



Access to the city

Mobility patterns, transport and accessibility in peripheral settlements of Dar es Salaam

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Access to the city: Mobility patterns, transport and accessibility in peripheral settlements of Dar es Salaam

Abstract

This paper is concerned with access to the city for urban residents living in the periphery of Dar es Salaam, Tanzania. The paper presents an analysis of the mobility practices of residents and investigates the mobility constraints they experience in relation to the limited accessibility provided by the urban transport system. The paper draws upon qualitative interviews with residents in the periphery as well as recently collected travel speed data and offers a unique combination of testimony with GIS-based modelling of overall accessibility. A central finding is the overall importance of regular mobility and access to the city for residents in the periphery. Regular mobility is an ingrained part of residents' livelihood strategies. The majority of households rely on one or more members regularly travelling to central parts of the city in relation to their livelihood activities. The analysis reveals a widespread, near-to-universal, dependence on motorized transportation, with the vast majority depending on public transport. Raster-based modelling of overall accessibility provides an indication of the very high travel times endured by residents in the periphery. The analysis identifies and distinguishes between three overall mode types: 1) Private car, 2) public transport and 3) motorcycle/car combined with public transport. While private cars appear marginally faster, differences in travel times are actually limited. This suggests that travel times are less influenced by mode of transport than by road and traffic conditions and highlights how accessibility problems of peripheral settlements are not easily understood separately from the general dysfunctions of the overall mobility system of city.

Keywords

- Mobility
- Accessibility
- Urban transport
- Urban expansion
- Peri-urban
- Cost-distance analysis

1. Introduction

Urban expansion is a significant trend in the cities of Africa (Angel et al., 2011; Arku, 2009). Much urban expansion is taking place in peripheral areas characterized by inadequate or non-existent transport infrastructure and services. Long-term under-investments have resulted in insufficient and over-stretched transport systems lagging far behind the demographic as well as the spatial growth of the cities (Foster and Briceno-Garmendia, 2010; Pieterse and Hyman, 2014; Sietchiping et al., 2012). Much expansion consists of

low-density urban sprawl, which encourages high levels of daily mobility, long journeys and dependence on motorized transport (WB, 2002).

This paper explores mobility and accessibility in the periphery of Dar es Salaam, the largest city and de-facto capital of Tanzania. In Dar es Salaam rapid population growth has resulted in widespread spatial expansion (Andreasen, 2013). Urban expansion has continued undeterred despite massive problems in the mobility system of the city, which is characterized by highly inadequate road networks, insufficient public transport and severe congestion problems (JICA, 2008; Kanyama et al., 2004; Kiunsi, 2013; Melbye et al., 2015).

Mobility is a basic need for most urban residents in sub-Saharan Africa, because of the strong links between mobility and livelihood (Bryceson et al., 2003; Esson et al., 2016; Gough, 2008; Langevang and Gough, 2009). As many urban settlements remain poorly serviced, urban residents often also need to travel relatively long distances to access urban facilities, services and markets (Lucas, 2011; UN-Habitat, 2010; WB, 2002). Mobility is a resource that not everyone has equal access to. Mobility constraints reduce the number of accessible jobs, limit access to services, prevent the development of social networks and contribute to processes of social exclusion (Olvera et al., 2003; Salon and Gulyani, 2010; WB, 2002). A number of studies highlight mobility constraints related to poverty, documenting that a substantial share of urban residents is unable to afford motorized transportation on a regular basis (Behrens, 2004; Bryceson et al., 2003; Hansen, 2005; Lucas, 2011; Olvera et al., 2008a; Olvera et al., 2008b; Olvera et al., 2013; Salon and Aligula, 2012; Salon and Gulyani, 2010; Venter, 2011). Some emphasize mobility constraints related to characteristics of the individual, esp. gender, but also age and disability (Kanyama et al., 2004; Levy, 2013; Njoh, 1999; Salon and Gulyani, 2010; Venter et al., 2007).

Accessibility is often highlighted as a crucial factor shaping and constraining mobility of residents in cities of sub-Saharan Africa (Behrens, 2004; Bryceson et al., 2003; Olvera et al., 2003; Sohail et al., 2004; WB, 2002). Accessibility is in this context concerned with the opportunity or potential for mobility provided by the urban transport and land-use systems. As such accessibility is spatially bounded and exhibits strong spatial variations (Bryceson et al., 2003; Howe, 2001). Previous studies have shown that peripheral urban settlements are often characterized by very poor accessibility (Melbye et al., 2015; Møller-Jensen et al., 2012), and that residents in the peripheries often face longer journeys and spend a larger share of their household budgets on transport expenses (Kanyama et al., 2004; Khosa, 1995; Khosa, 1998; Olvera et al., 2003; Ojoro, 2011; Sohail et al., 2006; Venter et al., 2007).

This paper contributes to the above literature with a study of access to the city for urban residents living in the periphery of Dar es Salaam, Tanzania. The paper presents an analysis of the mobility practices of residents and investigates the mobility constraints they experience in relation to the limited accessibility provided by the urban transport system. The paper draws upon qualitative interviews with residents in five selected settlements in the periphery of Dar es Salaam as well as recently collected travel speed data from same city and offers a unique combination of testimony with GIS-based modelling of overall accessibility. Firstly, mobility practices of residents are analysed to explore the variety in mobility patterns and modal choices. Based on this analysis, we consider that it is analytically useful to distinguish between three overall mode types: 1) Private car, 2) public transport and 3) motorcycle/car combined with public transport. Secondly, the collected speed data are used to model overall accessibility for the three mode types identified in the qualitative analysis. The analysis of accessibility applies a time cost-surface approach, which enables a fine-grained analysis of travel times from different parts of the urban territory with differing access to road networks and public transport services (Mitchell, 2012). Previous accessibility studies have looked primarily at accessibility for cars on networked roads (Melbye et al., 2015; Møller-Jensen et al., 2012). The approach of this paper ensures that both public transport as well as the travel time related to walking outside networked roads is taken explicitly into account.

2. Context: Growth and expansion of Dar es Salaam

Dar es Salaam is the largest city and de-facto capital of Tanzania. Administratively, Dar es Salaam consists of three municipalities; Kinondoni, Temeke and Ilala. With a total population count of 4.4 million in 2012, it is a large city in the context of sub-Saharan Africa (NBS, 2013). Dar es Salaam's population grew at a very rapid pace of 5.8 % per year on average in the most recent inter-census period from 2002-2012 (NBS, 2006; NBS, 2013). Recent population growth has resulted in widespread spatial expansion (Andreasen, 2013). A recent study estimates that the total built-up areas of Dar es Salaam increased by 133 % during 2002-2011, while the population only grew by 75 % during 2002-2012. A considerable increase has been noted particularly in low-density discontinuously built-up areas (Macchi et al., 2013).

Urban expansion has continued undeterred despite massive problems in the mobility system of the city. Dar es Salaam has a mono-centric structure, where most employment opportunities as well as most urban facilities and services are located in the central areas (Kiunsi, 2013; Mrema, 2011). The 2002-2012 period was characterized by extensive spatial growth, while the road network largely maintained status quo except for ad-hoc development in new urban areas (Melbye et al., 2015). The road infrastructure is highly insufficient and characterized by congested arterial roads in combination with rough feeder roads, which are often in a very bad condition (Hill et al., 2014; Kiunsi, 2013; Mrema, 2011). The network relies on only four main radial roads connected in big junctions that cannot easily be circumvented, while only two larger ring roads enable connectivity without going through the centre itself (Melbye et al., 2015).

Public transport services are highly insufficient and provided by numerous privately operated minibuses known locally as *daladalas*. The minibuses offer cheap public transport, but are characterized by low service levels, crowding, low vehicle standards and often reckless driving (DART, 2011; Kanyama et al., 2004; Kiunsi, 2013; Marcel and Ngewe, 2011; Mrema, 2011; Nkurunziza et al., 2012). More individualized and costlier public transport is offered by privately operated motorcycle taxis, known locally as *bodabodas*, and three-wheel scooter taxis, known locally as *bajaj*. In recent years the number of private cars has also been increasing rapidly and at a much faster pace than population growth (Mrema, 2011). The increasing rates of car ownership along with intense redevelopment of central areas into high-rise commercial buildings have further increased pressure on the urban transport system (JICA, 2008; Kiunsi, 2013). These factors combined result in massive congestion, very low speed levels, frequent queuing and traffic jams (CEP, 2010; Marcel and Ngewe, 2011). The massive congestion causes delays and reduces overall accessibility significantly (Melbye et al., 2015). Besides increasing fuel consumption congestion is also a major source of stress causing much frustration and exhaustion among regular travellers (Marcel and Ngewe, 2011).

3. Data collection

This paper is based on in-depth case studies of five rapidly growing, peripheral settlements in Dar es Salaam. Four are newly developing areas, while one is an older and more consolidated settlement. The selection of case study areas was based on an analysis of spatially disaggregated population data for Dar es Salaam from the two most recent censuses, which can be found in its full length in Andreasen 2013. All five case areas have experienced very high population growth rates, around or higher than 10 % per year in 2002-2012 period, and significant increases in population densities. Table 1 provides an overview of the selected case study areas. Locations of case study areas are indicated in figure 1.

All five areas have experienced large in-flows of new residents and transformed from sparsely populated rural or peri-urban areas dominated by bush and agricultural land-use to more densely developed residential areas forming part of the contiguously built-up urban area. Transformation processes are characterized by incremental construction of residential housing, financed, built and inhabited by growing volumes of new residents. The new residents are of mixed ethnic origin, but predominantly long-term

urban residents moving from central parts of the city (Andreasen and Agergaard, 2016). Their motivations for and aspirations towards settling in the periphery are shaped primarily by the search for affordable and comfortable housing, especially opportunities for self-built, owner-occupier housing (Andreasen et al., 2016). Housing development often began with very little services or infrastructure in place, though some levels of services and infrastructure has emerged subsequently (Andreasen and Møller-Jensen, 2016). The quality of transport services and infrastructure remains highly inadequate across all five case study areas. Only one or two primary outlet roads facilitate access to one of the main radial roads from each case study area. Interior access roads are rough, without proper drainage systems and often provide limited plot accessibility. The quality of outlet roads and interior roads is highly influenced by the specific geographies of the case study areas, esp. in terms of how much roads are affected by waterlogging. The quality and extent of public transport services is closely related to the road network and depends less on distance to the centre and more on the distance to good-quality roads. Small minibuses are to some extent servicing the interior parts of the settlements, connecting with larger bus routes along the main radial roads. Minibus routes often expanded into the interior areas closely following improvements of outlet roads.

Fieldwork was conducted between November 2013 and May 2014. The main bulk of qualitative data consists of semi-structured interviews with individual residents regarding their settlement preferences, housing practices, residential trajectories as well as livelihood and mobility practices. A total of 174 residents participated in individual interviews, spread fairly evenly across the five case study areas. Sampling of residents was done purposely and sought to ensure inclusion of residents living in visibly different housing types, under different tenure forms and with varying degrees of access to roads and public transport services. Most participants are relatively recent in-movers, who have settled in the areas within the last 15 years. The sampling targeted adult household heads, both males and females, in charge of housing decisions of their households i.e. land purchase, house construction, rent, tenancy arrangements etc. Special efforts were made to include residents working outside their area of residence through interviews on Sundays and on public holidays. The individual interviews were complemented with focus group sessions with long-term residents in each area, many of which are indigenous and/or lifelong residents. The focus groups were primarily concerned with creating a shared narrative of the various changes that the settlements had undergone during the last 15 years. This was supplemented with observations of the urban environment and interviews with relevant local key informants, such as local leaders, larger investors and informal land brokers in each area. Furthermore, data collection included interviews with urban planners from various central agencies and authorities involved in urban planning and service provision in Dar es Salaam. All the qualitative data have been transcribed, coded and systematically analysed for concepts using Nvivo software.

Travel speed data were obtained during travels by one of the authors in relation to the fieldwork through the use of GPS, resulting in a data set of approx. 62,000 GPS track-log points. The temporal resolution was 10 seconds except for periods with poor reception. Speed of travel was computed for each track point based on time stamp and distance covered. Five different modes of transportation were used: private car, *daladala* (minibus), *bajaj* (three-wheel scooter taxi), *bodaboda* (motorcycle taxi) and the ferry connecting Kigamboni peninsula with the city centre. The total length of all journeys was 3925km, of which 2312km (58.9%) was by car, 1169km (29.8%) by *daladala*, 341km (8.7%) by *bajaj*, 63km (1.6%) by *bodaboda* and 39 km (1%) by ferry. Tracks have mainly been recorded for the total route from origin to destination. However, in case of change of transport mode or change of minibus route, the track points related to any waiting times have been excluded from the analysis of average speed levels, since data are insufficient to include these in a systematic manner. A total of 24.2% of the journeys were made during peak hours (6-10 and 16-20 Mon-Fri) and 75.8% during off-peak hours including weekends. During peak hours the direction was in most cases opposite the predominant commuting patterns (to the periphery in the morning, and back in the afternoon). The GPS track-log points have been matched to a digital road map retrieved from OpenStreetMap (OpenStreetMap, 2015) following a method described more elaborate in section 5. As no official updated road map of Dar es Salaam exists, OSM was chosen because of its availability for digital

processing and coverage of the Dar es Salaam area. OSM network data are collected and edited by a user community via ground surveys, portable GPS devices and aerial photography in order to provide free editable geospatial map data. The potential errors and misrepresentations caused by the voluntary collection and editing process are continuously tested and corrected by other OSM-users. OSM data provide extensive coverage of the transport network. Despite this there may be areas that are less well covered especially in peripheral areas of Dar es Salaam where traffic levels are limited (Melbye et al. 2015).

Table 1. Selected case study areas					
	Ununio	Mzinga	Br. Mwinyi	Mjimwema	Maji Matitu B
Income levels	High	Mixed	Low	Mixed	Low
Population density	Low	Low	Very high	Very low	Medium
Status of the land	Completely surveyed	Mostly informal, with a small area of surveyed land	Completely informal	Mostly informal, with a small area of surveyed land	Completely informal
Dominant building types	Large single-family villas	Varying sizes of single-family houses	Small single-family and commercial houses for tenants	Varying sizes of single-family houses	Small single-family houses
Start of subdivision processes	End-1990s	End-1990s	1980s	Early-2000s	Early-2000s
Administrative status	Sub-ward of Kunduchi Ward, Kinondoni Municipality	Sub-ward of Kitunda Ward, Ilala Municipality	Sub-ward of Kilakala Ward, Temeke Municipality	Sub-ward of Mjimwema Ward, Temeke Municipality	Sub-ward of Charambe Ward, Temeke Municipality
Geographical location	App. 20 km north of the city centre along the coast	App. 15 km south-west of the city centre	App. 8 km. south-west of the city centre	App. 8 km south of the city centre on Kigamboni peninsula	App. 13 km south of the city centre
Quality of transport services and accessibility towards the centre	Good services related to privileged location and recent improvement of an all-weather outlet road	Poor services related to interior location, lack of all-weather roads and soil prone to water-logging	Poor services related to interior location, lack of all-weather roads and intense informal land subdivision processes	Good services, but hampered by the remote location on the Kigamboni peninsula	Fair services related to early improvement of an all-weather outlet road

4. Mobility practices of residents in peripheral urban settlements

This section analyses mobility practices of residents in the five case study areas and explore the variety in residents' mobility patterns and modal choices.

A central finding from the interviews with residents is the overall importance of mobility in general and access to the city in particular. Regular mobility is an ingrained part of residents' livelihood strategies. Urban-based livelihood activities predominate among residents across all five case study areas. The

majority of participating households (133 out of 174) rely on one or more members regularly travelling to the central parts of the city in relation to their livelihood activities. As the peripheral settlements remain poorly serviced, regular trips are also necessary in relation to shopping for household necessities, accessing education and other basic services as well as maintaining social networks.

The analysis of residents' mobility patterns uncovered a vast diversity, as illustrated in table 2. 84 out of the 174 residents in our sample regularly travel outside of their area of residence in relation to their livelihood activities. Some of them are daily commuters. This group includes many urban professionals with long educations and solid careers in government or private companies. A good example is a female commuter living in Ununio, who works as an accountant for a bank in the central business district of Dar es Salaam. She travels to the centre every day from Monday to Saturday, leaving early in the morning and returning late in the evening. Not all daily commuters belong to the wealthier segments of the urban population, though. The commuter category also include people who are casual workers or self-employed. For an example an elderly male commuter living in Mzinga travels to the centre every evening, seven days a week, to work as night watchman for a private company.

Far from all residents fit into a classic pattern of commuting. Many of those, who travel regularly outside of their settlements, have more diverse, irregular and shifting mobility patterns related to various kinds of informal livelihood activities associated with trading, freelancing and small-scale businesses. Their mobility patterns are captured in the categories of traders and freelancers in table 2. Their livelihood activities are often crucially dependant on access to central markets as well as to other parts of the city. For an example a male trader in Maji Matitu B makes a livelihood as a small-scale retailer in used-clothes. He travels to the central market in Kariakoo 2-3 times per week to buy commodities and spends the remaining days walking around in Maji Matitu B and neighbouring areas to sell his commodities. An elderly male trader in Mjimwema supplements his meagre government pension with a small poultry business. He travels to the centre 1-2 times per week to buy small chickens and fodder at central markets. When the chickens are grown he re-sells them, either to local food vendors within Mjimwema or brokers from the city. An example of a freelancer is a woman living in Br. Mwinyi, who functions as broker in relation to timber sales between carpenters in Dar es Salaam and suppliers from the Iringa region. She spends 4-5 days a week travelling to various parts of Dar es Salaam in relation to her business.

At the level of the individual quite a few residents rarely travel outside of their settlements. 52 of the 174 residents in our sample work within their area of residence. Some are engaged in specific local economic activities, such as fishing in Ununio and stone-quarrying in Mjimwema. They work locally, but supply central markets through middlemen and brokers. A few are formally employed teachers in local primary schools. The majority of those who work locally are self-employed or casual workers in the local business and service sectors, such as construction workers, hair dressers, tailors, drivers and food vendors, catering for the needs of the growing local populations. Quite a few of those working locally (24 out of 52) form part of households, where other breadwinners make regular trips to central areas in relation to their livelihood activities. Similarly many individual residents, 38 out of 174, are not themselves economically active, but most of them (25 out of 38) form part of households where main breadwinners make regular trips to central areas in relation to their livelihood activities.

Transport is perceived as a major hassle by residents across all five case study areas, almost irrespective of their mobility practices. Breadwinners in particular often spend an unbearable number of hours in traffic. Interior roads are rough and commonly become un-trafficable during rainy seasons. The minibuses servicing the interior areas are small, insufficient in number, operate infrequently and rarely at odd hours. Congestion and traffic jams add to the long and unpredictable travel times. A trip to the centre from one of the case study areas can take anything from 30 minutes to 3 hours depending on the road and traffic conditions. The element of unpredictability adds to the time spent in traffic, as residents seek to account for unpredictable travel times in their planning. A female commuter, travelling daily from her home in Ununio to her job in the city, explained: *"We just do like this. If today you leave at 6 and you are late, then*

the next day you leave at 5.30. If you are late again, the next day you leave at 5. Just to meet your employer's demands and to secure your income." The findings indicate that residents settle in poorly accessible peripheral areas well aware that transport will consume a substantial part of their time and detract from their quality of life. Residents commonly highlight that while transport is difficult and exhausting, it is at least possible to reach the central parts of the city. The hassle of transport is also considered "normal", in the sense that it is perceived as an inescapable part of life in Dar es Salaam.

Table 2. Categorization of residents according to mobility patterns and livelihood activities			
Category	Mobility pattern	Destinations	Livelihood activities
Commuters (42)	Daily trips, most often periphery-to-centre in the morning and back again in the evening	Predominantly central areas within and along the Nelson Mandela Road	<ul style="list-style-type: none"> • Formal employees in public and private organizations (24) • Business owners with office space or small shops in the centre (8) • Casual workers like guards and canteen workers (5) • Students in secondary school or higher education (5)
Traders (20)	Regular exchanges on central markets, often 2-3 times per week	Central market areas	<ul style="list-style-type: none"> • Small-scale retailers, who purchase goods to re-sell "on the streets" or in small shops (13) • Small-scale suppliers selling own produce of handicraft, chicken or vegetables at central markets (7)
Freelancers (11)	Diverse and unpredictable patterns	All over the city	<ul style="list-style-type: none"> • Self-employed in various trades, such as artists, traditional doctors, drivers and construction workers (11)
Long-distance workers (11)	Regular trips outside the city, often being away for longer periods	Other regions of Tanzania or other countries	<ul style="list-style-type: none"> • Formal employees within transport, tourism and international aid (7) • Self-employed importers/exporters (4)
Local workers (52)	Work close to home, with rare and irregular trips primarily related to shopping for raw materials, tools etc.	Central market areas	<ul style="list-style-type: none"> • Casual workers or self-employed in the local business and service sector (37) • Formally employed teachers in public primary schools (5) • Self-employed fishermen in Ununio (4) • Self-employed in small-scale stone-quarrying in Mjimwema (6)
Not economically active (38)	Rare and irregular trips primarily related to social visits, shopping for household necessities and accessing services	Central areas	<ul style="list-style-type: none"> • Housewives (20) • Retirees (13) • Unemployed (5)

The analysis of transport modes revealed a widespread, near-to-universal, dependence on motorized transportation, when residents travel outside of their area of residence, cf. table 3. Vehicle-ownership is limited, so the majority of residents rely on public transport. Cars are the most prominent form of private vehicle. Due to the high costs of owning and using private cars, this is an option only for the wealthier

segments of the population. There is a clear overlap between those owning a car and those commuting daily to the centre. Very few own bikes or motorcycles, and both modes are widely considered unsafe. Likewise only a few residents rely on walking only, when they travel outside of their settlements. They all live in the more consolidated and centrally located area of Br. Mwinyi and have less than 5 km to walk to their work in relatively nearby central areas. Distances to the centre from the further away peripheral areas are simply too large for walking to be a realistic option.

Table 3. Categorization of residents according to primary mode of transportation, when travelling outside area of residence

	Public transport	Private car	Motorcycle	Bike	Walking	Total
Commuters	20	20		1	1	42
Traders	19	1				20
Freelancers	6	3	1			10
Long-distance workers	9	2				11
Local workers	48	1	2	2		53
Dependents	29	7			2	38
Total	131	34	3	3	3	174

In the following section we will model accessibility in relation to the two most prominent transport modes: private cars and public transport. In the first mode, private car owners commonly drive their car the whole trip from residence to destination. This is clearly the most costly transport mode. In the second mode, residents relying on public transport commonly walk between their residence and the nearest bus stop and take minibuses the rest of the way. For residents living in the most interior areas, this mode can involve significant walking distances. Public transport is the cheapest and most commonly used transport mode. In general the travel costs tend to increase with distance. However, fares are paid per minibus, so the total trip cost also depends on the number of buses needed to reach the destination. Residents living at some distance from the main radial roads commonly have to take at least two minibuses to reach the centre.

We will furthermore model accessibility for a third mode combining public transport with private cars or motorcycle taxis. The third mode seeks to capture a variety of different travel practices. For an example residents relying on public transport sometimes choose to take a motorcycle taxi to the nearest main radial road, where minibuses are larger, operate more frequently and at odd hours. Many residents opt for this once in a while for particular trips, e.g. if they are in a hurry, if interior roads are very muddy, if it is late in the evening, if no buses are available in the interior parts, etc. For those living in the most interior areas motorcycle taxis may also be the only alternative to walking very long distances to reach a minibus stop. The use of motorcycle taxi is a more expensive option because it involves payment of a higher fare than the fare for minibuses. The third mode also seeks to capture a cost-saving practice of some private car owners, where they park their car along the main radial road and take a large minibus the rest of the way. Some do so because they consider it too expensive in fuel usage to travel by car all the way to the centre because of congestion, others because of the lack of parking opportunities in the centre.

We therefore consider it analytically useful to distinguish between three overall mode types:

1. Private car mode: Driving car the whole trip between residence and destination

2. Public transport mode: Walking between residence and the nearest bus stop in combination with public transport the rest of the way
3. Combined mode: Driving car or motorcycle taxi between residence and the nearest main radial road in combination with public transport the rest of the way

These mode types are not empirical categories and individual residents may not fit clearly into one of these categories. The specific selection and combination of modes of transportation for a specific trip may be based on a day-to-day evaluation of the financial situation, the availability of transport options and the specificities of the particular trip to be undertaken.

5. Accessibility of peripheral settlements

In this section travel speed data are used to model overall accessibility across the urban territory, distinguishing between varying degrees of accessibility related to the three mode types identified in the previous section. The analysis presents time cost-distance maps for the three mode types illustrating the differentiated accessibility related to different modes of transportation.

In order to extrapolate travel speed data to the total road network of Dar es Salaam, the obtained travel speed data were matched to a digital OSM road map. All track-log points were matched with the nearest road in OSM, a method with several pitfalls which are thoroughly discussed in Møller-Jensen et al. 2012. OSM supports the tagging of each road segment with a specific road type category. A close examination of the OSM data revealed that the classification of roads was often inadequate and that a large portion of roads were unclassified. Therefore it was necessary to manually validate and reclassify the OSM data based on local knowledge obtained during fieldwork and a visual inspection of the roads superimposed on high resolution satellite images. The final road type categories are shown in table 4 and figure 1 map A. For the purpose of this study we assume that private vehicles potentially navigate all roads in the OSM network. This is not the case for the public transport network, though. As no official updated map of minibus routes in Dar es Salaam exists, the extent of the public transport network has been mapped by drawing on our own track-log data, where app. 16.400 track points were recorded while using minibuses. Almost all of the track points recorded with public transport were on roads classified as primary, secondary or tertiary. As a starting point it was therefore decided to assume that minibus services are available on all roads of these types. The public transport network was subsequently adjusted based on local knowledge obtained during fieldwork and comparison with an unofficial overview map of minibus routes produced by blogger Anson Stewart (Ansoncfit.com, 2015).

Average speed levels of different road types for different modes of transportation are summarized in table 4. As expected the average speed levels are generally low across all road types and for both public transport and private cars. It is not possible to identify clear differences in average speed levels of cars vs. public transport on different road types. Speed levels for public transport are not significantly lower as one would expect, given that the minibuses have to drop and pick-up passengers. Across all road types both private cars and public minibuses had an average speed of around 17.5 km/h. Public transport is even the fastest mode on some of the road types. This may be related to driver experience, as the minibus drivers are professional drivers as well as infamous for reckless driving (Kanyama et al., 2004; Kiunsi, 2013; Mrema, 2011; Nkurunziza et al., 2012). It also indicates that speed levels for both these modes are highly influenced by road and traffic conditions. Once vehicles are on the roads, congestion and poor roads ensure that average speed levels are not able to vary significantly. This is furthermore supported by the fact that track points for motorcycles - famous for their ability to navigate both traffic queues and rough roads – had a considerably higher average speed of 26.3 km/h.

Table 4. Overview of road type categories				
Road type category	Total length of roads (km)	No. of track points recorded	Average speed for private cars (km/h)	Average speed for public minibuses (km/h)
Primary roads	218	30,160	18.2	18.3
Secondary roads	70	9,379	15.5	20.7
Tertiary roads	447	13,645	22.4	16.4
Uncategorized peripheral roads	60	1,400	21.0	25.8
Non-planned residential roads	1,107	5,676	10.4	8.6
Planned residential roads ¹	491	1,771	13.6	13.0
Total	2,393	62,031	17.6	17.3
1) Planned residential roads have been identified through automatic identification of parallel roads and curves. A high degree of parallelism is assumed to indicate that the local neighbourhood has been planned and surveyed. This method is the focus of a forthcoming paper.				

Average speed levels of the different road types and means of transportation have been extrapolated to the total road network of Dar es Salaam. This method of extrapolation levels evens out specific differences between individual roads within the same category as well as different segments of the same road. Speed on the main radial roads is often lower on the centrally located road segments as compared to more peripheral segments. Therefore the method is likely to underestimate travel times in the central parts of the city.

City-wide accessibility levels have been computed by applying a time cost-surface analysis in a cell-based, raster GIS-context. This approach allows for a fine-grained analysis of accessibility that takes into account travel times from interior locations outside the road network. In the analysis a grid of 40m x 40m cells has been applied to the entire urban territory. Travel times have been calculated from each of these individual cells by summarizing the time costs of passing through every cell on the least-cost path between the cell of origin and the selected destination. For the purpose of this analysis, the central junction between Morogoro Road and Bibi Titi Mohammed Street was chosen as destination. Cells that represent roads were assigned the average time costs for each travel mode on the specific road type, as provided by the track-log data. Cells outside roads were assigned a time cost value equal to walking the distance by foot with 3 km/h. Barriers such as fences, streams or inaccessible areas are not taken into account, though in reality travellers will rarely be able to walk in straight lines through interior areas. Therefore a relatively slow walking pace of 3 km/h may not be entirely inappropriate.

Accessibility has been computed separately for the three different mode types applying a number of different assumptions:

- In the private car mode travellers are assumed to travel by car all the way from the nearest road to the destination. It is assumed that private cars are able to navigate all roads in the network, but that cars owners are not willing to walk more than 400 meters to reach their car on the road. Areas beyond a 400 meter zone on each side of the roads are therefore assumed to be inaccessible to cars. A 90 minute time-cost is applied to driving a car on-board the Kigamboni ferry. Given that there are often very long queues for cars for the ferry this is a quite realistic time-cost.
- In the public transport mode travellers are assumed to walk to the nearest road serviced by minibuses and take public transport the rest of the way to the destination. The analysis is not able to consider the specific location of bus stops, but simply assumes that travellers switch to public transport at the point where the shortest walking path first meets the nearest road serviced by minibuses. This is not necessarily at the point where minibus stops are located in reality, though. An initial 10 minute time-cost is applied at the shift to public transport, but waiting times in relation to changing minibus routes later along the way are not considered. A 30 minute time-cost is applied to walking on-board the Kigamboni ferry, which is a quite realistic estimate given the queues for the ferry and the walking trips to the nearest bus stop on each side of the ferry.
- In the combined mode travellers are assumed to walk to the nearest road and use either a motorcycle taxi or a private car on the interior roads, until they reach the nearest main radial road. Here travellers are assumed to switch to public transport the rest of the way to the destination. The shift to public transport does not necessarily happen where it would most likely happen in reality, though. As in the public transport mode an initial 10-minute time-cost is applied at the shift to public transport, but waiting times in relation to changing minibus routes later on are not considered.

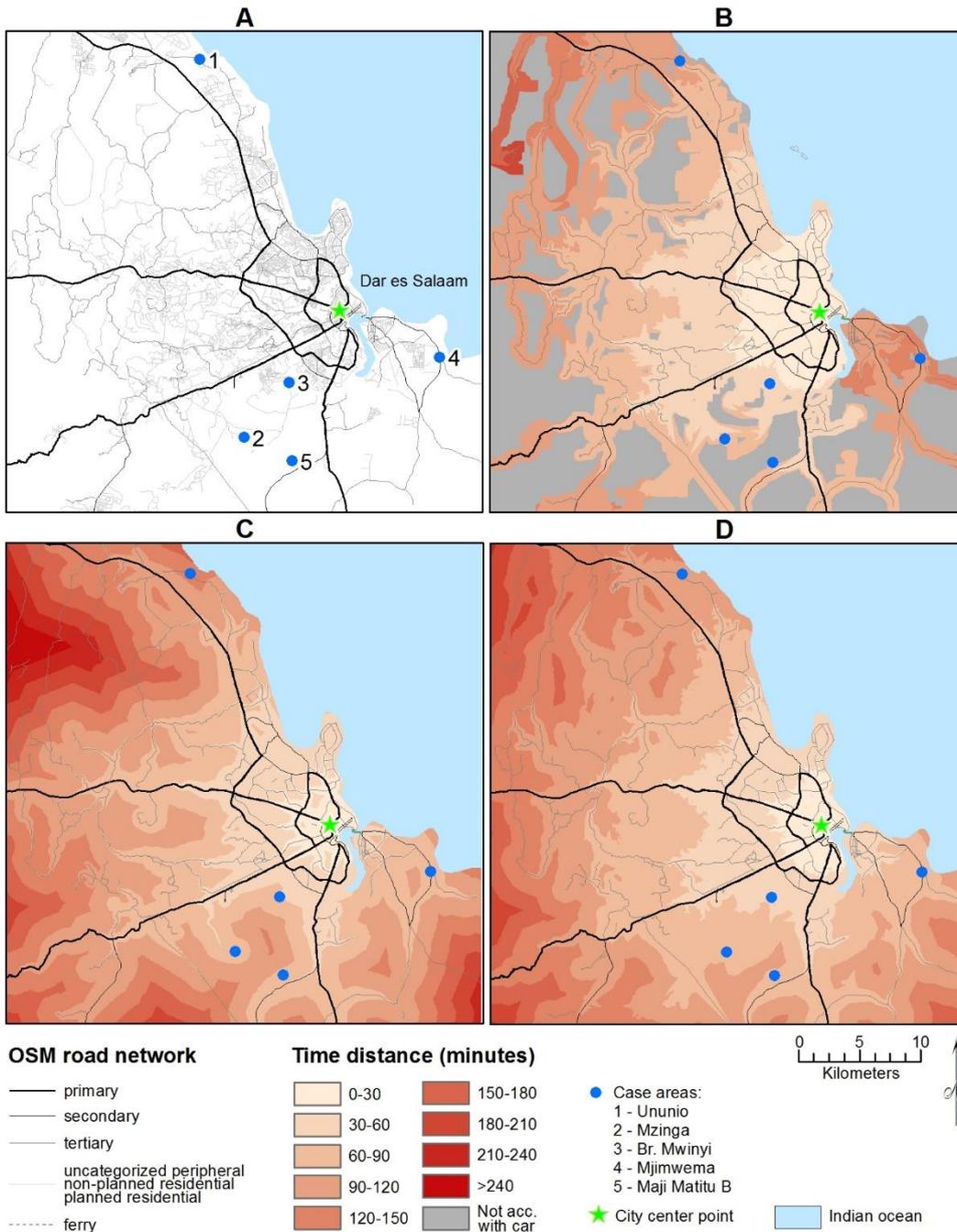
The final cost-distance maps presented in figure 1 provide a visualization of the travel times to the city centre from all parts of the urban territory for all three mode types. It should be noted that travel times are obviously only indicative estimates. Residents often highlight unpredictability as a core feature of transport in Dar es Salaam. Travel time for a specific trip may depend on traffic conditions, congestion, road construction work, weather, road conditions and waiting times in relation to public transport. With that in mind, the maps provide an indication of the very high travel times for residents in the peripheral settlements, esp. those residing in interior areas far from the main radial roads. This is also exemplified in table 5 summarizing the estimated travel times from the selected case study areas. As the track-log data were in many cases obtained at times and directions that avoided the worst rush hour congestion, it is fair to assume that many residents from the peripheral areas will often encounter travel times longer than the maps indicate.

Map B illustrates that private car is the fastest mode, though overall accessibility for private cars is limited in interior areas due to the lack of roads. In reality some of the interior areas may be more accessible to private cars on minor roads or tracks that are not depicted in the OSM road network. Given that roads are very rough, actual accessibility also relies on the specific road conditions and the quality and type of vehicle. For residents on the peninsula of Kigamboni private car is not the fastest mode, due to the very long queues related to bringing the car on-board the ferry. The analysis takes this into account by applying a 90 minute time cost for the Kigamboni ferry in the private car mode. For this reason many car owners on Kigamboni either opt for the combined mode, leaving their car on the Kigamboni side, or take the longer route to the centre via the south-bound main radial road. Interestingly, map B illustrates that while private cars do appear to be marginally faster than the other two modes, the differences between the three modes are not as large as one would expect. This suggests that speed is less influenced by mode of transport and more by road and traffic conditions. While private cars offer a certain measure of comfort and privacy, car owners still have to navigate traffic congestion, queues, jams and the same poor roads as everyone else.

Map C illustrates that public transport is the slowest mode. Given the finding that average speed of private cars and public transport are quite similar, this is primarily related to the limited reach of the public transport network and the subsequent time-costs related to walking to the nearest bus stop. The analysis takes into account that walking distances are longer from interior areas not yet serviced by minibuses. For those living in the most interior areas walking distances can be very long and form a substantial part of the total travel time. The analysis only includes 10 minutes waiting time in relation to the shift to public transport. In practice waiting time can be much longer as bus drivers often prefer to wait until buses are full before leaving a bus stop. Furthermore, the analysis does not take into account waiting times related to changing minibus routes later on. In practice this adds substantially to the total travel time for public transport users. Residents living at some distance from the main radial roads commonly have to take at least two minibuses to reach the centre. Therefore it seems fair to assume that residents using public transport often encounter actual travel times longer than indicated in map C.

Map D illustrates that the combined mode is not necessarily much faster than public transport. Perhaps residents opt for the combined mode less because of speed and more because of the inadequacies of the public transport network in the interior settlements. At certain times motorcycles may be the only option other than walking a very long way, as minibuses servicing the interior areas are few, infrequent and rarely operate at odd hours early in the morning or late in the evening. Minibus services may also retract from interior areas during rainy seasons if roads become too muddy. For those living in the most interior areas, where the minibus network has not reached yet, motorcycle taxis may be the only alternative to walking.

Figure 1.



- A. OpenStreetMap (www.openstreetmap.org) and location of case areas
- B. Cost distance map 1: walk + private car
- C. Cost distance map 2: walk + public transport
- D. Cost distance map 3: walk + motorcycle/car + public transport

Explanations:

Map A provides an overview of the OSM road network as well as location of case study areas.

Map B is a cost-distance map of private car mode.

Map C is a cost-distance map of public transport mode.

Map D is a cost-distance map of the combined mode.

Table 5. Modelled travel times in minutes for journeys to the centre from the five case study areas			
Case study area	Private car mode	Public transport mode	Combined mode
Ununio	89	133	101
Mzinga	59	70	73
Br. Mwinyi	35	52	49
Mjimwema	114	74	71
Maji Matitu B	68	79	78

6. Conclusions

This paper is concerned with access to the city for urban residents living in the periphery of Dar es Salaam, Tanzania. The paper highlights the diversity of residents' mobility practices and illuminates the mobility constraints they experience in relation to the limited accessibility provided by the urban transport system.

GIS-based modelling of overall accessibility provides an indication of the very high travel times endured by residents in the periphery. Accessibility levels have been modelled separately for each of three common commuting practices identified through the qualitative analysis of residents' mobility practices. The analysis therefore takes into account the differing degrees of accessibility related to different transport modes. Previous accessibility studies have looked primarily at accessibility for cars on networked roads (Melbye et al., 2015; Møller-Jensen et al., 2012). The time cost-surface approach of the analysis ensures that public transport as well as the travel time related to walking outside networked roads is taken explicitly into account.

Since there are very little travel speed and commuting time data available for this region – especially broken down by different means of transportation – no possibilities for direct comparison with other data exists. However, commuting times reported by interviewed residents in the case study areas, while providing only limited evidence, are similar in magnitude to the results obtained in the time cost-surface analysis. In the absence of evidence from other substantial quantitative datasets, we suggest that the collected data set is capable of providing an indication of city-wide accessibility that is not unrealistic. However, there are several factors that may influence the trustworthiness of the modelled accessibility levels:

Firstly, accessibility levels in this study rely on the collected travel speed data and the appropriateness of extrapolating these to other similar parts of the Dar es Salaam region, for which no speed data have been collected. The speed data have been generated on the basis of GPS track log data from app. 4000 km of journeys to many areas within the region. However, the collection of speed data is not from the outset designed to be representative. We did not have the possibility to travel with the purpose of collecting speed data on a pre-defined and representative set of roads and time windows. The collection of speed data was done as an add-on to the field work. The routes between the centre and the five case study areas are therefore well-measured directly, while accessibility levels in many other areas are to a higher degree based on extrapolation of the speed data.

Secondly, the least-cost path algorithm that computes the fastest route between a given cell in the periphery and the selected destination in the centre may potentially identify routes that are different from what is actually chosen by residents. This may be a result of incorrect time parameters in the model, but it may also be due to personal preferences or practical circumstances that are not taken into account in the model. Inspection of a number of computed routes from the case areas showed, however, in all cases the expected course.

Thirdly, the majority of the journeys were made in off-peak hours, and those that were made in peak hours commonly went opposite predominant flow directions. Previous studies have shown a reduced level of congestion level in this direction, allowing for higher travel speed (Melbye et al., 2015). While the consequences of the two previous factors are difficult to assess from the available data, the influence of the third factor is clearly an overestimation of the speed levels, and hence underestimations of actual travel times. It is fair to assume that many residents living in the periphery will often encounter travel times longer than the analysis indicates.

Fourthly, in relation to accessibility for public transport users, waiting times are not sufficiently taken into account in the analysis. In relation to the shift to public transport the model applies a fixed time-cost of 10 minutes. This value will in practice fluctuate as a consequence of the practice of having the bus wait until it is completely filled, as well as insufficient bus capacity at certain times and locations. The influence of this factor is also clearly an overestimation of speed levels and underestimation of actual travel times.

The time cost-surface analysis clearly illustrates that residents in the rapidly growing, peripheral areas are severely challenged in terms of accessibility. It can be concluded from this study that accessibility levels in the rapidly growing urban region of Dar es Salaam are low, and, consequently, that travel times between centre and periphery are high. This finding is well in line with previous studies remarking the very poor accessibility of peripheral urban settlements (Melbye et al., 2015; Møller-Jensen et al., 2012) as well as the long journeys endured by residents in the periphery (Kanyama et al., 2004; Khosa, 1995; Khosa, 1998; Olvera et al., 2003; Ojoro, 2011; Sohail et al., 2006; Venter et al., 2007).

Though accessibility is poor, the qualitative analysis of residents' mobility practices reveals a widespread livelihood-related dependency on mobility and regular journeys to the central parts of Dar es Salaam. Regular mobility is an ingrained part of residents' livelihood strategies. Urban-based livelihood activities predominate among residents, and the majority of households rely on one or more members regularly travelling to the central parts of the city in relation to their livelihood activities. This finding underlines the urgent need to tackle the deficit of transport infrastructure and services in the periphery of Dar es Salaam. Road networks in the periphery are clearly insufficient and often in poor condition. Public transport services are insufficient in supply, operate infrequently and rarely at odd hours. The most interior areas remain un-serviced by public transport. While major road improvements are obviously needed in order to improve accessibility of peripheral areas, improvements and expansion of the public transport network are likely to benefit the largest share of people. Reserved bus lanes with dedicated busses and 'stations' may be one of the more effective means, and one such route is currently under implementation along one of the main radial roads in Dar es Salaam.

However, the accessibility problems of peripheral settlements are not easily understood separately from the general dysfunction of the overall mobility system of city. The findings suggest that travel times are less influenced by mode of transport and more by road and, especially, traffic conditions. The analysis shows only a marginal advantage for private cars relative to other transport modes in terms of speed levels, and this difference between the transport modes may seem smaller than one would expect. Therefore measures to improve accessibility in the periphery should feature alongside measures to ease overall congestion.

The mobility constraints that result from the lack of sufficient urban transport services as well as the high levels of traffic congestion severely hamper the general efficiency of the urban mobility system. The

functional structure of the city and the road network are also important factors for understanding and dealing with the mobility problems of Dar es Salaam. Currently, there is an insufficient amount of road linkages between the arterial roads. The majority of vehicles are thus forced onto a few radial highways, which increases the vehicle density and congestion on these roads. The specific geography of Dar es Salaam adds to the congestion levels, with the coastline and harbour providing barriers to traffic flows into the central areas from many directions, leaving only four major access roads between periphery and centre. The majority of government offices and headquarters are located in this part of the city resulting in large in- and outflows to and from the centre.

A significant improvement of the quality and quantity of the road network is required to improve the current situation. It is, however, also necessary to re-think urban development strategies. The current study has focused on accessibility to the central parts of the city. It is clear, however, that the level of accessibility to other parts of the city is also very important. Given the high pressure on the central parts of Dar es Salaam, it seems evident that the city has to develop a more polycentric structure. This strategy would help to reduce the number of people who need to travel to the existing centre on a daily basis, but it also has some important limitations. Generally, it is more expensive to provide public transport services to all destinations in a polycentric urban area compared to a monocentric city. It has been argued that cities that are predominantly monocentric have better potentials for providing efficient public transport for the urban area. This is because a large share of the demand can be covered by high-capacity services in the radial links from the city centre (Bertaud, 2002). Dar es Salaam is, however, characterized by low-density expansion that severely hampers the possibilities for a cost-efficient public transport system, due to the required lengths of the rail or bus lines and the fact that the distances between such links will increase dramatically with distance to the centre. For Dar es Salaam there seems to be no alternative to reducing the importance of the traditional city centre and facilitate the emergence of alternative sub-centres. The recent high-rise building boom in the central parts indicates, however, that this may not happen anytime soon.

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References

- Andreasen MH. (2013) Working Paper 1. Population Growth and Spatial Expansion of Dar es Salaam. An analysis of the rate and spatial distribution of recent population growth in Dar es Salaam. In: Agergaard J (ed) *Rurban Africa Working Papers*. Copenhagen: University of Copenhagen
- Andreasen MH and Agergaard J. (2016) Residential mobility and homeownership in Dar es Salaam. *Population and Development Review* 42: 95-110. 10.1111/j.1728-4457.2016.00104.x
- Andreasen MH, Agergaard J and Møller-Jensen L. (2016) Suburbanisation, homeownership aspirations and urban housing: Exploring urban expansion in Dar es Salaam. *Urban Studies* pre-published April 2016. 10.1177/0042098016643303

- Andreasen MH and Møller-Jensen L. (2016) Beyond the networks: Self-help services and post-settlement network extensions in the periphery of Dar es Salaam. *Habitat International* 53: 39-47. <http://dx.doi.org/10.1016/j.habitatint.2015.11.003>
- Angel S, Parent J, Civco DL, et al. (2011) Making Room for a Planet of Cities. In: Policy LloL (ed) *Policy Focus Report Series*. Cambridge, USA: Lincoln Institute of Land Policy, Ansoncf.it.com. (2015) Accessed at 16th of July 2015. Available at: www.ansoncf.it.com
- Arku G. (2009) Rapidly Growing African Cities Need to Adopt Smart Growth Policies to Solve Urban Development Concerns. *Urban forum* 20: 253-270. 10.1007/s12132-009-9047-z
- Behrens R. (2004) Understanding travel needs of the poor: Towards improved travel analysis practices in South Africa. *Transport Reviews* 24: 317-336. 10.1080/0144164032000138779
- Bertaud, A. (2002) Note on Transportation and Urban Spatial Structure. ABCDE conference. Washington. April, 2002
- Bryceson DF, Mbari TC and Maunder D. (2003) Livelihoods, daily mobility and poverty in sub-saharan Africa. *Transport Reviews* 23: 177-196. 10.1080/0144164032000068966
- CEP. (2010) Monthly Report on Dar es Salaam Travel Time. Center for Economic Prosperity, DART DRTA. (2011) Dealing with congestion: The reform of public transport. *26th National Conference*. Arusha Tanzania
- Esson J, Gough KV, Simon D et al. (2016) Livelihoods in motion: Linking transport, mobility and income-generating activities. *Journal of Transport Geography* 54: 34-40. <http://dx.doi.org/10.1016/j.jtrangeo.2016.04.008>
- Foster V and Briceno-Garmendia C. (2010) Africa's Infrastructure: A time for transformation. Agence Française de Développement and the World Bank
- Gough KV. (2008) 'Moving Around': The Social and Spatial Mobility of Youth in Lusaka. *Geografiska Annaler Series B: Human Geography* 90: 243-255. 10.1111/j.1468-0467.2008.290.x
- Hansen KT. (2005) Getting Stuck in the Compound: Some Odds against Social Adulthood in Lusaka, Zambia. *Africa Today* 51: 2-16.
- Hill A, Hühner T, Kreibich V, et al. (2014) Dar es Salaam, Megacity of Tomorrow: Informal Urban Expansion and the Provision of Technical Infrastructure. In: Kraas F, Aggarwal S, Coy M, et al. (eds) *Megacities*. Springer Netherlands, 165-177. 10.1007/978-90-481-3417-5_12
- Howe J. (2001) Poverty and urban transport in East Africa. *Proceedings of the Institution of Civil Engineers-Municipal Engineer* 145: 267-271.
- JICA. (2008) Dar es Salaam Transport Policy and System Development Master Plan. Dar es Salaam, Tanzania: Japan International Cooperation Agency (JICA),
- Kanyama A, Carlsson-Kanyama A, Lindén AL, et al. (2004) Public transport in Dar es Salaam, Tanzania - institutional challenges and opportunities for a sustainable transportation system. *FOI MEMO*. Stockholm: Totalförsvarets forskningsinstitut,
- Khosa MM. (1995) TRANSPORT AND POPULAR STRUGGLES IN SOUTH-AFRICA. *Antipode* 27: 167-188. 10.1111/j.1467-8330.1995.tb00271.x
- Khosa MM. (1998) 'The travail of travelling': urban transport in South Africa, 1930-1996. *Transport Reviews* 18: 17-33. 10.1080/01441649808716998
- Kiunsi RB. (2013) A Review of Traffic Congestion in Dar es Salaam City from the Physical Planning Perspective. *Journal of Sustainable Development* 6: 94-103.
- Langevang T and Gough KV. (2009) Surviving through movement: the mobility of urban youth in Ghana. *Social & Cultural Geography* 10: 741-756. 10.1080/14649360903205116
- Levy C. (2013) Travel choice reframed: "deep distribution" and gender in urban transport. *Environment and Urbanization* 25: 47-63. 10.1177/0956247813477810
- 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: 1320-1334. 10.1016/j.jtrangeo.2011.02.007

- Macchi S, Ricci L, Congedo L, et al. (2013) Adapting to Climate Change in Coastal Dar es Salaam. AESOP-ACSP Joint Congress, Dublin,
- Marcel B and Ngewe G. (2011) Tumbling the impenetrable road congestion in Dar es Salaam: A commuter service perspective. *26th National Conference*. Arusha , Tanzania,
- Melbye DC, Møller-Jensen L, Andreasen MH, et al. (2015) Accessibility, congestion and travel delays in Dar es Salaam – A time–distance perspective. *Habitat International* 46: 178-186.
<http://dx.doi.org/10.1016/j.habitatint.2014.12.004>
- Mitchell A. (2012) *The Esri guide to GIS analysis v.3: Modeling suitability, movement, and interaction*, Portland: Ringgold Inc.
- Mrema GD. (2011) Traffic congestion in Tanzanian major cities: Causes, impacts and suggested mitigations to the problem. *26th National Conference*. Arusha, Tanzania,
- Møller-Jensen L, Kofie RY and Allotey ANM. (2012) Measuring accessibility and congestion in Accra. *Norsk Geografisk Tidsskrift - Norwegian Journal of Geography* 66: 52-60. 10.1080/00291951.2011.644322
- NBS. (2006) Tanzania Census 2002 Analytical Report. Vol. X. Dar es Salaam, Tanzania: National Bureau of Statistics,
- NBS. (2013) 2012 Population and Housing Census. Population Distribution by Administrative Areas. Dar es Salaam, Tanzania: National Bureau of Statistics,
- Njoh AJ. (1999) Gender-biased transportation planning in sub-Saharan Africa with special reference to Cameroon. *Journal of Asian and African Studies* 34: 216-234. 10.1177/002190969903400205
- Nkurunziza A, Zuidgeest M, Brussel M, et al. (2012) Spatial variation of transit service quality preferences in Dar-es-Salaam. *Journal of Transport Geography* 24: 12-21.
<http://dx.doi.org/10.1016/j.jtrangeo.2012.06.001>
- Ojoro GOM. (2011) Land-use control a necessary additional tool for the sustainable urban transport in Tanzania. *26th National Conference*,. Arusha, Tanzania,
- Olvera LD, Plat D and Pochet P. (2003) Transportation conditions and access to services in a context of urban sprawl and deregulation. The case of Dar es Salaam. *Transport Policy* 10: 287-298.
10.1016/S0967-070X(03)00056-8
- Olvera LD, Plat D and Pochet P. (2008a) Household transport expenditure in Sub-Saharan African cities: measurement and analysis. *Journal of Transport Geography* 16: 1-13.
10.1016/j.jtrangeo.2007.04.001
- Olvera LD, Plat D and Pochet P. (2008b) Walking and nothing more. Daily mobility and poverty Sub-Saharan African cities. *Scripta Nova-Revista Electronica De Geografia Y Ciencias Sociales* 12
- Olvera LD, Plat D and Pochet P. (2013) The puzzle of mobility and access to the city in Sub-Saharan Africa. *Journal of Transport Geography* 32: 56-64. 10.1016/j.jtrangeo.2013.08.009
- OpenStreetMap. (2015) Accessed at 11th of February 2015. Available at: www.openstreetmap.org
- Pieterse E and Hyman K. (2014) Disjunctures between urban infrastructure, finance and affordability. In: Parnell S and Oldfield S (eds) *The Routledge Handbook on Cities of the Global South*. Oxford: Routledge,
- Salon D and Aligula EM. (2012) Urban travel in Nairobi, Kenya: analysis, insights, and opportunities. *Journal of Transport Geography* 22: 65-76. 10.1016/j.jtrangeo.2011.11.019
- Salon D and Gulyani S. (2010) Mobility, Poverty, and Gender: Travel 'Choices' of Slum Residents in Nairobi, Kenya. *Transport Reviews* 30: 641-657. 10.1080/01441640903298998
- Sietchiping R, Permezel MJ and Ngomsi C. (2012) Transport and mobility in sub-Saharan African cities: An overview of practices, lessons and options for improvements. *Cities* 29: 183-189.
10.1016/j.cities.2011.11.005
- Sohail M, Maunder DAC and Cavill S. (2006) Effective regulation for sustainable public transport in developing countries. *Transport Policy* 13: 177-190.
<http://dx.doi.org/10.1016/j.tranpol.2005.11.004>

- Sohail M, Maunder DAC and Miles DWJ. (2004) Managing public transport in developing countries: Stakeholder perspectives in Dar es Salaam and Faisalabad. *International Journal of Transport Management* 2: 149-160. <http://dx.doi.org/10.1016/j.ijtm.2005.06.001>
- UN-Habitat. (2010) A new perspective. Sustainable mobility in African cities. Nairobi: UN-Habitat,
- Venter C. (2011) Transport expenditure and affordability: The cost of being mobile. *Development Southern Africa* 28: 121-140. 10.1080/0376835x.2011.545174
- Venter C, Vokolkova V and Michalek J. (2007) Gender, residential location, and household travel: Empirical findings from low-income urban settlements in Durban, South Africa. *Transport Reviews* 27: 653-677. 10.1080/01441640701450627
- WB. (2002) Cities on the Move: A World Bank Urban Transport Strategy Review. Washington DC: World Bank,