

# IMPROVING ACCESSIBILITY AND MOBILITY IN THE MASIA TRADITIONAL COUNCIL AREA IN VHEMBE DISTRICT MUNICIPALITY, LIMPOPO:

## Application of low-cost access and mobility technologies

**CHARLES NHEMACHENA<sup>1</sup>, JAMES CHAKWIZIRA<sup>2</sup>, SIPHO DUBE<sup>1</sup>  
AND MATHETHA MOKONYAMA<sup>1</sup>**

<sup>1</sup> CSIR Built Environment, PO Box 395, Pretoria, 0001, Tel (Business): +27 (0)12 841 2533 Mobile: +27 (0)83 863 8055; Fax: +27 (0)12 841 4054, Email: [cnhemachena@csir.co.za](mailto:cnhemachena@csir.co.za) ; [cnhemachena@gmail.com](mailto:cnhemachena@gmail.com)

<sup>2</sup> University of Venda, School of Environmental Sciences, Private Bag X5050, Thohoyandou, 0950, South Africa

### ABSTRACT

This study focused on the potential application of low-cost, integrated mobility and access technology interventions as key elements for improving socio-economic conditions and spatial livelihoods in rural areas. A feasibility study was conducted to unpack the access and mobility issues in the Masia Traditional Council area as a Comprehensive Rural Development Programme (CRDP) pilot site of Vhembe District in Limpopo. The study technique involved interrogating existing low-cost access and mobility technologies that can be used as interventions to improve and enhance intra and inter-community movement patterns and travel circulation. Ultimately such transport enhancements should provide robust platforms for strongly supporting socio-economic growth and development of rural communities at the CRDP pilot sites. The study considered integrated infrastructure interventions and generated strategies for implementing affordable access and mobility interventions. These included options such as all-weather roads, footpaths, pedestrian bridges and low-level crossing, all providing access to socio-economic facilities such as schools, clinics, shops and government offices. The results show that over time a number of low-cost access and mobility technologies suitable for application in rural territories have been developed. In making recommendations, the study emphasises that rural transport and development challenges should be addressed from two distinct but complementary perspectives. This study concentrated on the mobility perspective, which favours the deployment and provision of local-level infrastructure and services. Such approaches make transport and travel movement and circulation easier, efficient, effective and more convenient. In addition to providing more infrastructure, longer-term development planning should aim to locate facilities closer to the people, leading to self-contained rural neighbourhoods and communities.

*Keywords: Low cost, technology, interventions, access, mobility, Masia Traditional Council Area, South Africa*

## 1 INTRODUCTION AND PROBLEM STATEMENT

Transportation is a strategic factor in the dynamics of rural development and social change (Johnston & Mellor, 1961; FAO, 2004; Mashiri et al, 2002; World Bank, 2008; Chakwizira & Mashiri, 2009). Thus, rural transport infrastructure and services are key drivers of rural development. Transportation links factories and industries with markets, making it possible for finished products and industrial inputs to be available at the right time, at the right place, in the required form and desired quantities (IFAD, 2004; Chakwizira et al, 2008). Available literature (Kilkenny, 1998; FAO, 2004; IFAD, 2004; World Bank, 2008, Mashiri et al, 2008) suggests that investments in rural road construction and maintenance can have a significantly positive impact on rural incomes and quality of people's lives.

Until the beginning of the 1980s, it was widely accepted that all-weather motorised road and rail networks would provide adequate accessibility to rural areas in developing countries (World Bank, 2008). It was assumed that public investment in the physical infrastructure for motorised vehicles would eventually create an environment where the transport needs of all would be catered for adequately (IFRTD, 2007). After the 1990s, uncertainties were increasingly expressed about how well motorised transport could accommodate the full range of transport needs in rural areas where most people make little or no use of such transport (World Bank, 2008). The ability and suitability of motor vehicles to respond to the full range of transport needs in remote rural areas in particular remain questionable.

There is a growing appreciation that, at the local level, the conventional transport system will not cater fully for all movement, travel needs and demands (Chakwizira, 2010). This led to local level transportation planning and a host of appropriate access interventions. Finding the correct mix and balance of implementing community access technologies is still a huge challenge. This study seeks to involve local communities in improving their own mobility and access to reliable transport. It is earmarked for implementation in the Masia Traditional Council Area of Vhembe District in Limpopo.

The Comprehensive Rural Development Programme (CRDP) is cross-cutting and comprehensive, developed in collaboration with all sector departments and clusters through the Medium Term Strategic Framework (MTSF, 2009-2014) and the government's programme of action. The CRDP encompasses three distinct components, namely agrarian transformation, rural development and land reform. The vision of the CRDP is to create vibrant, equitable and sustainable rural communities including:

- contributing to the redistribution of 30% of the country's agricultural land;
- improving food security of the rural poor;
- creating business opportunities, de-congesting and rehabilitation of over-crowded former homeland areas; and
- expanding opportunities for women, the youth, people with disabilities and older persons who stay in rural areas.

Lack of basic infrastructure such as roads, water and electricity that characterises many rural areas entrenches the problems of poverty and limits the potential of communities to engage in productive socio-economic activities. South Africa still faces challenges relating to access to free basic services and government services such as education and health care in many rural areas (ANC, 2007). Lack of access is one of the principal contributing factors to poverty. In many rural areas, physical access remains a critical challenge with some rural communities being without all-weather road access and others having no road access at all. The Masia Traditional Council Area experiences some of these challenges.

Improved rural transport infrastructure and services provide proximity (reduced travel times between origins and destinations) and mobility, thereby increasing physical and economic access. The need remains for improved rural infrastructure, particularly roads and other services such as portable water, electricity and irrigation.

## **2 RATIONALE AND MOTIVATION**

Low-cost community access infrastructure technologies are a key component of rural development and important ingredient for ensuring sustainable poverty reduction. Advantages of investing in low-cost community access infrastructure technologies as the foundation for unlocking the potential for local economies include: (a) a reduction in transaction costs and costs of inputs used in production; (b) enabling individuals, government, business or civil society to invest in the local economy; and (c) the technologies facilitate trade and entrepreneurship.

Investments in community access and network infrastructure create opportunities for wider thinking, entrepreneurship and the promotion of trade with neighbouring economies. This includes integration with the larger national economy; creation of employment, for example public works models; enhanced human capital development; and attracting improved service provision (World Bank, 2008; Chakwizira et al., 2010; Nhemachena et al., 2010).

In September 2009, the University of Venda (UNIVEN) signed a memorandum of understanding (MoU) with the Masia Development Trust (MDT). The Centre for Rural Development and Poverty Alleviation (CRDPA) at UNIVEN was tasked to spearhead implementation of the MoU together with the MDT. Subsequent participatory engagement with children (boys and girls at least seven-years old), the youth, women, men and community leaders in the 13 villages that constitute the Masia Traditional Council Area yielded an integrated Masia community development plan. On 31 July 2010, leaders of all community institutions and organisations in the Masia Traditional Council Area adopted the development plan as the fundamental roadmap for achieving sustainable social change in the community.

Strategic goal number 3 of the development plan states “to enhance the provision of basic services to the Masia community”. The third objective of this goal is “to improve reliability of transport services”, with some of the activities to be implemented to achieve this clearly distilled as: (a) Liaise with Makhado Municipality to improve maintenance of access roads; (b) Promote the adoption and maintenance of sections of access roads by local communities; and (c) Introduce appropriate road construction and maintenance technologies.

This study was designed to improve rural mobility and access in the Masia Traditional Council Area in the Vhembe District of Limpopo. The main objective was to analyse, and spatially map the community access and network infrastructure technology requirements for improving transport and access infrastructure in the Masia Traditional Council area.

## **3 THEORETICAL FRAMEWORK**

### **3.1 Poverty, economic growth and rural transport services**

The achievement of several Millennium Development Goals (MDGs), including those relating to health, maternal and child mortality and education, depends on better access to services, which requires better transport infrastructure and transport services. Starkey et

al. (2006) showed that availability of dependable and affordable transport services was associated with improved productivity. These findings underscore the importance of improvements in local accessibility as a prerequisite for achieving rural growth and meeting the MDGs.

Roads in a poor condition lead to long journey times; unreliable services; high operating costs; high fares; poor access to health (and consequently higher mortality); poor access to education (and consequently lower school attendance); and low participation by rural people in the regional and national economy. Starkey et al. (2006) provide examples where road improvements have led to improved services and lower fares, with greater access of villagers to markets and social services. The same study also provides examples where road deterioration has led to reduced services, higher fares and increased isolation from markets and services.

Interventions focusing on improving mobility should consider a combination of appropriate transport infrastructure, improved transport services and affordable means of transport, both motorised and non-motorised (Department of Transport, 2007). About 50% of the South African population resides in rural areas, with these areas containing 72% of the poor. The rural areas face insufficient access to basic socio-economic services compared to urban areas. Based on this, improving rural transport infrastructure and services provides an important intervention for stimulating local socio-economic development, improved social access and poverty reduction in South Africa's rural areas (Department of Transport, 2007).

Empirical evidence shows that accessibility is an important factor in poverty reduction efforts (Bird *et al.*, 2007; Dercon, 2006; CPRC, 2005; and Bird and Shepherd, 2003). For example, improved access to markets in rural areas encourages diversification of rural economies through opening up markets to villagers who wish to sell their labour, artisanal products or agricultural produce. Alternatively, poorly connected remote areas both physically and in terms of communications are characterised by market imperfections that limit agricultural productivity and other rural livelihoods leading to high levels of poverty (CPRC, 2005; Yao, 2003).

### 3.2 Accessibility measurement and operationalisation

Various accessibility definitions are available in literature; accessibility is broadly defined as the ability of people to reach and engage in opportunities and activities (Farrington and Farrington, 2005; Gulliford et al., 2002). The various definitions of accessibility consider two key issues: (a) availability of services (having access to these) and (b) the individual's ability to utilise the available services (gaining access). Two perspectives of accessibility have been defined in literature: (a) non-spatial (socio-economic) and (b) spatial (Bisht et al., 2009). Non-spatial dimensions (means of access such as travel and communications) are an integral part of accessibility (Martin and Reggiani, 2007; Farrington and Farrington, 2005). This points to the importance of information as a determinant of accessibility. The World Bank defines rural accessibility as the accessibility of basic social and economic services to persons in dispersed rural homesteads and settlements.

The spatial dimension of accessibility has been mainly considered in accessibility measurement and operationalisation. This relied predominantly on measures of accessibility based on geographic information systems (GIS) (Bisht et al., 2009). Other studies (Bisht et al., 2009; Martin and Reggiani, 2007; Farrington and Farrington, 2005) have looked at a more holistic dimension of accessibility by considering the non-spatial

component as well. It is clear from literature that accessibility goes beyond the spatial dimension to include socio-economic and other non-spatial dimensions. This study also looks at the holistic dimension of accessibility taking into account the two dimensions. The study thus underscores the importance of both the locational relationship between service providers and surrounding populations; and the means of access to services. Distance is argued to be an important variable affecting the access to resources in studies that have considered the spatial dimension of accessibility. The present study takes into account measures of distance (as the spatial dimension) along with the accessibility index to help obtain a more comprehensive measure of accessibility to facilitate better informed policy decisions.

The traditional approach to measure accessibility was exclusively physical and based on the geometric structure of communications that is road, rail and air networks. The sum of the shortest path distances was used to the measure of accessibility of a place via the network between it and all other places in the system (Garrison, 1960). Accessibility was further analysed based on network analysis that was refined from time to time (Armstrong, 1972). According to Forbes (1964) travel time became the simple measure of accessibility when distance was qualified by the availability of transport services for non-car users.

Earlier studies on accessibility replaced the focus on accessibility to places with accessibility to specific functions or activities such as work, shopping, schools, hospitals and recreational outlets (Breheny, 1974). Traffic flow patterns was used as a measure of accessibility, calibrating distance exponents according to observed traffic flow patterns (Dalvi and Martin, 1976). Conventional transport policies fail to consider that mobility and accessibility needs vary widely across different populations, based on variables such as age, family role and stage in life-cycle (Markovitz, 1971). This implies that transport planning needs to be holistic to satisfy the varying travel needs across different population groups.

Further development of accessibility measures saw the emphasis of the importance of accessibility on specific activities or functions, defined social groups based on car ownership and time available for travel. The measures enumerated people's ability to use these functions at suitable times and frequencies (Moseley et al., 1977; Nutley, 1989). Farrington and Stanley (1978) applied an approach of taking into account the constraints (social, economic, land use, transport) that limit the ability of the prevailing transportation system to satisfy travel needs.

There was increased emphasis on accessibility needs and priorities of rural populations as empirical evidence on the impact of rural transportation on rural development had extremely mixed results, implying many other factors than improved transport-stimulated rural development (Sarkar and Mashiri, nd). This emanated in the focus on a coordinated and integrated set of interventions to meet access needs culminating in the development of Integrated Rural Accessibility Planning (IRAP) since the 1980s. The IRAP approach has been applied in a number of countries including Tanzania, the Philippines, Bangladesh, Malawi and Zimbabwe (Affum and Farhad 1995; Barwell and Jonathan 1993; Connerley and Schroeder 1996; Edmonds et al., 1994; Howe 1983; Ahmed et al., 1995; Sieber 1996; and Ali-Nejadfard, 1997). The approach emphasises participatory, local-level planning, training, prioritisation of access interventions and allocation of investments.

## 4 STUDY APPROACH AND METHODS

The preferred approach to measuring accessibility is the analysis of household surveys that include appropriate questions about access to transport (World Bank, 2006). This enables integration of household characteristics such as income, and access to services such as education, health and clean water supply. The study approach included a review of secondary information on rural accessibility; a pre-field visit, and a field visit for primary data collection at the village level. Interviews were conducted with key stakeholders in each village. The pre-field visit allowed researchers to refine the data collection tools and provided them with a good perspective of the area. The field work was aided with photography, secondary GIS data; and recording of global positioning system (GPS) coordinates on key identified points such as activity centres and infrastructures that require attention. Making use of the rapid assessment approach (Starkey et al., 2006), researchers made observations during the field work that allowed a unique opportunity to see a large range of road conditions, transport technologies and rural transport situations in the study area. Digital cameras were used to capture some of the observations and a GPS recorder was used to record coordinates of the observations necessary to build a spatial map of the existing transport infrastructure and services in the area.

Participatory interviews were conducted with stakeholders in each village. The interviews involved wide-ranging and open-ended discussions rather than 'question and answer sessions'. The researchers developed a village-level survey and household-level questionnaire for data collection. The former was designed to gather information on infrastructural facilities and services available in the area. The main objectives were to collect information on population, location of facilities and services, existing road conditions and public transport services. The later was designed to collect travel behaviour information mainly about the trip details of the family members, the importance put on easy accessibility to different activity centres by the respondents and the satisfaction levels with the existing accessibility levels. The respondents were asked to express their opinion in the form of satisfaction levels with the accessibility to various activities.

## 5 FINDINGS AND DISCUSSIONS

### 5.1 Satisfaction levels with present accessibility to activities

The household level data were used to determine satisfaction with present accessibility levels to activities. The respondents were asked about their satisfaction with accessibility levels to activities they are involved with such as work, education etc. Table 1 presents the rating of importance of accessibility to activity centres by households. The results clearly show that accessibility to schools, water sources, clinics, shops, the bank and post office was highly rated (73% and above) by households.

**Table 1: Importance of accessibility to activity centres**

Activity centre	Very important (%)	Important (%)	Not important (%)	Not very important (%)
Work	61.36	9.09		
Shop	72.73	22.73		4.55
Market	34.09	18.18	2.27	
Education/school	93.18		2.27	

Clinic	77.27	13.64		
Recreation	25.00	13.64		9.09
Church	68.18	15.91	4.55	
Pension point	56.82	6.82	4.55	
Post office/Telephone	75.00	11.36		4.55
Bank	72.73	22.73		
Crèche	43.18	6.82	4.55	
Police station	59.09	27.27	4.55	
Court/administrati on	25.00	38.64	9.09	2.27
Water source	86.36	6.82		
Firewood source	54.55	15.91	11.36	
Service station	65.91	29.55		

Table 2 below summarises the location and modes of transport used to get to activity centres and satisfaction levels of communities with the means of transport available. The results show that for activity centres located within the villages, communities usually walk and rely on public transport for those located outside their villages and also far away. Among the activity centres that scored high in terms of importance of accessibility (schools, water sources, clinics, shops, banks and post offices) the community members usually walk to access these. Satisfaction levels are generally low on the quality of roads and transport to get to the centres, including for the services highly-rated in terms of importance of accessibility.

**Table 2: Mode of transport to activity centres and satisfaction levels with quality of roads and transport means to activity centres**

Activity centre	Location of centre (%)	Mode of transport		Quality of roads and transport means to get to activity centre	
		Walk (%)	Bus/Taxi (%)	Good (%)	Poor (%)
Work	75.00	30.77	69.23	21.74	78.26
Shop	75.86	71.43	28.57	50.00	50.00
Market	83.33	27.78	72.22	50.00	50.00
Major market	0.00	0.00	100.00	48.65	51.35
Primary school	100.00	90.48	9.52	35.71	64.29
Secondary school	90.00	57.69	42.31	28.57	71.43
Tertiary education	0.00	0.00	100.00	41.67	58.33
Clinic	66.67	63.16	36.84	38.71	61.29
Hospital	0.00	0.00	100.00	45.71	54.29
Recreation	87.50	70.00	30.00	100.00	0.00
Church	100.00	86.11	13.89	38.89	61.11
Pension point	100.00	68.42	31.58	45.45	54.55
Post office/Telepho ne	75.00	61.76	38.24	25.00	75.00

Bank	0.00	2.44	97.56	35.14	64.86
Crèche	66.67	15.38	84.62	58.33	41.67
Police station	40.00	5.56	94.44	37.50	62.50
Court	37.50	0.00	100.00	29.17	70.83
Administration	0.00	25.00	75.00	33.33	66.67
Water source	85.71	100.00	0.00	42.11	57.89
Firewood source	87.50	100.00	0.00	15.79	84.21
Service station	60.00	42.86	57.14	10.00	90.00

## 5.2 Impacts of poor accessibility

The poor accessibility levels adversely affect the community members' travel behaviour and socio-economic potential. The results show that most of the respondents (84%) indicated that they would like to travel further than they are currently doing (Table 3). The main motivation cited for the need to travel further is to increase their income levels by taking products/services to bigger markets, while others felt they would be able to commute to work in far-off places like Thohoyandou and Makhado. About 66% of the respondents indicated that they are not willing to leave their area permanently, citing the need to develop their area and vested property rights. However, about 27% indicated that they would want to leave their area permanently to look for opportunities elsewhere.

A possible explanation for the above finding is that the communities are already organised in the Masia Development Trust and the earlier engagements which led to the development of the MDP have enlightened the members to the potential they have to contribute to local economic development in the area. This is a strength for efforts to improve local accessibility. One could harness this passion for local economic development and engage with the communities to help contribute to improving local accessibility using low-cost interventions. For example, the members can be organised to maintain sections of footpaths, tracks, etc. in their villages using local tools and materials.

**Table 3: Percentage of respondents who would like to travel further**

Variable	Yes (%)	No (%)
Would like to travel further	84.09	9.09
Would travelling further be useful	81.82	9.09
Would like to leave place permanently	27.27	65.91

Rural access changes have differential impacts across various sections of the population. The socio-economic impact of increased access varies by gender, age groups, different ethnic groups and income. For example, improved access potentially increases men's migration and may result in increased workload on women on farms and in households. Similarly, improved motor access brings consumption goods nearer to households, but affects rural artisans and those residents whose livelihoods depend on pottering. For policy makers, this underlines that transport interventions often need to be coupled with complementary policies if all socially and economically disadvantaged households are to reap the benefits of improved access (World Bank, 2006).



### 5.3 Interventions to increase accessibility levels of villages

The results presented in Table 2 show that the satisfaction levels of accessibility are generally poor. As a result of lack of reliable transport systems, rural household members are forced to spend significant time travelling to meet basic needs.

Some of the accessibility problems relating to accessing activity centres of importance to the community, such as schools and health facilities, include lack of transport to reach the facilities that are far from some of the villages, such as clinics. For example, there are only three clinics in Masia area and the location of these is far for some of the villages implying that they would require transport to get there. However, most of the villagers walk long distances (more than 4 km) to get to the clinic as they cannot afford to make use of transport or their location offers no direct transport to the clinic.

All villages reported that the current bridges and crossing points get flooded during the rainy season (seasonal flooding problems), cutting down supplies and accessibility to activity centres such as local shops, clinics and schools. This is a major problem for children who at times have to walk further than 5 km because crossing points are flooded, such as in De-Hoop village. Also, the clinic becomes inaccessible and the ambulances cannot reach the clinic, causing a health risk to patients who might be referred to hospitals for further treatment. At times, there are even cases of people drowning at some of these flooded crossing points..

The community members reported that maintenance and drainage of most local access roads such as footpath, tracks, earth roads, and gravel roads are poor. The community members regarded the maintenance of upgrading and maintaining local roads to be the role of the municipality. Although the field work was conducted after heavy rains in the areas and across the whole country, an earlier pre-field visit showed that local access roads were not maintained by communities. As a result, local access roads such as tracks and footpath were observed to be badly damaged. Figures 1 and 2 show some of the damaged sections of some local access roads in the community. This is an area where the local community members can be organised to contribute to upgrading and maintenance of local roads, especially local access roads. Local materials can be used to address these problems using simple tools and materials like stones.



**Figure 1: Sections of damaged local access roads and crossing points in Masia**



**Figure 2: Children crossing a small stream from De Hoop primary school (left) and another crossing point in Tshiphuseni (right)**

## **6 CONCLUSIONS AND RECOMMENDATIONS**

The study focused on the potential application of low-cost integrated mobility and access technology interventions as key elements for improving socio-economic conditions and spatial livelihoods in rural areas. This was motivated by the observation that affordable and reliable transport is critical for rural communities to access and exploit basic services and resources. However, existing challenges relating to geographical isolation, long distances, poverty levels, poor infrastructure and limited transport services in rural and peri-urban areas of South Africa inhibit the meeting of basic access and mobility service levels.

Scoping and interrogating existing community access and mobility technologies for appropriateness to responding to the rural development agenda in South Africa is an important policy and intervention issue. The study considered integrated infrastructure interventions and generated strategies for implementing affordable access and mobility interventions. These included options such as all-weather roads, footpaths, pedestrian bridges and low-level crossings, all providing access to socio-economic facilities such as schools, clinics, shops and government offices.

In making recommendations the study emphasises that rural transport and development challenges should be addressed from two distinct but complementary perspectives. This study concentrated on the mobility perspective, which favours the deployment and provision of local-level infrastructure and services. Such approaches make transport and travel movement and circulation easier, efficient, effective and more convenient.

The other perspective, which was not the focus of this study, is a location approach. This considers that the placement and provision of facilities and services are responsible for trip generation, travel behaviour, traffic flow and movement patterns.

In addition to providing more infrastructure, longer-term development planning should aim to locate facilities closer to the people, leading to self-contained rural neighbourhoods and communities.

## REFERENCES

- ANC, 2007. Discussion document towards a resolution on rural development, land reform and agrarian change, The National Policy Conference of the ANC, Gallagher Estate.
- Bird, K and Shepherd, A, 2003. Livelihoods and chronic poverty in semi-arid Zimbabwe. *World Development* 31, No 3, pp: 591–61.
- Bird, K, McKay, A and Shinyekwa, I, 2007. Isolation and poverty: the relationship between spatially differentiated access to goods and services and poverty. Paper presented at the International Workshop “Understanding and addressing spatial poverty traps”, Stellenbosch, South Africa, 29 March 2007.
- Bisht, SS, Mishra, V and Fuloria, S, 2009. Census Based Accessibility Index: A Tool for Policy Initiatives Evaluation, IGIDR Proceedings/Project Reports Series PP-062-18. <http://www.igidr.ac.in/pdf/publication/PP-062-18.pdf> Accessed 15 November 2010.
- Chakwizira, J, Nhemachena, C and Mashiri, M, 2008. Using the Integrated Rural Mobility Access Programme to Prospering Rural South Africa, 2<sup>nd</sup> Biennial CSIR Conference, 17-19 November, 2008, Pretoria, South Africa.
- Chakwizira, J, 2010. Stretching the concept of the expanded public works programme in South Africa: Tracing the footsteps and gauging the footprints - the unfinished rural development transformation story. 29th Annual Southern African Transport Conference, "Walk Together", CSIR International Convention Centre, Pretoria, South Africa, 16-19 August 2010, pp 240-254.
- Chakwizira, J and Mashiri, M, 2009. The Contribution of transport governance to socio-economic development in South Africa, SATC 2009, Pretoria, South Africa
- Chronic Poverty Research Center (CPRC), 2005. The chronic poverty report 2004-05. Manchester: Institute of Development Policy and Management/CPRC.
- Deichmann, U, 1997. Accessibility Indicators in GIS. Department for Economic and Social Information and Policy Analysis. United Nations Statistics Division. pp 24.
- Department of Transport, 2007. Rural Transport Strategy for South Africa, Department of Transport, South Africa.
- Farrington, J and Farrington, C, 2005. Rural accessibility, social inclusion and social justice: towards conceptualization. *Journal of Transport Geography*. 13 (1):1–12.
- Gulliford, M, Figueroa-Munoz, J, Morgan, M, Hughes, D, Gibson, B, Beech, R and Hudson, M, 2002. What does ‘access to health care mean? *Journal of Health Services Research and Policy*, 7(3), 186–188.
- IFAD, 2004. Guidelines for the incorporation of land tenure issues into IFAD-supported operations in Eastern and Southern Africa. Rome, March 2004.
- Sixth Annual State of Logistics survey of South Africa, 2009. CSIR Built Environment, Pretoria.
- Johnston, B and Mellor, J, 1961. The role of agriculture in economic development, *American Economic Review* 51, 566-593.
- Kilkenny, M, 1998, Transport Costs and Rural Development, *Journal of Regional Science*, 38 (2): 293-312.
- Mashiri, M, Naude, A and Nchabeleng, AI, 2002. Rural Transport Strategy for South Africa, Department of Transport, South Africa, Pretoria.

Mashiri, M, Chakwizira, J and Nhemachena, C, 2008. Rejecting the inevitability of poverty”: Empowering women for sustainable rural livelihoods through community-based employment intensive rural infrastructure maintenance projects. Science Real and Relevant: 2nd CSIR Biennial Conference, CSIR International Convention Centre, Pretoria, 17-18 November 2008.

Martin, JC and Reggiani, A, 2007. Recent Methodological Methods to Measure Spatial Interaction: Synthetic Accessibility Indices Applied to High-Speed Train Investments. *Transport reviews*. 27(5): 551–571.

Sarkar, AK and Mashiri, MA, nd. Quantification of accessibility levels of rural areas: a case study in the Northern Province, South Africa. CSIR Transportek, Pretoria, South Africa.

Starkey, P, Awadh, A, Fernando, P, Murray, P, Musonda, H, Njenga, P, Newport, S, Sirpé, G, Tapper, L and Tchinda, K, 2006. Rapid Assessment of Rural Transport Services. Intermediate Technology Consultants (ITC)

Yao, X, 2003. Infrastructure and poverty reduction – making markets work for the poor. Economic and Research Department Policy Brief No. 14. Manila: Asian Development Bank.

World Bank, 2006. Rural Access Index: A key development indicator, The International Bank for Reconstruction and Development/The World Bank 1818 H Street NW, Washington, DC 20433

World Bank, 2008. Agriculture for development. World Development Report 2008, Washington, DC October 2007.