000	51.5	2.0	10.2	3.7	32.6	100
2015	45.2	4.1	16.0	6.1	28.5	100

Table 6 shows the percentage of the region's inhabitants that traveled to each department the day before. The relative reduction in Dakar's attractiveness is confirmed, 43% of the inhabitants traveled to Dakar the day before in 2015, i.e. 5% less than in 2000. This reduction is partially explained by the general decrease of the percentage of mobile individuals, the effects of which are also observed in Guediawaye and Rufisque. Travelling to Pikine, on the other hand, has greatly increased, rising from 21% to 28% of the region's inhabitants. This is due in particular to its stronger attraction for individuals living in Rufisque: while in 2000 5% of this group traveled to Dakar and only 2% to Pikine, in 2015 the rates were practically the same (8% and 7%, respectively). Residential moves on the part of middle-class inhabitants from Dakar to Rufisque to access better housing conditions at lower cost increased travel between the two departments. However, the department located between the two, Pikine, has also benefited from this situation. The observed changes are small but they nevertheless show a relative reduction over the 15 year period of the disparity between functional centrality (Dakar) and geographical centrality (Pikine).

Table 6. Proportion of the region's residents travelling to the different departments (percentage, population aged 14 and over, Monday to Friday).

	Dakar	Guediawaye	Pikine	Rufisque
2000	47.9	10.5	21.2	13.1
2015	42.8	8.5	27.8	11.7

6. Modal mobility profile

Categorization of the inhabitants of the region of Dakar according to the modes of transport they used on the previous day sheds a new light on daily use of transport modes and how this changed between the surveys (Table 7). The population is thus divided into six groups:

- those who did not travel at all;
- "captive pedestrians" who traveled only on foot;
- those who used a road public transport mode at least once but who may also have traveled on foot or by a non-motorized mode of transport or "other transport modes" (see below);
- users of a personal mode of transport, motorcycle or car, as the driver or a passenger, but who may also have traveled on foot, by a non-motorized mode of transport, "other transport modes" (see below) or a road public transport mode;
- users of the other transport modes, motorized or not, such as a horse-drawn carriage, bicycle, boat, truck, bus services for school children and employees, and urban train, but who may also have traveled on foot;
- finally, those who made at least one interurban trip, of any distance and by any transport mode, but who may also have made urban trips.

Table 7. Modal mobility profile of population and mobility indicators (population aged 14 and over, Monday to Friday).

	%		Number of trips		Travel time budget (min)	
	2000	2015	2000	2015	2000	2015
Did not travel at all	12.5	15.4	0	0	0	0
Traveled only on foot	49.2	39.1	3.87	3.92	40	45
User of public transport ¹	30.8	37.9	3.43	3.79	107	98
User of a personal motorized mode ²	5.8	5.9	3.83	4.32	95	105
User of other modes (non-motorized and motorized) ³	0.6	1.2	3.74	4.38	64	87
Urban and inter-urban traveler	1.1	0.5	0.86	1.03	19	17
All	100	100	3.21	3.28	59	62

¹ Individuals in this group may also have traveled on foot or by a non-motorized mode of transport or “other transport modes”.

² Personal car or motorcycle, as driver or passenger. Individuals in this group may also have traveled on foot, by a non-motorized mode of transport, “other transport modes” or a road public transport.

³ Horse-drawn carriage, bicycle, boat, truck, bus services for employees and students, urban train. Individuals in this group may also have traveled on foot.

The number of residents who did not travel the day before the interview and stayed at home all day has increased and currently more than one in seven individuals belongs to this category. Nearly two in five individuals traveled solely on foot in 2015, which is ten points less than in 2000. The fact that for more than half of the 2015 population mobility was either null or limited to pedestrian trips should not conceal the increasing use of motorized transport modes. Nearly 44% of the population use a motorized transport mode in 2015 compared to 37% in 2000. Moreover, if we consider only the population that was mobile on the day before the survey, more than half used a motorized transport mode, be it public or personal, at least once (52% in 2015 and 41% in 2000).

The group of public transports users is larger in 2015 than in 2000 (by 7 points), and has become almost as large as that of captive pedestrians. The group of personal modes users remained the same size in percentage terms, standing at 6%. The last two groups of the list are still minorities, but they have undergone different changes: the group consisting of the users of “other modes” has become larger, while that of individuals having made interurban trips has shrunk.

Among all the groups, we observe an increase of the number of daily trips, but this increase is greater among the users of personal vehicles and the users of “other modes” (by 0.49 trip and 0.64 trip, respectively). In line with this, these are the same groups for whom the travel time budget has increased notably (by 10 minutes and 23 minutes, respectively), but this trend has also affected those who travel only on foot (who spend 5 minutes longer). On the other hand, users of public transports saw their travel time budget diminish (by 9 minutes).

A more detailed analysis of the use of transport modes within each group provides some interesting findings. On the one hand, the decrease of the proportion of captive pedestrians (a 5 point reduction) is higher than the decrease in the number of trips on foot (a 4% reduction). This is due to the fact that the number of pedestrian trips increased to differing degrees in the various groups of users: captive pedestrians (3.9 trips in 2015 compared to 3.8 in 2000), public transport users (1.6 trips in 2015 compared to 1.2 in 2000), and personal mode users (1.2 trips in 2015 compared to 0.9 in 2000). On the other hand, among the public transport users, the use of public transport remained stable: 2.2 trips on average, in 2015 as in 2000. Thus the increased prevalence of public transport in the modal distribution results mainly from the acquisition of new customers within the population and not because of more intensive use by public transport users.

Finally, the type of modal mobility profile seems closely related to the economic capacities of the individual’s household, as well as to gender, age, and place of residence. At both dates, the percentage of captive pedestrians decreases as the per capita household income rises and this decrease seems to be more regular in 2015 (Fig. 3). Conversely, the percentage of the population using public transport increases with income. There is, however, a drop among the wealthiest individuals due to the greater use of personal vehicles, which is a characteristic that strongly marks out this group.

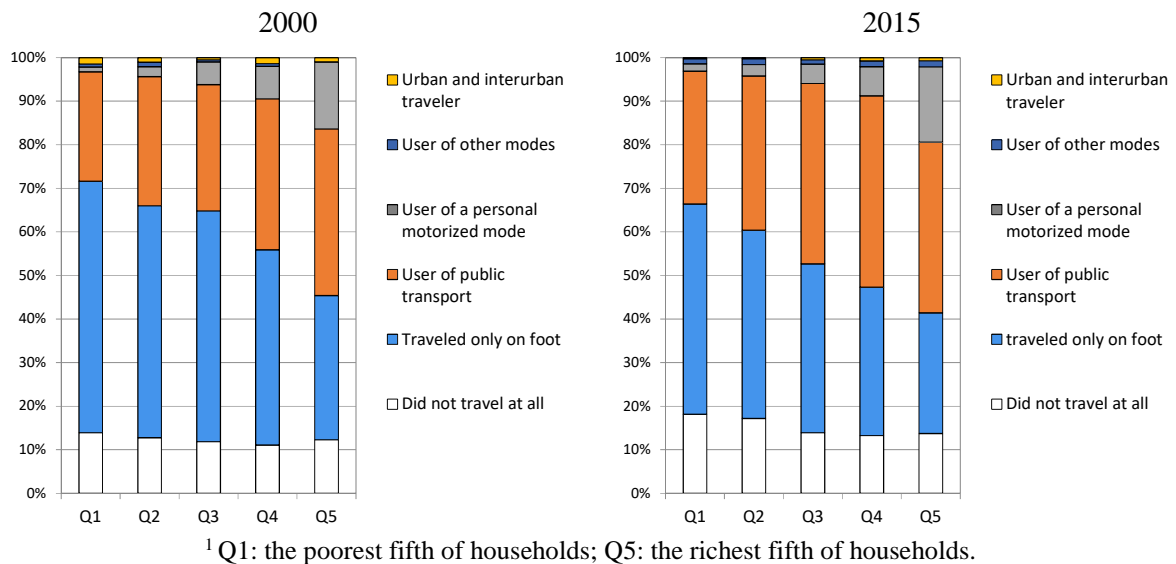


Fig. 3. Modal mobility profile, according to per capita household income by quintile in 2000 and 2015 (percentage, population aged 14 and over, Monday to Friday)¹.

Clearly men use personal vehicles more than women and women are more often captive pedestrians than men, even if gender differences became less marked between 2000 and 2015 (Fig. 4). Women benefited more than men from the growing use of public transport. Conversely, the proportion of women who did not travel the previous day is nearly twice that for men (19.6% compared to 10.4%).

Immobility is strongly connected not only to age but also to not having a job or having a low level of education. The proportion of immobile individuals distinctly increases above the age of 45 years and this was even more apparent in 2015 than in 2000. In 2015, for the population aged between 46-55 years, the proportion of immobile individuals was about 20% compared to approximately 30% for those between 56-65 years old and 40% for the 66-75 year-olds (Fig. 5). At both dates, the use of walking as the only mode of transport during the day was very frequent among youngsters, particularly those from primary and junior high school. The increase in the use of public transport is confined to adults and does not affect individuals under 18 years old.

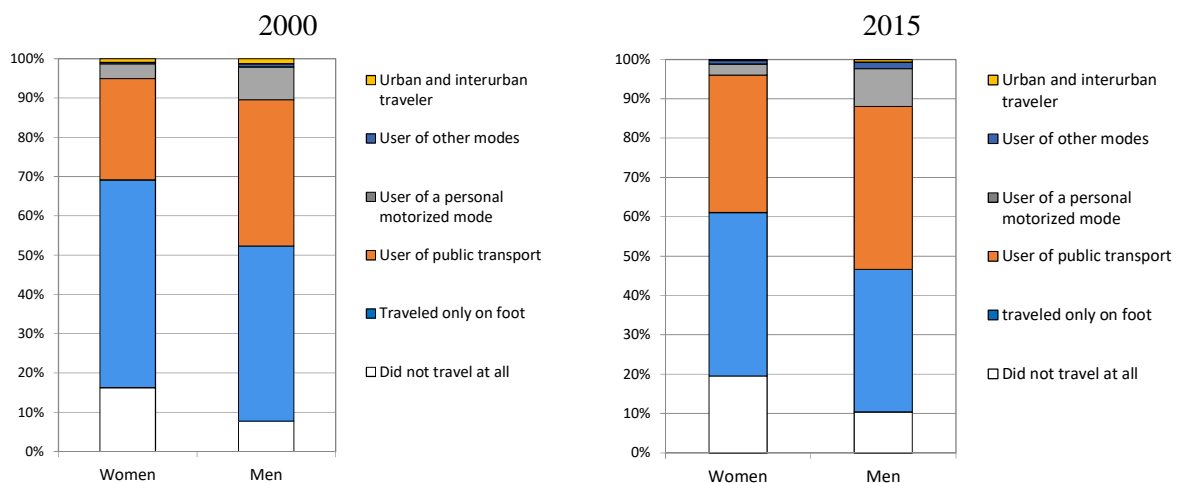


Fig. 4. Modal mobility profile, according to gender in 2000 and 2015 (percentage, population aged 14 and over, Monday to Friday).

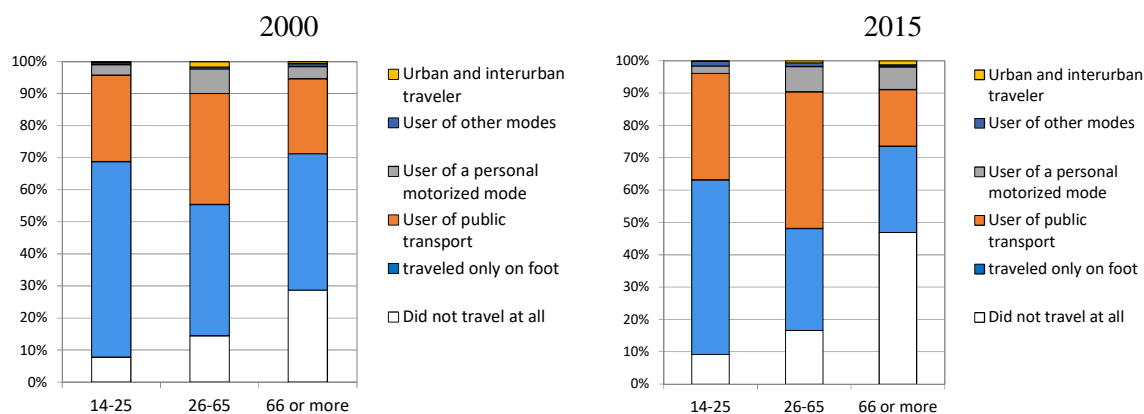


Fig. 5. Modal mobility profile, according to age group in 2000 and 2015 (percentage, for population aged 14 and over, Monday to Friday).

Finally, use of transport modes is also influenced by residential location. In 2015, the proportion of captive pedestrians is markedly higher in the peripheral departments (49% in Rufisque and 42% in Pikine) than in Dakar (35%) and Guediawaye (32%). In 2000, residential location was most influential for the most distant department, Rufisque, where the proportion of captive pedestrians was 8 percentage points higher than in the other departments.

7. Public transport use

When the percentage of the population that uses public transport has increased, it is interesting to examine the use of each public transport mode more closely (Table 8). The AFTU *Tata* buses, which did not exist in 2000, are currently the public transport mode that is the most widely used on a daily basis, by nearly one in five residents. Logically, the AFTU buses grew at the expense of the *car rapide* and *Ndiaga Ndiaye* minibuses which they replaced (see Section 2). The latter modes are in rapid decline, but they are still far from being marginal because they are used by one resident out of seven.

The percentage of individuals using taxis has remained fairly steady, while there has been an increase in the use of unlicensed taxis (*clandos*) and *Dakar Dem Dikk* buses. The improvement in the bus services (number of vehicles and routes) provided by the state-owned enterprise which replaced SOTRAC, put a stop to the reduction in patronage observed in 2000.

Table 8. Individuals who used public transport modes in the region of Dakar (percentage, population aged 14 and over, Monday to Friday).

Percentage of individuals who used a...	2000	2015	2015-2000
Taxi	5.1	5.8	+0.7
<i>Clando</i> – unlicensed shared taxi ¹	6.6	9.1	+2.5
<i>Car rapide</i> minibus	17.9	11.1	-6.8
<i>Ndiaga Ndiaye</i> minibus	13.0	3.6	-9.4
<i>Tata</i> – AFTU bus	0	19.5	+19.5
<i>Dakar Dem Dikk</i> bus ²	2.5	4	+1.5
Individuals who used a public transport mode at least once on the previous day ³	30.8	37.9	+7.1

¹ In 2000 this included licensed “green-taxis”.

² SOTRAC buses in 2000.

³ The value is less than the sum of the column because if an individual used more than one public transport mode, he/she has been counted only once.

An examination of the use of public transport modes among the population that uses them confirms these findings and provides an additional understanding of the changes in the public transport market

(Table 9). In 2015 a public transport user traveled on average by 1.36 different public transport modes and half of the users traveled by AFTU bus. This proportion is similar to that for the *cars rapides* in 2000. The *cars rapides* and *Ndiaga Ndiaye* have suffered significant falls but together they are still used by more than one-third of public transport users: the *car rapide* is required by nearly three users out of ten and the *Ndiaga Ndiaye* by nearly one tenth of users. Lastly, the relative position of the unlicensed taxis has improved.

Table 9. Public transport patronage in the region of Dakar
(percentage, population aged 14 and over who used public transport modes, Monday to Friday)¹.

Percentage of individuals who traveled by public transport at least once on the previous day and who used a...	2000	2015	2015-2000
Taxi	15.0	14.8	-0.2
<i>Clando</i> – unlicensed shared taxi ²	19.4	23.8	+4.4
<i>Car rapide</i> minibus	53.8	28.5	-25.3
<i>Ndiaga Ndiaye</i> minibus	37.7	8.5	-29.2
<i>Tata</i> – AFTU bus	0	49.9	+49.9
<i>Dakar Dem Dikk</i> bus ³	7.5	10.3	+2.8

¹ For each column, the sum of percentages is more than 100%, as public transport users may have used different public transport modes during the day.

² In 2000 this included licensed “green-taxis”.

³ SOTRAC buses in 2000.

8. Conclusion

A million more inhabitants and the rapid growth of urban areas towards the east are the most visible signs of the galloping urbanization that has occurred in the region of Dakar during the last 15 years. The strong spatial constraints due to the geographical location of the city on a peninsula, and the fact that the central business district is located at the end of this peninsula, create major difficulties for the population for accessing urban amenities and jobs. Although Dakar has lost some of its attractiveness in favor of Pikine, it remains nonetheless a place of high residential density and, even more, a place where social and economic activities of all types are concentrated. This spatial and functional imbalance generates massive flows of persons, both within Dakar and between Dakar and the other departments. The construction of new expressways (including a toll motorway), the progressive structuring of the urban public transport sector and the increase in transport supply have provided some quantitative responses to the growing mobility needs.

Indeed, while the proportion of “immobile” residents of the region of Dakar on an average weekday has increased by three percentage points, among the mobile population the proportion of those who traveled exclusively on foot has declined substantially between 2000 and 2015. This is because the spatial extension of the city now makes it necessary to use other modes of transport. In a context where the number of vehicles possessed by households is very low, regular access to areas and urban resources located outside individuals’ home neighborhood and often quite far away, depends on the public transport services provided by the different types of operators. High demographic growth since 2000 (more than 50%), the increase in the average number of public transport trips per person (by 19%), and the slight reduction of their average duration indicate the capacity of public transport supply to respond to the growing demand for motorized mobility. However many problems still persist, including harsh travel conditions, long waiting and travel times, as well as the high costs of public transport in relation to the limited incomes of many households. This paper presents the first comprehensive findings on changes in daily mobility during the last 15 years. Future in-depth multivariate analysis will help to identify the winners and losers as a result of these changes, and to evaluate the social sustainability of the changes in question.

The large market share gained by the AFTU buses at the expense of the *car rapide* and *Ndiaga Ndiaye* minibuses indicates that the goals of formalizing and imposing a regulatory framework on transport supply, which have been pursued by the public authorities through the bus renewal and staff professionalization programs are well under way. Nevertheless, transport supply still relies heavily on small-scale operators, driving either minibuses or unlicensed taxis, and the latter are now used even

more than 15 years ago. Unlicensed taxis and *cars rapides* operate over short and medium distances, sometimes on roads that are in poor condition and also play an important role as feeder modes to the main bus routes. These recent developments also clearly show that today's mobility needs are varied, and influenced by diverse economic, social and geographical factors. It is therefore critical to rely on the operators that are present in all market segments in order to satisfy the complex demand for mobility more effectively. The ongoing BRT project provides a genuine opportunity to reconsider the organization of the public transport system in the whole of the region of Dakar and to move towards the creation of a real transport network by developing complementarities between the different transport services operating in the region.

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References

- ANSD, 2014. Recensement Général de Population et de l'Habitat, l'Agriculture et l'Elevage. Rapport Définitif RGPFAE 2013, Dakar, 417 p.
- Bertoncello, B., 2008. Disparités socio-spatiales recomposées et centralités émergentes : les nouvelles cartes d'une gestion privatisée. In: Bredeloup, S., Bertoncello, B., Lombard, J. (Eds), Abidjan, Dakar : Des villes à vendre ? La privatisation *made in Africa* des services urbains, L'Harmattan, Paris, 243–253.
- Bryceson, D.F., Mbari, T.C., Maunder, D., 2003. Livelihoods, daily mobility and poverty in Sub-Saharan Africa. *Transport Reviews* 23 (2), 177–196.
- Cissé, O., Sèye, M., 2015. Flooding in the suburbs of Dakar: impacts on the assets and adaptation strategies of households or communities. *Environment and Urbanization* 28, 183–204.
- Diaz Olvera, L., Plat, D., Pochet, P., 2005. Marche à pied, pauvreté et ségrégation dans les villes d'Afrique de l'Ouest. Le cas de Dakar. In: Buisson, M.A., Mignot, D. (Eds), Concentration économique et ségrégation spatiale, Ed. de Boeck, Bruxelles, 245–261.
- Diaz Olvera, L., Plat, D., Pochet, P., 2013. The puzzle of mobility and access to the city in Sub-Saharan Africa. *Journal of Transport Geography* 32, 56–64.
- Diaz Olvera, L., Plat, D., Pochet, P. 2015. Assessment of mobility inequalities and income data collection. Methodological issues and a case study (Douala, Cameroon). *Journal of Transport Geography* 46, 180–188.
- Dimitriou, H.T., Gakenheimer, R., 2011. Conclusions: emergent crucial themes. In: Dimitriou, H.T., Gakenheimer, R. (Eds.), *Urban Transport in the Developing World. A Handbook of Policy and Practice*. Edward Elgar, Cheltenham-Northampton, 589–603.
- Diouf, I. 2002. C comme Car rapide à Dakar. In : Godard, X. (Ed.), *Les transports et la ville en Afrique au sud du Sahara*, Karthala-Inrets, Paris-Arcueil, 45–56
- Godard, X., 2002. D comme Dakar ou le bilan mitigé d'une ville pilote. In : Godard, X. (Ed.), *Les transports et la ville en Afrique au sud du Sahara*, Karthala-Inrets, Paris-Arcueil, 57–72.
- Kumar, A., Diou, C., 2010. *The Dakar Bus Renewal Scheme: Before and After*. World Bank, Sub-Saharan Africa Transport Policy Program, (SSATP) Discussion Paper n°11, Washington D. C.
- La Gazette, 2014. Dans le tracés des navettes bus-boulot-dodo, 22 juin. <http://www.lagazette.sn/dans-le-tracés-des-navettes-bus-boulot-dodo/>.
- Lammoglia, A., 2013. Analyse et modélisation multi-agents de transports flexibles Comparaison de services français et sénégalais. Thèse de Docteur, spécialité Géographie et Informatique Université d'Avignon et des Pays de Vaucluse, France; Université Cheikh Anta Diop de Dakar, Sénégal, 300 p.
- Langevang, T., Gough, K.V., 2009. Survival through movement: the mobility of urban youth in Ghana. *Social and Cultural Geography* 10 (7), 741–756.
- Lombard, J., Bruez, F., Diakho, A., 2006. Les transports sénégalais à l'aune du système-monde. In: Lombard, J., Mesclier, E., Velut, S. (Eds). *La mondialisation côté Sud. Acteurs et territoires*. IRD Editions – ENS, Paris, 183–202.
- Lombard, J., 2015. *Le monde des transports sénégalais. Ancre local et développement international*. IRD Editions, Marseille.
- Lucas, K., 2011. Making the connections between transport disadvantage and the social exclusion of low income populations in the Tshwane Region of South Africa. *Journal of Transport Geography* 19 (6), 1320–1334.
- Mandel, J.L., 2004. Mobility matters: women's livelihood strategies in Porto Novo, Benin. *Gender, Place and Culture* 11 (2), 257–287.

- Myers, G.A., 2005. *Disposable Cities: Garbage, Governance and Sustainable Development in Urban Africa*. Ashgate, Aldershot.
- Ndiaye, S.A.S., 2012. *Analyse des mécanismes de financement des GIE : Cas des GIE de l'Association de Financement des Professionnels du Transport Urbain Dakar*. Centre Africain d'études Supérieures en Gestion (CESAG). Mémoire de fin d'étude. Master professionnel Comptabilité et Gestion Financière, 85 p.
- Ndiaye I., 2015. *Étalement urbain et différenciation sociospatiale à Dakar (Sénégal)*. Cahiers de Géographie du Québec 59 (166), 47–69.
- Nkurunziza, A., 2013. *Sustainable Transport in Dar-es-Salaam: The Potential for BRT and cycling from a user*, PhD Dissertation, ITC, University of Twente, Enschede, The Netherlands, 192 p.
- Orrico Filho, R.D., Ribeiro, R.G., Thiam, M.K., 2015. A comparative study of the organization of alternative transport in the cities of Rio de Janeiro and Dakar. *Case Studies on Transport Policy* 3, 278–284.
- Rakodi, C., 2005. The urban challenge in Africa. In: Keiner, M., Koll-Schretzenmayr, M., Schmid, W.A. (Eds.), *Managing Urban Futures. Sustainability and Urban Growth in Developing Countries*. Ashgate, Farnham, 47–70.
- Sakho, P., 2002. U comme Urbain ou Développement urbain et transport à Dakar. In : Godard, X. (Dir.), *Les transports et la ville en Afrique au sud du Sahara*, Karthala-Inrets, Paris-Arcueil, 331–342.
- Sakho, P., 2014. *La production de la ville au Sénégal : entre mobilités urbaines, migrations internes et internationales*. Volume 1. Rapport de synthèse. Thèse de doctorat d'Etat sur travaux. Université Cheikh Anta Diop de Dakar, Faculté des Lettres et Sciences Humaines, Département de Géographie.
- Salon, D., Gulyani, S., 2010. Mobility, poverty, and gender: travel 'choices' of slum residents in Nairobi, Kenya. *Transport Reviews* 30 (5), 641–657.
- SCE-Safege, 2014. *Préparation d'une expérience pilote d'un système de bus rapides en site propre à Dakar, et de son programme d'investissement, rapport provisoire pour le CETUD*, Dakar, mai, 89 p. + ann.
- Sitrass-Curem, 2015. *Enquête sur la mobilité, le transport et l'accès aux services urbains dans l'agglomération de Dakar*. Rapport d'Analyse final, pour le compte du CETUD, Crédit IDA N° 47370-SN ; Projet P101415 ; Notice 2012/05/CETUD, 304 p. + ann.
- Syscom International, 2001. *Enquête sur la mobilité, le transport et les services urbains à Dakar (EMTSU) 2000*. Rapport d'analyse pour le CETUD. Syscom. Dakar, 201 p.
- Teurnier, P., Mandon-Adoléhousse, B., 1994. *L'intégration du transport artisanal dans un service public de transport urbain : le cas de Dakar*. INRETS-CODATU, Paris.
- Vasconcellos, E.A., 2014. *Urban Transport Environment and Equity: The case for developing countries*. Earthscan, London.
- Venter, C., 2011. *Transport expenditure and affordability: The cost of being mobile*. *Development Southern Africa* 28, 121–140.