Budget Support and the Development of Infrastructure in Zambia

Background Paper for the Evaluation of Budget Support in Zambia

Please note: This report reflects the findings of field missions in the first half of 2010 and additional information gathered up to October 2010. The findings served as background information for: A. de Kemp/J. Faust/S. Leiderer (2011): Synthesis Report – Between high expectations and reality: An evaluation of budget support in Zambia (2005-2010)

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Contents

List of Tables

List of Figures

List of Abbreviations

AADT	Average annual daily traffic
AfDB	African Development Bank
AICD	Africa Infrastructure Country Diagnostic
AWP	Annual work plan
BADEA	Arab Bank for Economic Development in Africa
BMZ	German Federal Ministry for Economic Cooperation and Development
CP	Cooperating Partner
CSO	Central Statistical Office
CU	Commercial Utility
DANIDA	Danish International Development Agency
DfID	Department for International Development
DHID	Department of Housing and Infrastructure Development
DHS	Demographic and Health Surveys
DTF	Devolution Trust Fund
DWA	Department for Water Affairs
D-WASHE	District-Water, Sanitation and Hygiene Education
ERB	Energy Regulation Board
EU	European Union
FNDP	Fifth National Development Plan
GBS	General budget support
GRZ	Government of the Republic of Zambia
IOB	Policy and Operations Evaluation Department of the Dutch Ministry of Foreign Affairs
JICA	Japan International Cooperation Agency
LA	Local Authority
LCMS	Living Conditions Monitoring Survey
MACO	Ministry of Agriculture and Cooperatives
MCDSS	Ministry of Community Development and Social Services
MCT	Ministry of Communications and Transport
MEWD	Ministry of Energy and Water Development
MLGH	Ministry of Local Government and Housing
MMMD	Ministry of Mines and Mineral Development
MoE	Ministry of Education
MoFNP	Ministry of Finance and National Planning
MoH	Ministry of Health
MoU	Memorandum of Understanding
MPW	Ministry of Public Works
MTEF	Medium Term Expenditure Framework
MTENR	Ministry of Tourism, Environment and Natural Resources
MWS	Ministry of Works and Supply
NCC	National Council for Construction

NRFA	National Road Fund Agency
NRWSSP	National Rural Water Supply and Sanitation Programme
NUWSSP	National Urban Water Supply and Sanitation Programme
NWASCO	National Water Supply and Sanitation Council
O+M	Operation and Maintenance
ORUC	Other road user charges
PAF	Performance Assessment Framework
PPP	Public Private Partnership
PRBS	Poverty Reduction Budget Support
RDA	Road Development Agency
REA	Rural Electrification Authority
REF	Rural Electrification Fund
REMP	Rural Electrification Master Plan
ROADSIP	Road Sector Investment Programme
RRU	Rural Road Units
RTSA	Road Transport and Safety Agency
SBS	Sector budget support
SIDA	Swedish International Development Cooperation Agency
SNDP	Sixth National Development Plan
SOMAP	Sustainable Operation & Maintenance System
UFW	Unaccounted for water
UNICEF	United Nations Children's Fund
V-WASHE	Village-Water, Sanitation and Hygiene Education
WASHE	Water, Sanitation and Hygiene Education
WSS	Water supply and sanitation
ZACCI	Zambia Association of Chambers of Commerce and Industry
ZDA	Zambia Development Authority
ZESCO	Zambian Electricity Supply Company
ZKM	Zambian Kwacha

Executive Summary

This report reflects the findings of field missions to Zambia in the first half of 2010 and additional information gathered up to October 2010. The findings served as background information for: A. de Kemp/J. Faust/S. Leiderer (2011): Synthesis Report – Between high expectations and reality: An evaluation of budget support in Zambia (2005-2010).

In the course of the aid effectiveness debate, international development cooperation has witnessed a shift in aid modalities. Over the past decade, donors have increasingly focused on budget support, considering it to be an effective instrument to enhance donor harmonisation, the alignment of development cooperation to partner countries' strategies, and the ownership of partner countries, thereby contributing to more effective and efficient development cooperation and more sustainable development in general. Given the growth of budget support and the increasing demand for the assessment of its effectiveness, a series of evaluations of budget support were commissioned, one of them being the evaluation of budget support in Zambia covering the period from 2005 to 2010. The evaluation was led by the Evaluation Department of the German Federal Ministry for Economic Cooperation and Development (BMZ), the Policy and Operations Evaluation Department (IOB) of the Netherlands Ministry of Foreign Affairs, and the Secretariat for the Evaluation of the Swedish International Development Cooperation Agency (SIDA), working closely with the Ministry of Finance and National Planning (MoFNP) in Zambia.

The whole series of budget support evaluations, including the Zambian one, was based on a comprehensive evaluation methodology developed by a group of Cooperating Partners (CPs) of budget support that takes into account the complex effects of budget support. It follows a three step approach: In a first step, the contribution of budget support to government policies is analysed by focusing on evaluation questions related to inputs, direct outputs, and induced outputs. In a second step, the outcomes and impacts concerning the livelihoods of the population of the partner countries are assessed to which budget support has contributed via the national government's policies. To this end, case studies on different sectors were carried out that serve as background information for the actual budget support evaluation. Finally, the results of the first and the second step are synthesised (third step), the results for Zambia being presented in the Synthesis Report (2011) mentioned above. The report presented here summarises the findings of a case study on the infrastructure sector in Zambia conducted by the Independent Evaluation Department of KfW Entwicklungsbank, Germany. It thus provided input for the Zambian budget support evaluation as part of step two. In particular, the aim of this study is firstly, to analyse how budget funds and sector budget support had an impact on the development of infrastructure, and secondly, to assess the impact of the development of infrastructure in Zambia.

Within the Zambian budget support process, the Performance Assessment Framework (PAF) is the main reference to measure progress based on performance indicators jointly agreed upon by the Government of the Republic of Zambia (GRZ) and the CPs. In the PAF, the infrastructure sector is divided into three sub-sectors: the roads sector, the power sector, and the water supply and sanitation (WSS) sector. In the scope of this study, the roads sector and the WSS sector are chosen for in-depth analyses, whereas the power sector is briefly discussed by means of a literature review. Both qualitative and quantitative research methods are applied in the study. Extensive analyses of existing studies and relevant policy documents on the sectors serve as the basis for the evaluation. Furthermore, qualitative findings result from interviews with important stakeholders including ministries, government and sector institutions, and donors active in the respective sector as well as from field visits of the evaluation team to Southern Province, Eastern Province, and to peri-urban areas of Lusaka. Regarding the quantitative analyses, emphasis is placed on using existing data. Descriptive statistics, comparisons over time as well as econometric analyses are based on two representative household surveys, the Living Conditions Monitoring Survey (LCMS) and the Demographic and Health Survey (DHS). Econometric techniques are used to identify causal effects of

access to roads and access to improved WSS, respectively, on the living conditions in rural areas, specifically on poverty, education, and health. Firstly, fixed effects panel regressions on chief-area-level are performed based on the LCMS 1998 and 2006. Secondly, propensity score matching on household-level is applied based on the individual LCMS and the DHS 2007 for triangulation of the results. The main findings of the case study are summarised in the following.

Findings Roads

The institutional setup

The institutional setup of Zambia's roads sector is the result of donor-supported reforms that were initiated in 2002. In the course of the reforms, three road agencies were created, each responsible for different aspects of sector development: the National Road Fund Agency (NRFA), the Road Development Agency (RDA), and the Road Transport and Safety Agency (RTSA). While the formal setup of the sector is considered international best practice and convinced donors to start sector budget support, the collaboration between the sector parties and the implementation of road works remains problematic. Particularly the interaction between the three agencies, which all report to different ministries, is not running smoothly. Owing to the decentralisation tendencies in Zambia, selection and prioritisation of road works formally starts at the local level. However, in practice, the sector remains fairly centralised as decision-making often takes place at central or provincial level and local priorities are partly overruled by top-down implementation of road works.

Following the sector reforms, the Road Sector Investment Programme (ROADSIP) II was formulated, which constitutes the strategic, multi-year planning instrument for the roads sector pursued by the road agencies as well as the CPs. The goals of ROADSIP II for the period from 2004 to 2013 are to bring a core network of roads with a total length of 40,113 km up to a maintainable condition and to maintain paved and unpaved roads, including part of the feeder roads. This core network includes trunk roads, main roads, district roads, urban roads, tourist roads, and 91% of primary feeder roads. The network of secondary and tertiary and remaining primary feeder roads is not included.

Financing

The overall budget of Zambia's roads sector is composed of income from the Road Fund, which includes income from the fuel levy and from road user charges, a relatively large share of the general budget, sector budget support from the European Union, and – to a lesser degree – project aid. Since 2002, the budget has increased significantly as a result of increased funding from GRZ which is partly attributable to general budget support, higher revenues of the Road Fund, and a reorientation of donors towards infrastructure. The European Union, the largest donor in the roads sector, however, stopped sector budget support in 2008 due to an over-commitment of funds in the sector. Expenditures on roads have increased from 1.01% of GDP in 2006 to 1.76% of GDP in 2009. Yet, this share remains relatively low compared to similar African countries.

Output

Between 2006 and 2009, the average annual ROADSIP II objectives have been realised with regard to *paved* roads. Consistent with the objective, on average, 250 km of paved roads have been rehabilitated per year. The goal of maintaining on average 7,180 km of paved roads per year has been exceeded by 8%, implying that nearly the whole paved core network has been maintained in the considered time period. Concerning *unpaved* roads, the goal of rehabilitating on average 1,493 km annually has been exceeded by 40%. By contrast, the maintenance target for the unpaved network has not been met. Almost two thirds of the unpaved network has not or not regularly been maintained in the time period under consideration. These figures clearly illustrate that GRZ has given priority to the paved trunk and main road network over the district and primary feeder roads. This finding is confirmed by the condition of the roads: whereas the paved network is in reasonably good

condition, the unpaved network has deteriorated drastically between 2006 and 2009. This reflects the fact that only a small part of the total budget is allocated to the routine maintenance of the whole network, while higher priority is given to periodic maintenance, rehabilitation, and upgrading. At large, the amounts spent on rehabilitation and maintenance of the core network have been much too low, threatening the long-term sustainability of the roads network.

In order to improve the feeder road network which is not included in the core network, GRZ decided to import road equipment from China and have part of this non-core network maintained by Rural Road Units (RRUs). It is estimated that by these means, 19% of the non-core feeder road network (5,124 km) have been maintained or rehabilitated in 2009. According to the RRUs, problems include insufficient funding, shortage of fuel, machinery break-downs, and shortage of inspection vehicles, spare parts, and skilled operators. Government authorities expressed a positive view on the work of the RRUs; evidence on the cost effectiveness compared to private contractors, however, is lacking.

Sector performance at the operational level

Several major concerns exist with regard to the performance of the roads sector at the operational level. They were examined in the context of a fully-fledged audit requested by the foreign donors covering financial, technical, and procurement aspects. Its results are summarised as follows:

Adherence to annual work plans
A great concern raised in the audit report is the lacking adherence to the annual work plan and the approved budgets on part of the RDA. This is reflected in an "over-commitment" of ZMK 1 trillion (approximately USD 250 million) in 2008, meaning that this contract sum was above and therefore not covered by the annual budget. This resulted in serious cash flow problems and the postponement of a large number of contracts, leading to penalty payments and mounting arrears for GRZ. As a consequence of this illegal behaviour, the President dissolved the Steering Boards of RDA and NFRA and dismissed the Permanent Secretary of the Ministry of Works and Supply as they obviously did not accomplish the task of controlling the activities of RDA.

Procurement procedures and project execution
Moreover, the audit report points to severe deficits in the procurement procedures that are linked to weak supervision by the RDA and create risks that the works are not carried out professionally. Among others, it was found that drawings for the contracts were often delayed or not prepared at all, condition surveys were not conducted leading to inadequate interventions, and consultants were mostly not engaged until after the work contract had started implying that part of the contract period was going on without supervision. As to project execution, there were considerable delays in decision-making that led to an increase in time and costs, contract clauses were not always respected, payments were made for work not done, and most projects were not completed on time.

Quality of road works
Alarming results were further found with regard to the quality of road works. The examination of 18 randomly selected road projects revealed that none of them met the agreed quality. In the majority of cases the cement content was too low, plasticity too high, and the base layers thinner than specified, among others. According to the audit report, these deficiencies drastically shorten the pavement lives of the roads which has disastrous implications for the Zambian economy in terms of high costs for repairs and reconstructions that will have to be carried out much earlier than planned.

Unit prices of roads
Unit rates of road works in Zambia are considerably higher than in neighbouring countries and have also been increasing in recent years. Several contributing factors have been identified, such as the lack of competitors which was aggravated by the works of the 2010 Soccer World Cup in South Africa, collusion between main contractors, response by contractors to the temporary removal of advance payments, and the remoteness of the work locations. The perceived risk of doing business in Zambia is exceptionally high and the market structure allows contractors to price high risk premiums.

Hence, in order to increase the operational efficiency in the sector, it is crucial that the Zambian road agencies and ministries reduce the risk of doing business as well as the unit rates. As to the competition between local and foreign companies, more training would have enhanced the competitive edge of the local construction industry and supported local companies in responding to the increase in tendering that resulted from the growing budgets for the roads sector.

The role of the donors and the way ahead

Despite the shift towards sector budget support and the fact that most donors align to the budgeting and financing arrangements of NRFA, there remains a wide range of aid modalities in the roads sector. The mixture of modalities between project aid and budget support seems rather conducive to sector development; however, there is an urgent need for a better coordination of donor activities. Although the new road agencies received technical assistance in the past years, a persisting lack of capacity impedes better planning, implementation, and supervision of works. There are concerns that the technical assistance provided did not meet the requirements associated with budget support which include giving support in public financial management to strengthen the agencies' own procedures. The dialogue between the donor community and Zambian authorities associated with sector as well as with general budget support has created a level of exchange and influence for the donor community in the roads sector that would not have been possible solely through project aid. However, the shortcomings in the sector have led to a breakdown of sector dialogue as well as to temporarily stopped disbursements of funding and scepticism among donors. Yet, the fact that the deficits of the road sector were detected and examined can be attributed to the increased influence of donors on auditing practices related to the shift to budget support. Currently, the CP community and GRZ negotiate a Remedial Action Plan to address the shortcomings in the roads sector. In the view of the evaluators, the most pressing tasks include the improvement of the quality of the road works, the increase of the efficiency of RDA, the increase of domestic financing, the reduction of unit costs, as well as finding a balance between the allocation of budget to the core and the non-core network that does not neglect sparsely populated areas.

Impacts

A large body of evidence shows that a good road network is of great importance for poverty reduction and economic development. On the macro-level, improvements in the road network can stimulate economic development as many sectors depend on good transport links. On the micro-level, roads provide better access to economic and social facilities such as health centres, schools, and markets which is crucial for the improvement of living conditions, most notably in rural areas.

On the macro-level, the study findings indicate that improved roads have contributed to the economic development of Zambia, particularly in the areas of trade, mining, agriculture, and tourism. In a landlocked country, trade crucially depends on roads for the transport of goods. In the case of Zambia, 80% of the exports are transported on the road. It is plausible that better roads have played an important role in the recent rise in trade volumes in Zambia, as it coincided with the period in which the roads sector received stronger funding. Traffic figures show an increasing trend and volumes are highest on trunk and main roads indicating that the decision of GRZ to invest especially in these roads is justified and economically profitable. Large shares of the road network as well as the traffic flows are concentrated in the Copperbelt region, where one of the world's largest copper deposits is located. This illustrates the link between the roads sector and mining, the country's biggest export earner. With regard to the agricultural sector, which has high potential for the development of Zambia, a stronger investment especially in rural roads is crucial to create access to local markets and connectivity to trunk roads. More than two thirds of the people in Zambia depend on agriculture but only 17% of these lived within 2 km of an all-season road in 2006. In addition, the largest share of high value land is in remote areas. Similarly, a good road network is essential for the growth of the tourism sector that is becoming an important foreign exchange earner. The majority of tourists in Zambia travel by road and the main attractions are situated in remote areas. However,

despite growing investments in the roads sector, studies suggest that the road infrastructure is still impeding stronger growth rates in Zambia. High costs of doing business, of which a significant part are transport costs, slow down private investment and the poor condition of the roads is still a major constraint for further development of tourism.

On the micro-level, descriptive analyses of the LCMS 1998 and 2006 reveal that access to social and economic facilities is very limited in rural Zambia and has only slightly improved during this period. Several factors indicate that the road and transport situation is inadequate to the needs in rural areas and constrains development: households report that it is too expensive to go to facilities or that these are too far away, walking remains the predominant mode of travelling, travel speed is low, and households express a high priority for the improvement of roads. A comparative study carried out in Southern Province also reveals that households consider bad roads as a major limiting factor for the development of their businesses, both agricultural and non-agricultural.

The econometric analyses of the LCMS data provide evidence that roads have positive impacts on the living conditions in rural areas. In particular, effects can be found on reducing the share of households living in extreme poverty, on increasing secondary school attendance rates, and on the consultations of modern health facilities. Sub-sample analyses by poverty status show that road projects benefit all groups similarly meaning that no distributional effects are found. Yet, the impact analyses were carried out for rural areas where the extremely poor are overrepresented suggesting that the findings are of special importance for the poor.

Relating these positive impact findings to the inefficiencies in the road provision and the neglect of rural areas leads to the conclusion that the effects both on the macro- and on the micro-level could have been more pronounced and widespread. Hence, whereas the general assessment of the impact of ROADSIP II is positive, more could have been achieved in recent years and more is needed to exploit the potential of improved road infrastructure for the development of Zambia.

Findings Water Supply and Sanitation

The institutional setup

In the early 1990s, GRZ initiated far-reaching policy and institutional reforms in the WSS sector aiming at decentralisation and commercialisation. Among the key sector principles are the devolution of authority to Local Authorities (LAs) at provincial level and the achievement of full cost recovery for WSS services through user charges in the long run, at least in urban areas. The reforms have created a supportive environment for sector development. The Ministry of Energy and Water Development (MEWD) has the overall responsibility for the sector and the corresponding policy formulation. In the course of the reforms, the responsibility for WSS service provision was transferred from the MEWD to the Ministry of Local Government and Housing (MLGH), which, in turn, delegates the task to LAs. In urban areas, the LAs have predominantly opted to establish Commercial Utilities (CUs) which are thus responsible for urban WSS service provision on the operational level. Due to geographical and socio-economic conditions, a "bottom-up" approach was pursued in Zambia's rural areas and the operational responsibility for providing WSS services was delegated to so-called District and Village Water, Sanitation, and Hygiene Education Committees (D-/V-WASHEs). Formally, the institutional setup of the WSS sector seems appropriate for rural and urban areas and clearly defines responsibilities. In practice, however, sector activities do not function smoothly. The shift of responsibility of WSS provision from the MEWD to the MLGH did not involve a transfer of staff leading to a lack of staff in the MLGH both in terms of quality and quantity. Serious capacity shortcomings are found specifically with respect to rural WSS as a large number of staff formerly in charge of rural WSS chose to join CUs. Effective sector development is further hampered by ongoing disputes between the two ministries about their relative responsibilities.

The WSS sector is supported by a large number of CPs and NGOs. Although coordination, harmonisation, and alignment to national policies has made great progress over the last few years,

donor support is still heterogeneous as evidenced by the existence of many different modalities regarding procurement, tendering, and the role of consultants in the sector.

Financing

The WSS sector is financed through user fees for water consumption in urban areas, through contributions from GRZ, and through project aid. Unfortunately, no reliable data on the revenues generated in the sector is available. Between 2002 and 2007, the sector budget comprising of GRZ and CP contributions, i.e. without user fees, more than doubled from USD 48 million to USD 111 million, primarily due to an increase in CP spending. Project aid remains the prevailing mode of financing in the WSS sector. Contrary to sectors as education and health, GRZ only allocates a minor share of the general budget to the WSS sector: In 2009, the budget allocated to WSS accounted for 1.4% of the total budget. Moreover, there is a large gap between allocated and disbursed funds of GRZ which is explained by the lack of institutional capacities and the fact that allocated funds are often shifted to other politically more prioritised sectors. In 2007, only 25% of the allocated budget was actually disbursed. However, in recent years, a positive trend can be identified which the MLGH and the MEWD attribute to the budget support process. Both financial contributions from GRZ as well as the release rate have increased significantly since 2010. Nevertheless, given that the sector is far from full cost coverage through user fees, major contributions from GRZ and CPs will be necessary to provide and expand WSS services for a long time. As the WSS sector is largely financed by CPs, the question arises whether project aid led to a reduction in the financial commitment of GRZ to the sector. This study found no conclusive evidence with regard to crowding-out effects of project aid. Given the comparatively low government priority for WSS, it is possible that shifting funds from project aid to general budget support would decrease the overall financial contribution to the WSS sector in Zambia as this would give more leeway to GRZ to shift budgets to more favoured sectors.

Output

The Fifth National Development Plan WSS Key Performance Indicators and the related MDGs envision safe water supply coverage of 75% and adequate sanitation facilities for 60% of the Zambian population by 2015. Within the PAF, the goal is to reach water supply coverage of 40% in rural areas and 68% in urban areas by 2010. Due to unreliable data sources that give diverging estimates of coverage rates, it is difficult to assess whether the different indicators are met. Current estimates of access rates for safe water for Zambia vary between 57% and 60% and the access rates to sanitation vary between 64% and 87%. According to the LCMS, access to safe water remained unchanged at 57% for all Zambia between 1998 and 2006. In rural areas, access to safe water supply improved slightly from 37% to 41%, while it declined in urban areas from 91% to 87%. This is due to the high population growth and migration to urban areas which made it difficult to keep up with expanding services. Regarding sanitation, access rates increased slightly from 81% to 87% between 1998 and 2006 for all Zambia. The data indicate that nearly all urban households and also a high share of rural households (81%) have access to some sort of toilet facility. These figures, however, clearly overstate the actual access rates, as they do not differentiate between acceptable and unacceptable latrines.

Given the available data sources, it seems realistic that at least the water supply goals for 2010 will be met while it will be difficult to achieve the MDG targets by 2015, especially for sanitation. Furthermore, the data clearly indicate that rural areas in Zambia are significantly lagging behind the development in urban areas in terms of access to safe water and adequate sanitation facilities. However, there has been progress regarding the quality of infrastructure provided in rural areas.

The operational level

The urban WSS sector
The decentralisation process resulted in the formation of 10 CUs in urban areas that are responsible for developing and managing WSS services on a commercial basis. Although the CUs increased tariffs

over the last decade and recorded improvements in service coverage, hours of supply, and metering ratios, on average, they are not even able to cover basic operation and maintenance costs through user fees. Major inefficiencies include the extremely high unaccounted for water related to dilapidated infrastructure, a metering ratio of only 50%, and a collection efficiency of about 80%. Also, the sanitation coverage is still very low. In order to achieve cost coverage, the elimination of inefficiencies should precede or at least accompany a further increase in tariffs. The tariff system is designed as a block tariff system aiming at cross-subsidising poorer households with low water consumption by charging higher tariffs to wealthier households with higher water consumption. In practice, the cross-subsidisation is very limited. The lack of understanding that the costs of services should be covered by user fees on the part of the consumers causes problems for the collection efficiency. In addition, many wealthier households withdraw from cross-subsidising the poor by drawing water from their own boreholes free of charge. In peri-urban areas, a positive development can be recorded due to the Devolution Trust Fund (DTF) established in 2002. The DTF, in which CPs and GRZ pool their funds to assist the CUs in extending WSS services to peri-urban areas, made it possible to maintain the water supply coverage rate despite rapidly growing settlements. Only minor improvements can be reported for sanitation also in peri-urban areas. A particular problem is the fact that during the rainy season, the tanks of the latrines are sometimes emptied directly into the streets, contaminating the stagnant rain water and causing endemic cholera outbreaks.

At large, even if CUs continue to increase tariffs and collection efficiency, the necessary investments to replace dilapidated infrastructure and expand WSS service coverage in urban and peri-urban areas cannot be borne by CUs alone and would require significant additional sources of funding. Recommendations on financing mechanisms and organisational structures and arrangements are currently under discussion under the National Urban Water Supply and Sanitation Programme.

The rural WSS sector
Within the community-driven approach pursued in the rural WSS sector, the operational responsibilities for providing services lie with District and Village WASHEs. Most of the investments focus on the drilling of boreholes and are financed by CPs. In the last three years, almost 4,000 boreholes have been constructed. The MLGH sets certain quality standards for borehole construction in order to simplify spare part provision and to achieve more uniformity in unit costs, which varied significantly in the past. To guarantee an adequate supply of spare parts, JICA's Sustainable Operation and Maintenance System (SOMAP) has been adapted for the entire sector. The communities are supposed to contribute to borehole investments in terms of working hours, materials, or small amounts of money and are also expected to provide funding for operation and maintenance. As sustainable safe water supply thus depends on effective community participation, intensive training measures focusing on organising water point committees, adequate usage of pumps, and health and hygiene education are carried out to foster community commitment. Funding for greater rehabilitation measures constitutes a problem for all communities. Hence, major subsidies are required to improve and expand services also in rural areas. Due to the lack of personnel resources, the low coverage rates, and the fact that permanent education of the target group is necessary, this is likely to be even more challenging than in urban areas. With regard to sanitation, costs are intended to be covered by households themselves. However, the national hand washing campaign which aims at encouraging households to build pit latrines at their own expenses – but most likely with the support of NGOs – has not effectively been rolled out yet.

Impacts

Access to improved WSS is associated with many benefits for households, particularly health benefits and time savings for collecting water in rural areas. Lower disease incidence and closer water facilities are, in turn, assumed to free up time for income-generating activities and school attendance. Evidence suggests that piped water reduces child mortality. Community-level facilities, however, which are usually provided in rural and peri-urban areas, seem to be less effective in improving health as the water is often contaminated between the source and the point-of-use.

Descriptive analyses of the LCMS 1998 and 2006 reveal that access to safe water in rural and peri-urban Zambia is correlated with poverty. Access to safe water is considerably lower among the poorest households compared to the richest households and the latter also benefit from better infrastructure like taps and boreholes. In rural areas, access to safe water for the poorest households remained nearly unchanged between 1998 and 2006, whereas it increased by 25 percentage points among the wealthiest households. Treatment of drinking water, an effective measure to avoid water borne diseases, is only performed by few households in Zambia, especially in rural areas. Only 20% of the rural households without access to safe water supply treat their water compared to 56% of the urban households, possibly reflecting differences in income and hygiene education.

As concerns the impacts of access to safe WSS on the living conditions in rural Zambia, several general findings emerge from the econometric analyses of the LCMS and the DHS. Although significant effects are found on reducing severe diarrhoea among children under 60 months, the first round effects of safe WSS, i.e. health and time savings effects, need to be examined with more detailed survey data in the future. The evidence is clearer for the second round effects. Access to safe WSS significantly increases primary and secondary school attendance rates of both girls and boys. As regards access to safe sanitation, girls seem to benefit more in terms of increased school attendance than boys, indicating differential gender effects. Furthermore, although reverse causality cannot completely be ruled out, the analyses suggest that access to improved WSS reduces the share of households living in extreme poverty. The effects are strongest if households have access to both, safe water and adequate sanitation, while the effects of safe water could only be identified for boreholes suggesting that boreholes are the only safe water source in rural areas. Sizeable effects on the living conditions in rural Zambia could also be shown for water treatment. With respect to distributional effects, stronger effects emerge for extremely and moderately poor households as compared to non-poor households, although not very pronounced. Similar as for roads, the fact that access to improved WSS in rural Zambia is inadequately low and service expansion has been very slow implies that for a large share of the population these positive impacts are not existent.

Finally, a case study on the micro-environmental effects of the WSS systems in place in rural and peri-urban areas revealed that depending on their location, the pit latrines generally constructed in Zambia may contaminate the ground water. In case they are constructed without taking into account the water flow of the ground water, they constitute a threat to the collective health of surrounding communities. Hence, as for some sanitary systems, it is highly questionable that they are considered improved technologies in different strategic planning documents of the GRZ.

Findings Power

Zambia has great potential for hydropower and is richly endowed with various other natural energy sources. Nevertheless, in the last years, the country has been importing power from neighbouring countries while still experiencing power shortages during peak hours. The excess demand is mainly due to the fact that the mining industry has grown considerably since the early 2000s while the power generation capacity has not increased notably since the 1970s. Due to the low demand in the past, tariffs remained at levels which only allowed for the coverage of operation and maintenance costs but not for additional investments. Even today, power tariffs in Zambia are among the lowest in Africa.

The institutional setup

Since 1994, several reforms have been carried out in the energy sector. The sector is dominated by ZESCO, a state-owned company established in 1970. The Energy Regulation Board has the mandate to oversee the sector which includes approving power tariffs, licensing energy utilities, and investigating consumer complaints. In 2009, GRZ announced that electricity tariffs would increase to full cost covering levels by 2011. 50% of the available energy is consumed by the mining industry at tariffs that had been agreed upon in long-term contracts and that are considerably below a full cost

recovery level. Currently, these contracts are being renegotiated. Moreover, the Energy Regulation Board has implemented a list of performance benchmarks for ZESCO mainly consisting of efficiency targets. The promotion and facilitation of rural electricity lies with the Rural Electrification Authority and is financed by a 3% levy on non-mining activities and is supported by several donors.

Outputs

The national electrification rate in Zambia was about 23% in 2006 and therewith exceptionally low in African comparison. The power sector is further characterised by very slow progress as well as high spatial disparities as 46% of the population in urban areas and less than 3% of the rural population had access to electricity in 2006. GRZ aims at increasing the electrification rate to 66% by 2030. Solar photovoltaic systems are increasingly used as a least-cost alternative in the sparsely populated country since connecting each household to the grid is economically not sensible. However, even these systems will be unaffordable for a large part of the population implying that the provision will require contributions from government or donor side. In order to assess the performance of the sector and ZESCO in particular, the PAF has specified two indicators which relate to the increase in domestic connections to the grid and the number of customers who are unmetered. GRZ refused to include an indicator related to tariff increase. Although the targets have mostly been met since 2007, the electricity rate has remained more or less constant due to population growth.

Impacts

Electrification has positive effects on business development and macroeconomic growth, which indirectly promotes poverty reduction, and direct effects on the living conditions of the population. For instance, lighting can increase the time used for work or education and radio and television can improve access to education. Power is likely to lead to higher productivity of small businesses owing to the use of electric tools and longer working hours. Evidence shows that electricity has positive effects especially in rural areas ranging from higher income to improved educational outcomes.

With regard to Zambia, studies suggest that the low electrification rate undermines the pace of development and economic advancement particularly in rural areas. According to the enterprise survey, power is a severe infrastructure handicap and considerably hampers productivity. There is a strong correlation between access to electricity and wealth of households. The fact that tariffs are not fully cost covering implies that richer households are subsidised, highlighting a further reason for the need to increase tariffs. In sum, electricity is a bottleneck in Zambia and expanding access would considerably increase household welfare.

Conclusion

On the first sight, the roads and the WSS sector seem quite different, especially regarding the potential influences of budget support. On the second sight, however, a number of similarities emerge. Firstly, although the aid modalities differ between the sectors, both are characterised by a mixture of existing modalities. The roads sector is predominantly financed by the Road Fund, general budget flows, and sector budget support, however, project aid is still existent. The WSS sector is mainly financed by project aid and user fees, but pooled funding can be found in form of the DTF, the contributions from GRZ show an increasing trend, and on-budget sub-sector baskets are in preparation. Secondly, via the policy dialogue, budget support has contributed to the development of both sectors, especially through the creation of institutions and the formulation of policies and sector frameworks. This is particularly the case for the roads sector due to the large amounts of general budget funds and sector budget support, but the PAF dialogue is perceived as very conducive to sector development also in the WSS sector. Thirdly, in both sectors, the institutional setup can be classified as good or even best practice on paper, but considerable shortcomings exist in practice. These include the lack of coordination, inefficiencies, partly overlapping responsibilities, and lack of capacity and resources that is especially prominent at the local level. Fourthly, both sectors have

witnessed improvements on the outcome level but the attainment of sector-specific indicators has been moderate. Nevertheless, fifthly, road projects and access to safe WSS have positive impacts on poverty reduction, health, and education. This implies that the effects could have been more widespread and stronger if resources had been used more efficiently and the quality of works had been higher. With respect to the power sector, budget support had only a small effect on sector performance as the sector receives barely any contributions from the general budget and the PAF dialogue is not very intensive. The findings for the sector, however, certainly fit into the picture: Considerable inefficiencies remain, the achievement of sector-specific indicators has been moderate, and positive impacts of electricity on macro- and microeconomic development are very likely.

All in all, the general assessment of the development of the infrastructure sectors is cautiously positive. More would have been possible in recent years and more is needed to overcome the constraints that the roads, the WSS, and the power sector still present for the further development of Zambia. It has to be emphasised that the main impacts of structural changes in Zambia which have been supported by budget support most likely will be of a long term nature. However, these long term effects cannot be captured at this point in time.

1 Introduction

1.1 Study background and report structure

The case study **"Budget Support and the Development of Infrastructure in Zambia"** provides input for the Evaluation of Budget Support in Zambia (de Kemp/Faust/Leiderer 2011: Synthesis Report – Between high expectations and reality: An evaluation of budget support in Zambia) as part of "Step 2" of the evaluation methodology which tries to capture the outcomes and impacts concerning the livelihoods of the Zambian population to which budget support has contributed via the policies of the Government of the Republic of Zambia (GRZ). Within this second step, infrastructure is one of the sectors to be analysed, beside the sectors of education, health, and agriculture.

The case study aims at analysing the key evaluation questions outlined in the evaluation methodology and the respective model Terms of Reference (see summary of relevant questions and answers in Annex 9). More specifically, the following two main research questions are addressed:

1. How did budget funds/sector budget support have an impact on the development of infrastructure?

2. And what was the impact of the development of infrastructure in Zambia?

The report is structured as follows: Besides providing the study background, Chapter 1 describes the term infrastructure in the context of the Performance Assessment Framework (PAF) for Budget Support and explains the focus on the roads and the water supply and sanitation (WSS) sector. Furthermore, the evaluation methodology that has been applied for this case study is explained. Chapters 2, 3, and 4 form the heart of the report including the evaluation results for the roads sector (Chapter 2) and the WSS sector (Chapter 3) and also a comparably shorter sub-chapter on the power sector (Chapter 4). For the roads sector, first, Section 2.1 introduces the institutional setup of the sector and clarifies which institutions are involved and assesses their interaction. The section thereafter (2.2) presents budget flows and financial sources and discusses the achievement of the sector indicators and objectives (output level). Related to these findings, the following Section 2.3 looks at crucial issues at the operational level, e.g. unit rates and adherence to annual work plans and budgets, based partly on the Auditor General report on the roads sector. To assess the specific role of general budget support (GBS) and sector budget support (SBS), the role of the donors is analysed subsequently in Section 2.4. Findings on the impact on (economic) development and livelihoods follow in the sections starting with Section 2.5, investigating macro-level impacts (Section 2.6) and micro-level impacts (Section 2.7) as well as based on the comparative outcome/impact study supported by the Central Statistical Office (CSO) Zambia (Section 2.8). For the water sector, again, first the institutional and organisational setup is presented (3.1) followed by the financial flows to the sector including a section on potential crowding-out effects (3.2). Section 3.3 focuses on the performance development of the WSS sector and Section 3.4 details the operational setup and challenges faced by the sector, both for urban and rural areas. Findings on the effects of access to WSS on livelihoods follow in the sections thereafter (3.5 to 3.8) while Section 3.9 presents the results from a case study on micro-environmental impacts of WSS. For the power sector, after a general introduction, first, the institutional setup is briefly explained (4.1) followed by an assessment of the performance of the sector over the last years (output) in Section 4.2. The sub-chapter concludes with an analysis of the impact of the power sector on the macroeconomic development and the population in Zambia. Finally, Chapter 5 summarises the evaluation results for all sectors and links the findings to the key evaluation questions.

1.2   Infrastructure in the Zambian development strategy

Within the PAF, the term infrastructure subsumes three sub-sectors, namely the roads sector, the power sector as well as the WSS sector. All of these sectors are key determinants of Zambian development and growth according to the Zambian Fifth National Development Plan (FNDP). The Sixth National Development Plan (SNDP) was being developed during the period of the evaluation.

In general, there is a broad consensus that infrastructure is an important determinant of economic growth and that the lack of improvements of infrastructure had a negative effect on economic development in Africa.[1] Power and transport are important elements of economic infrastructure while WSS are key elements of social infrastructure and have as such an important influence on the livelihoods of Zambian citizens.

The Zambian PAF[2] specifies seven indicators for judging the progress in the infrastructure sector which are almost identical with corresponding performance indicators in the FNDP. Therefore, these indicators give decisive hints at what the development strategy of the Government of the Republic of Zambia (GRZ) and the providers of GBS, respectively, emphasise. The indicators are:

- Kilometres of (trunk, main, and district) roads maintained (paved, unpaved, total)
- Kilometres of feeder roads under the core road network rehabilitated and maintained
- Number of new domestic connections connected to the Zambian Electricity Supply Company (ZESCO) grid
- Number of ZESCO customers who are unmetered
- Water supply coverage in rural areas (FNDP: rural and peri-urban areas)
- Water supply coverage in urban areas[3]
- Per capita storage of water (refers to water resources management)

Assessing the overall sector performance on the basis of only two indicators for each sector (plus an additional indicator for water resources management) is certainly problematic, because two indicators cannot cover all important facets of a sector. However, given that only a limited number of indicators can be chosen, an overall number of seven for the infrastructure sector seems to be at or even over the upper limit. Taking this into account when judging the usefulness of the indicators, the two indicators for roads are an appropriate choice. The focus is on maintenance, and not only on road investments, and therefore gears the monitoring towards maintenance as a generally weak point in the sector. Furthermore, the inclusion of unpaved roads and feeder roads gives some attention to rural areas. This may serve as a counterbalance to the widespread preference for trunk roads. In the power sector, the indicators seem to overemphasise extending access to electricity while power shortages as the potentially most important impediments for economic development and growth are not covered. Concerning the WSS sector, water supply receives all of the attention; sanitation, as so often, is neglected in the PAF, although a lack of sanitation can be a dangerous source of disease especially in densely populated areas. All in all, even if PAF indicators are chosen well for some sectors, they do not seem suitable as the only measures of sector performance, all the more as none of them gets down to the impact level. This might be due to data problems which, however, are present even for some of the output/outcome-based PAF indicators, as will be discussed in the chapters devoted to the sector analyses.

As it would go beyond the scope of this background study to analyse all three sub-sectors in detail, two of them, namely roads and WSS, were selected for in-depth analyses while the power sector is briefly discussed by means of a literature review and some empirical analyses. The rationale for the selection of the sectors is the following:

In order to represent the economic infrastructure, the roads sector was chosen. The reasons are that first, in Zambia, national development plans recognise that the further development of the roads

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[1] See for instance, Barro and Sala-i-Martin (2004) and Ndulu (2006).
[2] Performance Assessment Framework 2009 – 2011, Final Draft Document 2009 – 2011, 17th November, 2009.
[3] New PAF indicator; not included till 2009.

sector plays a key role in the economic and social development of the country.[4] Second, within the flows from the general budget to the transport sector, the roads sector receives almost the entire budget and the sector received a considerable amount of funds through SBS in the past as well. And third, two of the PAF/FNDP infrastructure indicators focus on roads, which is why a concentration on roads seems to be adequate.

The second sector to be analysed is WSS because WSS represents social infrastructure and has utmost importance for the wellbeing of the whole population. Although only a comparatively small amount of the general budget goes into WSS and a large part of WSS investments is still provided by project support, GRZ's determination to improve access to WSS for the poorest parts of the population is underlined by the Zambian National Rural Water Supply and Sanitation Programme (NRWSSP).[5] Furthermore, WSS (like power) is supposed to be revenue-generating which implies that cost coverage should be achieved through water users' payments, at least in the long run. Accordingly, the sector is well suited for obtaining insights into whether the strategy of decentralisation and commercialisation complemented by a self help 'bottom-up' approach in rural areas contributes to achieving the sector targets.

1.3 Methodology

1.3.1 Qualitative analysis

The qualitative findings for the sectors are a result from the review of already existing studies on the sectors and relevant policy documents as well as the interviews held and the field studies undertaken during a mission of the evaluation team to Zambia.

The mission to Zambia, which included in particular interviews with relevant stakeholders and field studies in the roads sector and the WSS sector, was prepared through in-depth desk studies of available documents on the two sectors. Within the roads sector, interviews were held with the three roads institutions (Road Development Agency (RDA), National Road Fund Agency (NRFA), and Road Transport and Safety Agency (RTSA)) on the national, provincial, and district level as well as with the relevant ministries (Ministry of Finance and National Planning (MoFNP), Ministry of Communications and Transport (MCT), Ministry of Public Works (MPW), Ministry of Local Government and Housing (MLGH), and Ministry of Tourism, Environment and Natural Resources (MTENR)), government institutions (Zambia Development Authority (ZDA), National Council for Construction (NCC), Zambia Association of Chambers of Commerce and Industry (ZACCI)) and donors active in the sector (European Union (EU), Department for International Development (DfID), World Bank, Danish International Development Agency (DANIDA)). Furthermore, field visits to the Southern Province (Siavonga and Choma districts) were undertaken which included assessments of the quality of rural roads and were used as background information for the setup of a study on the socio-economic impact of roads.

Within the water sector, interviews were held with stakeholders from the relevant water institutions (Commercial Utilities (CUs), Devolution Trust Fund (DTF), District-Water, Sanitation and Hygiene Education Committees (D-WASHEs)), relevant ministries (MLGH, Ministry of Energy and Water Development (MEWD), government institutions (National Water Supply and Sanitation Council (NWASCO), and Local Authorities (LAs)) and donors active in the water sector (World Bank, United Nations Children's Fund (UNICEF), Japan International Cooperation Agency (JICA), DANIDA, African Development Bank (AfDB), Care International, Germany). Furthermore, field visits were undertaken to the peri-urban areas of Lusaka as well as to the Eastern Province (Chipata District) which also included visits to local government institutions. Similar to the roads field study, an area with limited

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[4] See the Zambian FNDP 2006-2010.
[5] National Rural Water Supply and Sanitation Programme 2006-2015 (2007, 2009), Republic of Zambia; a National Urban Water Supply and Sanitation Plan exists as a draft (2009).

access to safe water and adequate sanitation was contrasted with an area that has good access to these services. More specifically, this study helped to assess the quality of WSS service provision and the adequacy of excreta disposal on the ground.

1.3.2 Quantitative analysis

The quantitative analyses for the roads and the WSS sector are based on the Living Conditions Monitoring Surveys (LCMS) which are conducted in regular intervals by the CSO and the Zambian Demographic and Health Surveys (DHS). More precisely, the 1998 and 2006 LCMS and the 2007 DHS were used for descriptive statistics, comparisons over time, and econometric analyses aiming at assessing the impact of access to roads and improved WSS, respectively.

1.3.2.1 The Living Conditions Monitoring Surveys

In regular intervals of several years, the CSO carries out a LCMS. These surveys are carried out nation-wide in all 72 districts of Zambia on a sample basis. Household samples are chosen such that the findings are representative for the entire country. The main objectives are to monitor the effects of government policies on households and individuals, to measure and monitor poverty over time as an evaluation of the government's poverty reduction programmes, and to monitor the living conditions of the households in the form of access to various economic and social facilities, infrastructure, and access to basic needs, food, shelter, clean water and sanitation, education, health, etc. The concept of "poverty" in the LCMS follows the Zambian national poverty line which is based on a food-basket approach. More precisely, three poverty groups are defined in the LCMS: the "extremely poor", the "moderately poor", and the "non-poor". The group of extremely poor households is defined as those who could not afford basic minimum food requirements even if their total expenditures were on food. In the LCMS 2006 this corresponded to total monthly expenditures of less than ZMK 62,248 per adult equivalent. The moderately poor are defined as those who can afford minimum food requirements, but not any non-food basic needs such as health, shelter, and education. Finally, the non-poor are defined as those households who are located above the overall poverty line which is derived by dividing the food poverty line by the average food expenditure share of households in the 5th and 6th deciles of the expenditure distribution. In 2006, this corresponded to a monthly ZMK 106,413 per adult equivalent.

The survey includes several questions that are in relation to roads, transport, and water supply and sanitation. With respect to roads it is recorded whether road projects had been carried out in recent time, how access to public transport and various other facilities changed, what transport-related assets and expenses households have. Regarding water supply and sanitation, detailed information is available on the type of water supply used by the households and the sanitary facilities available which further allows for a differentiation between safe and unsafe WSS systems.

As there are various questions in the LCMS regarding education, health, expenditures, etc., the effect of access to roads and water supply and sanitation on the living conditions of Zambian households could be estimated using the econometric techniques described below.

1.3.2.2 The Demographic and Health Surveys

The 2007 Zambia DHS is the fourth nationally representative DHS of Zambia. The surveys have been carried out between 1992 and 2007. For the 2007 survey, a representative sample of 8,000 households was drawn. It was designed to provide up-to-date information on background characteristics of the respondents, fertility levels, the nutritional status of mothers and young children, early childhood mortality and maternal mortality as well as maternal and child health, among others. Additionally, information on so-called basic environmental health facilities such as access to water and acceptable basic sanitation was gathered. Compared to the LCMS, the

information collected on health-related issues, e.g. diarrhoea, is more detailed which is why the 2007 DHS was analysed for possible impacts of WSS as well.

1.3.2.3 Econometric approaches

In order to analyse the effect of access to roads and improved WSS on the living conditions in rural areas, particularly on poverty, education, and health, two estimation techniques were used: panel regressions (fixed effects method) and propensity score matching.

The key challenge when estimating the effects of access to a road or to improved WSS is to establish the counterfactual. As we do not know how households would have fared if e.g. the road or the borehole had not been built, a control group is needed which is as similar as possible to the so-called "treatment group". Without such a comparison, the estimated effects are likely to be biased as the distribution of roads and WSS facilities is likely to be non-random.

In general, there exist various methods for estimating the impact of such an intervention, yet their applicability crucially depends on the data available. In our case, two methods were chosen which are likely to yield estimates coming at least close to the actual effect of roads and WSS on the living conditions of the population. The two methods chosen are first, fixed effects panel regressions based on a comparison between the 1998 and 2006 LCMS and second, propensity score matching based on the individual LCMS and DHS datasets.

Panel analyses

Estimating a fixed effects panel regression with two periods basically implies that the observations which are available for both periods are compared over time by taking first differences. This means that for each household or community with multiple observations, the changes in the variables of interest between the two years are compared and then related to changes in e.g. road or WSS access. Yet, as the LCMS is not a panel as such, i.e. not the same households are interviewed in the separate surveys, the data had to be aggregated to a level for which observations were available for both years, 1998 and 2006. Therefore, for this purpose, the household information of the 1998 and 2006 data was aggregated to so-called "chief areas", which are areas in Zambia based on traditional social structures. In total, 187 chief areas could be identified for which information was indeed available for both years.[6] Thus, with this aggregation, a comparison of the changes in the averages of the outcome variables (e.g. poverty) with the so-called treatment variables (e.g. roads construction) was possible. More precisely and to give an example, the development of the share of extremely poor households between 1998 and 2006 was compared to the development of the share of households having access to boreholes in those chief areas. Besides of the treatment variables, several other control variables such as household characteristics or access to electricity were included in the estimations as well.

In general, this fixed effects approach will yield unbiased and consistent estimates of the effects of interest as long as no time-varying unobserved effects have an influence on the outcome and treatment variables of interest as well. Time-constant unobserved effects which may have an effect on the outcome variables can, however, be differenced out. An example for such a time-constant effect would be, for instance, the geographical conditions in the respective chief areas. Even though it cannot be completely ruled out that some time-varying unobserved effects influence the results, with the control variables we try to limit potential biases as much as possible.

Propensity score matching

In general, the fixed effects panel regressions are likely to yield more reliable estimates compared to propensity score matching as time-constant unobserved effects are differenced out in the regressions. However, as the information had to be aggregated to the chief area level, the number of

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[6] All chief areas with less than five observations, i.e. households, were dropped from the analysis.

observations for the regressions was considerably reduced which is why propensity score matching was used for the triangulation of the results obtained from the panel regressions.

The idea of propensity score matching in our case is to identify those households who have reported that a road was recently constructed or rehabilitated or who have access to improved WSS and compare those to households who do not have such access but are otherwise as similar as possible. To find those comparable households, first, the propensity score, i.e. the probability of treatment given some observed covariates, is estimated for all households. Then the most similar households are identified and matched according to their propensity scores, in our case by using a non-parametric matching approach. The difference in the outcome variables observed is then assigned to the effect of roads construction or WSS, respectively. As propensity score matching can be applied to individual households, considerably more observations were available for the estimations compared to the panel analyses. Nevertheless, in the end, the fixed effects panel results are considered to be more reliable.

2　Findings: Roads

2.1　The institutional setup of the roads sector

Today's roads sector in Zambia is a result of donor-supported institutional reforms that started between 2002 and 2003. Following the 2002 Transport Policy and the 2002 Public Roads Acts, three agencies were created: The National Road Fund Agency (NRFA), which is responsible for the coordination and management of road financing, the Road Development Agency (RDA) which plans, manages and coordinates the road network and road works on the core road network, and the Road Transport and Safety Agency (RTSA) being responsible for traffic management and road safety. The three agencies were fully operational by 2007.[7] Following the start of the reforms, the Road Sector Investment Programme (ROADSIP) II covering the years 2004-2013 was formulated and SBS started. With GBS, additional funds through GRZ were channelled to the roads sector. ROADSIP II is the strategic, multi-year planning instrument for the sector, made up of individual road projects and cost estimates.

The structure of this institutional setup was considered a "model case", following international best practice. A complication, however, and certainly a Zambia-specific issue is that each agency is reporting to a different ministry: RDA to the Ministry of Works and Supply (MWS), NRFA to the MoFNP, and RTSA to the MCT. Inter-ministerial boards have an oversight function for the road agencies. Also the MLGH is active in the roads sector, channelling a small amount of funds to the district level which implements road works on the non-core road network (priority: emergency works, spot improvements).

While this formal setup of the sector convinced donors to start SBS and other programmes, the implementation of road works and the interaction between the sector parties remained problematic. The interaction between the three agencies is not running smoothly. A striking example is the "over-commitment" by RDA in 2008. Adherence to annual budget constraints, which requires checks and balances between RDA, NRFA, and MoFNP, was flawed (see section on "Adherence to annual work plans").

In the context of overall Zambian decentralisation tendencies, including in the roads sector, the local level has gained importance. Selection and prioritisation of works start formally at the local level in the District Councils which act also as Local Road Agencies. Interviews at the local level in Siavonga, Monze, and Choma (all Southern Province) showed, however, that the District Councils are partly not even aware of their role in the roads sector and hence leave decision-making to the RDA-assigned Senior Engineers at the provincial level or to the RDA central level. Indications that the central level

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[7] For more details, see RDA, NRFA and RTSA Annual Reports and web pages.

also seems to partly overrule local priorities by implementing works top-down or by modifying the scope of work as suggested by the District Councils could not be investigated in detail. In sum, however, the sector remains fairly centralised.

2.2 Planning, financing, implementation, and output of the roads sector

2.2.1 Planning of a national road rehabilitation and maintenance network in Zambia

The FNDP of Zambia covering the years 2006-2010 assigns a crucial role to the roads sector. It stresses its importance for socio-economic services, for the economic growth of the main sectors of Zambia (agriculture, mining, manufacturing, and tourism), and for the wellbeing of the population. The goals specified for 2010 include:

- Bring a core network of 33,500 km up to a maintainable condition;
- Maintain paved and unpaved roads, including feeder roads.

The goals of the ROADSIP II for the years 2004-2013 are even more ambitious:
- Bring a core network of roads with a total length of 40,113 km up to a maintainable condition;
- Maintain paved and unpaved roads, including part of the feeder roads.

This planned core network includes: trunk roads, main roads, district roads, urban roads, tourist roads, and 91% of primary feeder roads. The road net of secondary and tertiary and remaining primary feeder roads of a total length of approximately 27,000 km is, however, not included.

In the following we will concentrate on the more ambitious ROADSIP II pursued by the implementing agencies in the roads sector, i.e. the RDA, the NRFA, and the RTSA as well as the foreign Cooperating Partners (CPs). The indicators given for the attainment of road targets are fixed in the ROADSIP II bankable document from October 2003. Unfortunately, the ROADSIP II targets presented in the Annual Performance Assessment Reports of the FNDP (or in the annual reports of RDA) deviate from the yearly indicators in the bankable ROADSIP II document. These deviating annual targets are set in the annual work plans (see below) and depend on the available funds of the years.

The annual planning focuses on the so-called "annual work plans" (AWPs). In theory, the process of developing an AWP is decentralised. In reality, however, the process remains quite centralised. The AWPs are bottom-up planning documents that are dependent on the available financial means for the next year(s). The prioritisation process starts with the local councils. Their wishes are submitted to the Roads Regional Engineers in the province capitals. The Roads Regional Engineers cannot remove these wishes, but they may add new proposals. The project lists of the provincial level are then submitted to the RDA headquarters. Here the real prioritisation process is done. RDA uses for the trunk, main, and district roads a computer-based programme (Highway Management System) that is highly sensitive to the traffic volume. For the prioritisation of primary feeder roads, a subsystem of the Highway Maintenance System is used. This gives a high weight to the population density. The RDA list is then submitted to the NRFA and the ROADSIP committee. From there it is sent to the related ministries and via the MoFNP finally to the parliament.

2.2.2 Sources of finance

The sources of finance are income from the Road Fund (fuel levy and other road user charges, ORUC), from GRZ, from the EU SBS, and from other donors' project aid (Table 1 and Figure 1).

The income of the Road Fund includes the income from the fuel levy (a levy of 15% on the petrol wholesale price and of 7% on the diesel wholesale price) and of the ORUC (registration and license fees, toll fees). This income is transferred from the MoFNP to the NRFA in full. The Government started to supplement the funding to the roads sector by additional budget contributions in 2005. It has subsequently increased this funding up to ZMK 300 billion in 2009. Since the end of 2007, NRFA is allowed to carry over unspent financial means to the next financial year.

Table 1: Road finance and expenditure in ZMK billion (real values in 2008 ZMK[+]) [8]

Income by source	2006		2007		2008		2009	
	nom.	real	nom.	real	nom.	real	nom.	real
Road Fund	214	265	241	267	340	340	487	450
GRZ	72	89	135	150	150	150	300	278
GRZ via MWS (Rural Road Units)	0	0	0	0	0	0	14	13
NRFA (interest receipts)	7	9	6	7				
NRFA (carry-over of local funds)	0	0	0		180	180	120	111
EU sector budget support (incl. interest)	221	274	5	6	158	158	0	0
Donors (project aid)	87	108	69	76	106	106	106	98
Carry-over of external funds							132	122
Total receipts	600	743	456	505	934	934	1,159	1,072
Total expenditures	399	494	444	492	866	866	1,132	1,047
Total expenditure (million USD)	106		111		245		221	
Exchange rate (ZMK/USD)*	3,755		4,114		3,814		5,121	
Surplus** (in ZMK)	201	249	12	13	68	68	27	25
Expenditures/GDP (%)	1.01		0.96		1.57		1.76	
GDP of Zambia***	38,561	47,747	46,195	51,163	55,079	55,079	64,326	59,502

[+] World Bank deflators: 2006 – 123.822717; 2007 – 110.753899; 2008 – 100; 2009 – 92.5
* Source: OANDA currency converter
** Domestic surplus has been carried over to next years' roads sector budget since 2007/2008
*** Source: CSO

The EU is by far the largest donor in the roads sector. It released ZMK 221 billion as SBS in 2006 (including a tranche due in 2005) and ZMK 158 billion as SBS in 2008 (including a tranche due in 2007). Since June 2008, the EU has stopped SBS because of the over-commitment of funds (see section on "Adherence to annual work plans"). Other donors that are channelling their project funds through NRFA are the World Bank, DANIDA (partly), OPEC fund, and the Nordic Development Bank. German Development Cooperation through KfW, the Arab Bank for Economic Development in Africa (BADEA), and AfDB had not yet started with disbursements (end 2009). German Development Cooperation will not channel funds through NRFA.

As shown in Table 1, total expenditures on roads have increased from a very low level in 2006 (1.01% of GDP) to a considerably higher level in 2009 (1.76% of GDP). Compared with the average shares in other comparable African countries during 2001-2006, e.g. non-fragile low income countries (2.36%) or landlocked low-income countries (2.51%)[9], this is still a low percentage.

[8] Source: NRFA, Annual Report 2007, 2008, draft 2009. Values for 2005: Sheladia/Mwila: ROADSIP II Midterm Review.

[9] AICD, Financing Public Infrastructure in Sub-Saharan Africa: Patterns and Emerging Issues, June 2008, p. 37.

Figure 1: Roads sector finance and expenditure (nominal)
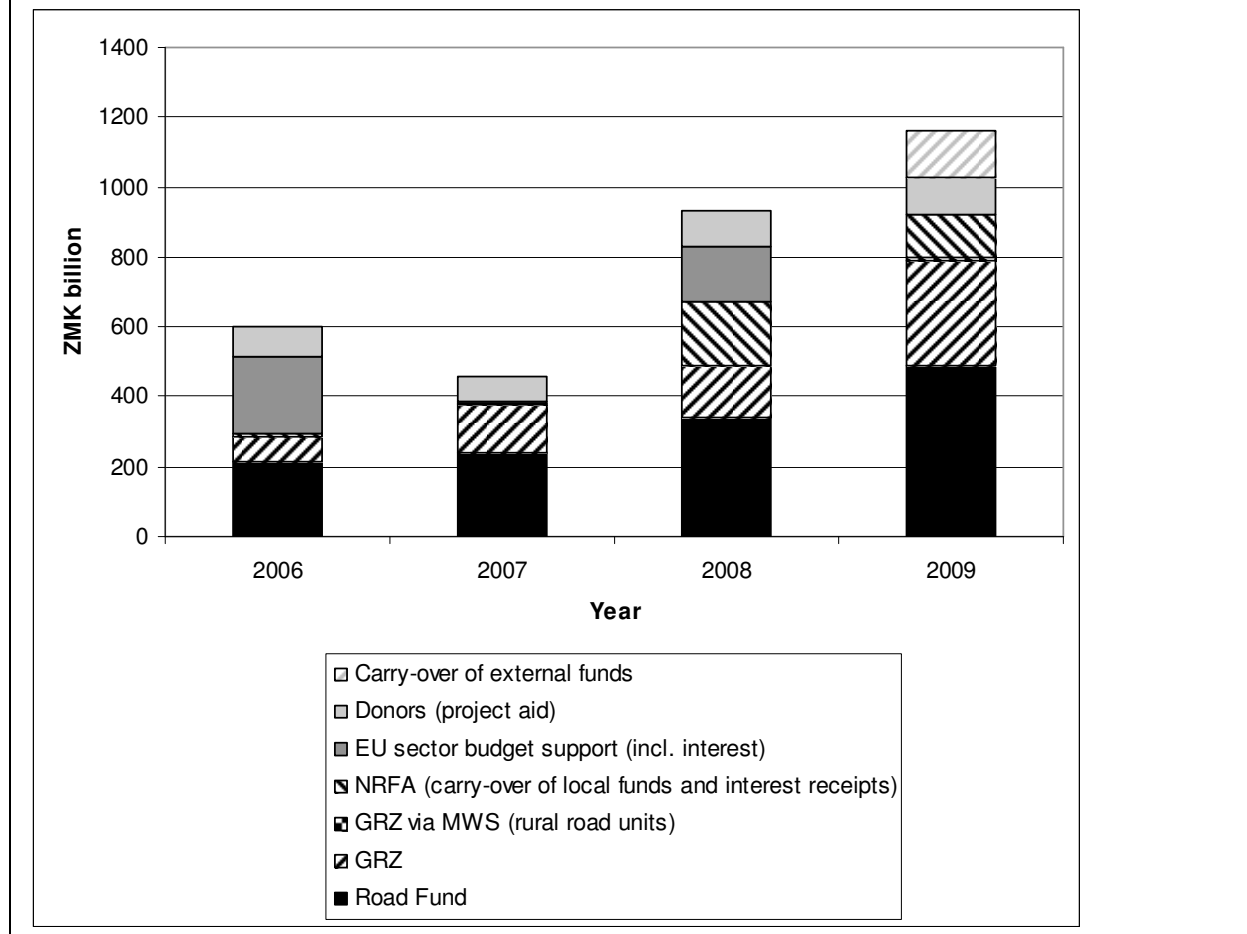
The Consultants Sheladia/Mwila[10] summarise that between 2003 and 2007 neither the budgeted nor the spent amounts have been sufficient to realise the ROADSIP programme. The budgeted **domestic** amounts between 2003 and 2007 have been made available at 85% while the budgeted **foreign** amounts have been made available at only 40% of the expected ROADSIP budget level. Not all contributions have been spent. On average, only 42% of the expected five years' cost had actually been spent on roads. The general reason is that expenditures were lagging behind available budgets before 2007 (Sheladia/Mwila, Midterm Review on ROADSIP II). The relatively low execution rate of the domestic capital budget can be explained by the restructuring of the roads sector institutions and the former rule of the MoFNP that remaining funds in the road budget could not be carried over to the next period.

In order to reach the long-term sustainability for the core network, the domestic funds should at least be sufficient for the routine maintenance of the core network. The cost for routine maintenance had been estimated by the Consultants of Deloitte & Touche[11] and their partners to be USD 160 million, price level 2003. Even in 2009, the year with the highest domestic expenditure, the domestic contribution (from Road Fund and GRZ) was slightly lower (96%) than the required amount for routine maintenance.

All in all, the spent amounts for rehabilitation and maintenance of the core network have been much too low to reach the goal of the ROADSIP II programme. The goal itself is ambitious. The need for road improvements, however, suggests that the goal was justified. More could have been done to reach it.

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[10] Sheladia/Mwila; ROADSIP II Midterm Review.

[11] Deloitte & Touche, ROADSIP II, Bankable Project, Final Document, October 2003.

2.2.3 Attainment of the ROADSIP II indicators, assessment of results

Table 2 describes the development of the ROADSIP II performance indicators for the years 2006-2009. Unfortunately, these indicators are not related to the indicators given in the bankable ROADSIP II document. They are set in the AWPs.

Table 2: ROADSIP II targets and actual performances 2006-2009[12]

2006 Intervention	Unit	Target	Actual performance	% achieved
Rehabilitation, paved	km	464	316	68
Maintenance, paved	km	6,298	8,238	131
Rehabilitation, unpaved	km	2,695	2,693	100
Maintenance, unpaved	km	14,746	8,239	56

2007 Intervention	Unit	Target	Actual performance	% achieved
Rehabilitation, paved	km	305	248	81
Maintenance, paved	km	6,732	5,845	87
Rehabilitation, unpaved	km	1,712	2,940	172
Maintenance, unpaved	km	17,591	10,934	62

2008 Intervention	Unit	Target	Actual performance	% achieved
Rehabilitation, paved	km	119	243	204
Maintenance, paved	km	6,968	6,428	92
Rehabilitation, unpaved	km	761	1,005	132
Maintenance, unpaved	km	20,058	12,436	62

2009 Intervention	Unit	Target	Actual performance	% achieved
Rehabilitation, paved	km	119	194	163
Maintenance, paved	km	8,723	10,605	122
Rehabilitation, unpaved	km	803	1,716	214
Maintenance, unpaved	km	21,939	10,465	48

Between 2006 and 2009 an average length of 250 km of **paved roads** has been rehabilitated per year. The average target of 252 km has nearly (99%) been attained. On average, 7,779 km of the paved network has been maintained. The maintenance goal of on average 7,180 km per year has therefore been slightly exceeded (108%). Since the total paved network had a length of approximately 7,914 km at the end of 2009 (6,172 trunk, main, and district roads and 1,742 urban and feeder roads) nearly (98%) the whole paved core network has been maintained.

During the same time span, an average length of 2,088 km of **unpaved roads** has been rehabilitated per year. This compares with the goal of 1,493 km per year (140%). But only 10,519 km of the unpaved network have on average been maintained per year (57% of the average target of 18,584 km per year). Since the total unpaved network had a length of 32,277 km at the end of 2009, it is evident that two thirds of the unpaved net have not or not regularly been maintained in the past.

These figures confirm that it has been the priority of GRZ to improve and maintain the paved trunk and main road network first before the district and primary feeder roads are taken care of.

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[12] Source: RDA, Annual reports. Year 2009: RDA, 4th quarterly report on ROADSIP progress.

Looking at the road network condition gives a similar picture. Even if the high volatility of the data from one year to the next raises some doubts about their reliability in detail, they point towards a fairly consistent overall picture: The paved network has continued to be in a good or fair condition (Table 3) though the percentage of the network of the first category has deteriorated from 29% to 18%.

Table 3: Paved road network condition during 2006-2009[13]

Condition	% of network 2006	% of network 2007	% of network 2008	% of network 2009
Good	29	17	33	18
Fair	64	72	61	76
Poor	7	11	6	6
Total	100	100	100	100

The condition of the unpaved network has, however, deteriorated drastically: The share of the network in good and fair condition dropped from 52% in 2006 to 21% in 2009 (Table 4). It is not imaginable that the ROADSIP II goal (attainment of a maintainable core network of 41,113 km) will be reached in 2013.

Table 4: Unpaved road network condition during 2006-2008[14]

Condition	% of network 2006	% of network 2007	% of network 2008	% of network 2009
Good	22	36	8	10
Fair	30	24	9	11
Poor	48	40	83	79
Total	100	100	100	100

What are the reasons for neglecting the maintenance of unpaved roads? First of all, only a small part of the total budget is allocated to the routine maintenance of the whole road network as compared with periodic maintenance/rehabilitation/upgrading. For 2010, only ZMK 34 million have been allocated to the routine maintenance of 16,454 km. On the other hand, ZMK 1,060 million have been allocated to the periodic maintenance/rehabilitation/upgrading of 10,526 km of the network. This reflects the higher priority of periodic maintenance/rehabilitation/upgrading as compared to routine maintenance. Additionally, priority to the latter works has also been given if contracts turned out to be more expensive than planned. Finally, it may be difficult and time consuming to find contractors for routine maintenance in the remote areas of Zambia.

2.2.4 Rehabilitation and maintenance of secondary and tertiary feeder roads by force account

The feeder road network of secondary and tertiary order and part of the primary feeder roads were not included in the core road network. In order to improve this network as well, the GRZ has decided to import road equipment from China (total value: USD 39 million) and to have at least part of the a. m. feeder road network maintained by a Rural Road Unit (RRU) that is assigned to the MWS. The equipment arrived in Lusaka in June 2008 and was immediately distributed to the 9 provinces. The establishment of RRUs at the provincial level took some time. However, at the end of 2008 the units were operational.

Unfortunately, the MWS does not publish an annual report on the activities of the RRUs. According to unpublished papers and presentations the following results have been attained in 2009 (Table 5)[15]:

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[13] Source: RDA, Annual Report, 2008 and Road Condition Report, 2009.
[14] Ibid.

Table 5: 2009 RRU Activity Progress Report

No.	Province	Amount of km achieved in 2009	Released budget (ZMK billion)
1	Central	760	2.000
2	Copperbelt	720	1.300
3	Eastern	476	1.500
4	Luapula	590	1.500
5	Lusaka	750	1.500
6	Northern	370	2.000
7	North-Western	405	1.333
8	Southern	728	1.237
9	Western	325	2.000
	Total	5,124	14.370

All in all, 5,124 km of feeder roads including spot improvements have been maintained or rehabilitated in 2009. This amounts to 19% of the non-core feeder road network of 27,000 km. Sometimes the RRUs also rehabilitate core primary feeder roads or even district roads (e.g. in the Monze district). Information on the coverage of works (e.g. spot improvement or continuous improvement) or on their quality are, however, lacking. It was foreseen that every province should receive ZMK 2 billion in 2009. However, the actual releases have been less. The financial means were handled by the MWS (not by the NRFA). In 2010, the RRU of every province should receive ZMK 5 billion.

The RRUs, as stated in interviews of the evaluators, have the following main complaints:

- Insufficient and irregular funding;
- Shortage of fuel supply at the site;
- Frequent machinery break-downs;
- Shortage of inspection vehicles;
- Shortage of spare parts and skilled operators.

The past experience with road maintenance by force account in Africa during the 1980s and 90s has been very bad. Only very limited maintenance work was actually carried out.[16] Among the reasons were: shortage of foreign exchange for spare parts and repair services, no stable budget for covering the running costs, and no motivation by the public force account units to do the work. Therefore, donors are usually reluctant to have their funds spent via force account units and would prefer the involvement of private contractors. However, government authorities in Zambia expressed a very positive view on the work of the RRUs.

At present, empirical evidence on the cost effectiveness of the RRUs compared to private contractors is lacking in Zambia. It is recommended that the MWS prepares detailed annual reports on RRUs' activities and that a study is commissioned to an independent consultant in order to analyse the issue of cost effectiveness.

2.3 Audit findings and further assessments at the operational level

Some of the crucial discussions about the Zambian roads sector centre on the performance of the sector at the operational level. Two of the main topics were the high unit rates of contractors and the so-called "over-commitment" by RDA in 2008, as will be explained in this section. The foreign donors had been informed on this over-commitment at the semi-annual Joint Donor Forum on the 23rd and

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[15] Source: MWS, unpublished documents.

[16] See MCT and Deloitte and Touche: ROADSIP II, Financial Strategy, Oct. 2003.

the 24th of April 2009 and had been very worried about these activities. They proposed that the Auditor General should carry out a fully-fledged audit covering financial, technical, and procurement aspects. This audit report has been submitted to the foreign donors in a preliminary version[17] at the end of April 2010 and later as an official document. This audit report is a key resource to assess the performance at the operational level.

2.3.1 Adherence to annual work plans

One of the main topics in the roads sector in 2009 was the lacking adherence to the AWP and its approved budget, the "over-commitment" of about ZMK 1 trillion by RDA in 2008. This means that the contract sum of ZMK 1 trillion (approx. USD 250 million) was not covered by the annual budget in 2008 and 2009. Since the figures on this over-commitment given in the annual reports of RDA and NRFA slightly differ, the reliable figures of the Auditor General's report are used here. The over-commitment amounted to ZMK 1,015,817,097,718 in 2008. This resulted in serious cash flow problems because the local resources in the AWP 2008 were only about ZMK 685 billion (USD 180 million). Consequently, the main focus of the AWP 2009 and of the AWP 2010 was on reducing the 2008 over-commitment by focusing the budget on on-going contracts.[18] Since a large number of contracts could not be implemented in 2008, some contract executions had to be postponed to 2009 resulting in penalty payments and mounting arrears for GRZ. Another 5 contracts that had been awarded but not signed in 2008 had been activated in 2009.

Such over-commitment by RDA was only possible by not consulting NRFA, not respecting the AWP, and not following the annual budget ceilings. All these are the basis for planning, budgeting, and implementation in each year. Obviously, the Board of RDA and the steering Ministry (MWS) of RDA did not control the activities of RDA. Not surprisingly, the President had dissolved the Steering Boards of RDA and NFRA and dismissed the Permanent Secretary of the MWS after submission of the audit report.

The reasons given by RDA in several discussions were the following: Firstly, project execution has always been behind project planning in the past. Thereby the financial allocations could not be used fully. This could only be changed by speeding up project contracting. Secondly, a higher financial contribution than budgeted to the roads sector was expected. The recession of the economy in conjunction with the fall in the copper prices prohibited, however, any additional release of funds by the MoFNP.[19] Thirdly, RDA pointed to the medium term budget planning for the sector (Medium Term Expenditure Framework, MTEF) as reliable framework for commitments: expenses of the additional contracts signed in 2008 would occur partly only in future fiscal years, so that the "over-commitment" would not really be a problem. However, firstly, the annual budgets are still a binding framework for any commitments. Secondly, as the Auditor observed, a lot of the contracts signed in 2008 have an end-date in 2008 or 2009, so that inevitably serious cash problems ensued in these two years as a result of the contracts signed.

The behaviour of RDA was clearly irresponsible and against the law. The annual budget ceilings are to be respected as hard ceilings.

2.3.2 Procurement procedures and project execution

Part of the Financial and Technical Audit was the "Procurement Audit of Roads for the period Jan 2008 to Aug 2009". A sample of 100 out of all contracts signed between 1st of January 2008 and 30th of September 2009 was drawn. From this sample 60% were fully and 15-20% partially audited. Additionally, 18 roads were selected for various physical tests.

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[17] Office of the Auditor General, Financial and technical audit of road contracts for the period Jan 08 to Aug 09, Lusaka, Jan 12, 2010.

[18] For detailed figures, see RDA AWP 2009 and 2010.

[19] See RDA AWP 2009 and AWP 2010.

Based on the findings of the audit report, the defects of the **procurement stage**[20] are the following:

- "Drawings for the contracts were in most cases either delayed or not prepared. It was also observed that a condition survey was not conducted leading to inadequate interventions and unnecessary variations.

- Contrary to common practice, the engineer's estimates were not used when carrying out evaluations. It was therefore difficult to ascertain the reasonableness of the bid sums.

- Consultants were mostly engaged later than the starting of the work contract. In this regard, a part of the contract period was going on without supervision.

- RDA does not usually hold contract negotiation meetings despite the inconsistencies in the evaluation and poor contract documents.

- The contract documents are sometimes very poor (not signed, no date, drawings missing, drawings relating to other roads)."

These observations of the Auditor point to severe deficits in the procurement, linked to weak supervision by RDA. These deficits create risks that the works are not carried out professionally.

Based on the findings of the audit report, the main deficits of the **execution stage**[21] are:

- "There were considerable delays in decision making relating to issues raised by consultants/contractors that led in some cases to an extension of time and additional cost.

- The clause of performance bond was not always respected thereby failing to penalize the contractor in case of non-performance.

- Some payments to contractors were delayed resulting in interest charges and standing time.

- In some cases payments were made for work not done.

- In some cases the Agency issued instructions directly to the contractors disregarding the consultants.

- Only few projects were completed on time. In most cases the contract had to be extended and in some cases more than once. There were also cases where RDA instructed the contractors to slow down or stop works because of lack of funds.

- Progress reports were in a number of cases not prepared by the supervisors.

- It was observed that payment certificates were processed by RDA in the absence of measurement sheets.

- In cases where the supervision of contracts was done by RDA, supervision funds were paid through the contractor thereby raising issues of objectivity."

The evaluators judge these deficits to be very serious. They have to be eliminated as fast as possible.

2.3.3   Quality of works

Infrastructure projects are very costly. They absorb a high volume of the national budget. Therefore it is very important that the quality of works delivered by the contractors is the same that is agreed upon. Otherwise, the public funds are not efficiently used and partly wasted.

The audit report[22] examined the physical condition of 18 road projects that were randomly drawn out of the aforementioned 75–80 projects sample. The report states the following summary of the tests:

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[20] Quotation: Audit Report, Executive Summary.

[21] Quotation: Audit Report, Executive Summary.

- "44%   of samples for gradation did not meet the gradation requirement;
- 75%   of samples tested for plasticity were too plastic;
- 67%   of aggregate samples did not meet the requirements of crushing strength;
- 81%   of base thickness samples were thinner than was specified;
- 39%   of surface dressing samples stripped off from the base course;
- 82%   of samples for surface dressing layers were thinner than specified;
- 100%   of samples taken had cement content less than specified;
- 50%   of concrete samples tested were weaker than was specified".

Among the report's conclusions and recommendations[23] are the following:

"Tests carried out revealed deficiencies in gradation of material particles, high plasticity, low cement content for stabilized layers and, above all, **thinner** base layers than specified.

The combinations of these deficiencies is drastically shortening the pavement lives (of the roads) and thus costing the Government of Zambia in terms of repairs and/or reconstructions that will have to be carried out much earlier than planned. The implications of this to the economy of the country need not be overemphasized."

These are disastrous results. The evaluators fully agree with the assessment of the Auditor General. The findings are a clear indicator of inefficient operational efficiency, "value for money" is missing in many cases. Investigations have to be carried out against RDA staff, engineering consultants and contractors in order to detect possible fraudulent activities.

2.3.4   Unit prices of roads

One topic high on the sector agenda are the unit rates of road works. Road agencies, the NCC, and the donors all mentioned that unit rates are very high in Zambia, higher than in neighbouring countries, and have been increasing in recent years. NCC is working on a Unit Rate Study; results are expected in early summer. First figures are, however, already available: RDA states that unit rates have increased by 20-30% on average.[24] In some cases, bid sums double the original unit rates.[25] A DANIDA-commissioned study found, for example, that the abandonment of advance payments to contractors required these to take up bank loans at interest rates above 30%, costs which were passed on to the bid sums. Further investigation is required to confirm if in some cases specific unit rates were more than 300-400% above estimates. Furthermore, as a DANIDA-financed study found, there does not seem to be a countrywide applied database with unit rates which would provide the base for RDA's estimates.[26] As is well known, a general problem in assessing ex post unit rates is related to the different ex ante conditions of the roads, to the different scope of works that have been done, and to the transport distance of building materials.

A whole range of influencing factors is cited for the high unit rates:

- **Lack of competitors** in the sector (influenced also by works in preparation of the 2010 Soccer World Cup in South Africa). This has been aggravated by the fact that the Zambia Public Procurement Authority issued on the 4th March of 2008 an extensive blacklist of 42 companies. The blacklist withdrew many of the major bidders from the Zambian road

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[22] Office of the Auditor General, Financial and Technical Audit of the Road Projects 2008/09, Road Material Test Report, January 2010, p.12.

[23] Office of the Auditor General, Financial and Technical Audit of the Road Projects 2008/09, Road Material Test Report, January 2010, p.14.

[24] See RDA AWP 2009.

[25] See RDA AWP 2008, p. 32.

[26] Draft "Cost Based Unit Rate Analysis and Design Review of District Roads Projects in Luapala and Western Provinces.", DANIDA 2009.

construction and maintenance market. From mid-June 2008, some of the companies were removed from the blacklist.

- **Collusion** between main contractors.

- Shortcomings in the **bidding and evaluation process** (e.g. high rejection rates of bids due to inadequate bureaucratic procedures, too short contract duration, inadequacy of bid period).[27] Domestic construction firms are hereby primarily affected.

- Response by contractors to the temporary **removal of advance payments** to contractors.[28]

- **RDA delaying the contracted works** and/or payment due to a shortage of funds (see section on "Adherence to annual work plans").

- **Long duration of payment** of disbursement requests (agreed time frame for signatures: 19 days for RDA provincial and head quarter level, 7 days for NRFA).

- **Remoteness** of the work locations.

- **Materials shortages.**

- **Volatility of the exchange rate.**[29]

In consequence, a frequent general judgement is that the "perceived risk of doing business" in Zambia is exceptionally high. In response, contractors price a "risk premium". The market structure is such that contractors succeed in winning tenders even though they charge high risk premiums. The 2008 over-commitment and the subsequent delays in contract executions are one set of examples for the uncertainties that contractors face. It is a crucial challenge for the Zambian road agencies and steering Ministries to reduce the risk of doing business and to reduce the unit rates, and thereby also to increase the operational efficiency in the sector.

Both local and foreign companies compete as contractors for road construction. The international participation has positively influenced roads sector projects. International bidding can create more competition, bring in expertise and reduce cost. A negative consequence, however, is that the local construction industry does not benefit as much as it could. As stated by the NCC, local contractors did not have the required expertise when suddenly more road works were tendered because of increasing budgets of the roads sector.[30] According to the NCC, more training to local companies would have increased the competitive edge of the local construction industry.

The unit price increase is, however, not a unique Zambian problem. As the Africa Infrastructure Country Diagnostic (AICD) demonstrates[31], unit rates rose in all sampled countries. The reasons varied, but especially the rise of the oil price in the period under evaluation (2005-2006) and the competitive structures of the markets were made responsible for the increase.

2.4   The role of the donors and the way ahead

As mentioned above, the roads sector reforms initiated in 2002/3 were both donor-influenced and a pre-condition for the new aid modality of SBS in this sector. Since 2002/3, the overall budget of the roads sector has increased significantly. This is a result not only of more funds provided by GRZ (resulting partly from GBS), but also revenues through the fuel levy and ORUC. Also the donors reoriented towards financing infrastructure (see section on "Planning, financing, implementation,

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[27] Office of the Auditor General, Procurement Audit of Roads, Contracts for the Period Jan 08 to Aug 09, Prelim. Report, Dec 31, 2009, 6-9.

[28] According to the NCC, this gives some competitive advantage to companies with easy access to finance, as it is the case for many Chinese companies operating in Zambia and receiving financial services by the Bank of China's Zambian branch.

[29] For an elaboration on these points, see the above mentioned DANIDA 2009 study on unit rates.

[30] More information about the Zambian construction industry in Mwape, F. (NCC principal) (2008): „Challenges facing education and training of construction industry personnel – A case for Zambia", presented at Construction Industry Forum 2008 in Dar es Salaam.

[31] AICD (2006), Unit Costs of Infrastructure Projects in Sub-Saharan Africa.

and output of the roads sector"), a reinstated acknowledgement of the importance of (roads) infrastructure for economic development.

Despite the move towards SBS, the range of aid modality in the roads sector remains wide. Most donors align to NRFA budgeting and financing arrangements, but there remains a continuum of donor activities between project aid and SBS/GBS. The use of procurement rules, the prioritisation of individual measures, and the role of consultants are just some examples of how donors balance their own regulations, political agendas, and perceived risks of the roads sector against the general tendency to fully align with the sector programme and the sector agencies. However, considering what the sector in fact requires, this continuum seems rather conducive to sector development. Certainly, sector structures and procedures actually are and should be strengthened through SBS and GRZ budget funds, but at the same time, more focused project support can help e.g. RDA with regard to state-of-the-art cost-benefit analysis and high-quality consultant supervision of road works.

With newly created road agencies and increasing funds for the sector, the issue of capacity building and technical assistance had to be high on the agenda of donors and GRZ. All road agencies have received technical assistance in recent years. However, both from the donor side and from Zambian authorities, continuing lack of capacity was mentioned as a crucial factor impeding a better planning, implementation, and supervision of works. Particularly, the capacity of procurement units in RDA and the supervision of works through RDA units are regarded as sub-standard. Also, the limited operational budget of RDA is seen as a reason for slow capacity development.[32] Yet, there are also critical views from the donor community that the technical assistance provided to the roads sector was not up-to-date with the focus on SBS. Apparently, consultants sometimes acted as mere "gap fillers", focusing on the rapid implementation of individual projects. The response to SBS from a technical assistance point of view must, however, also be to give support in public financial management. This support should strengthen the agencies' own procedures in e.g. planning, procurement, and supervision.

The sector dialogue related to SBS between the Zambian sector authorities and the donor community is organised through the ROADSIP Steering Committee. At the national level, related to GBS support, an additional dialogue takes place between the donor community and the GRZ. The roads sector is included in the PAF/FNDP with two indicators. These two levels of dialogue have created a level of exchange and also influence for the donor community concerning the roads sector that would not have been possible through project aid only.

However, at the time of the evaluation, the dialogue on the sector level was not working smoothly. No Steering Committee meetings with the donors had been held in 2009. This is a result of (1) RDA's "over-commitment" problems in 2008 (see section on "Adherence to annual work plans") and (2) the donor community waiting for the release of the Auditor General's report on the roads sector. This report was commissioned in response to the 2008 sector problems and was distributed to the donors only at the end of April 2010. Also from the Zambian side, the dialogue has not been actively promoted in recent times. As the donor community stated in 2009[33], the breakdown of the sector dialogue, and particularly of the sector reporting is worrisome and "severely limits the ability of CPs and GRZ to properly monitor the performance of the road sector". Temporarily stopped disbursements of on-going funding and scepticism with regard to future SBS are further consequences of the recent problems. It has to be noted as a positive side-effect of GBS that this audit was commissioned in the first place. The shift of the donors to GBS increased the influence of the donors on auditing practices in all sectors of the GRZ. The Poverty Reduction Budget Support (PRBS) Memorandum of Understanding (MoU) requires annual audits and stipulates consequences if audits are not presented in time. The Auditor General also received technical assistance through the donor community.

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[32] See April 2009 Joint Donor Mission Aide Memoire.

[33] See April 2009 Joint Donor Mission Aide Memoire.

In addition, also the donors face new conditions. The Chinese are already active in the roads sector (through road contractors and by having financed maintenance equipment for the RRUs). Further financial support also for roads construction – "no strings attached" – might decrease the influence of the rest of the donor community. The influence of the donor community on pushing ahead further reforms in the sector – as response to the findings of the Auditor General – is therefore not to be taken for granted.

A new start in the sector, also with regards to the sector dialogue is certainly needed. In response to the publication of the Auditor General's report, the President dismissed the Permanent Secretary of the MWS, who is responsible for the operations of RDA, as well as the governing boards of RDA and NRFA. The CP community currently (May 2010) negotiates with GRZ a common Remedial Action Plan (RAP), to be finalised still in the first half of 2010. The Remedial Action Plan focuses on the following objectives:

1. To implement adequate corrective measures in order to address the audit findings.

2. To ensure that the shortcomings having led to mismanagement in the sector are not repeated.

3. To allow for a medium term strategic sector framework to put the roads sector on a sustainable footing (bankable ROADSIP II).

4. To facilitate a review of the institutional setup of the roads sector and identify the possible capacity building projects that would accompany a reform of the same.

In the view of the evaluators, the most serious problem to be solved is the **poor quality of the road works** done by the contractors (point 1 and 2 of the RAP objectives). Since these roads have been supervised and taken over by RDA, the roads sector management and the RDA senior management have to be reviewed for unlawful activities (involvement of Anti-Corruption Commission ACC) and possibly replaced. If this problem is not solved, the goal of budget support cannot be achieved. This statement is in line with the President's statement from the 11th of April[34]: "In this regards, RDA officials and Consulting Engineers to supervise these road works are directed to ensure that each and every road constructed meets the highest standards of quality and durability".

Secondly, the **efficiency of RDA** has to be increased (point 4 of the RAP objectives). This implies more staff and higher qualification of the staff at the central and province level. All the deficits of procurement and project execution have to be overcome. The main weaknesses in the public financial management of the roads institutions need to be addressed, internal control mechanisms have to be strengthened. This should be done with the goal of reducing the fiduciary risks in the sector.

Thirdly, as regards the **sector finance** (point 3, bankable ROADSIP II), it seems reasonable to assume that Zambia has to cover at least the yearly running costs to keep the network at the present condition. This had been estimated by Deloitte & Touche at USD 160 million per year, price level 2003. Sheladia/Mwila[35] estimated for a constrained alternative of the future ROADSIP II programme, time span 2008-2014, a Zambian contribution of USD 161 million per year. This would imply a drastic increase of the domestic financial contribution (from an average level of USD 82 million per year between 2005-2009 to a level of USD 161 million per year in future). In our view, this increase can only be realised if the **fuel levy** would be drastically increased from its present level. At the moment, the Zambian fuel levy of 7% on the diesel wholesale price is at the lower end of African fuel levies.[36] Tanzania, for example, has a fuel levy of 16%. Additionally, the confidence of the donors in the professional work of RDA has to be regained so that they would take up their support to the roads sector again.

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[34] State House Lusaka, Media Statement, President calls for speedy roads construction, 11th of April, 2010.

[35] Sheladia/Mwila: ROADSIP II Midterm Review.

[36] AICD, The Burden of Maintenance, Roads in Sub-Saharan Africa, June 2008, p. 17.

Fourthly, to maximise the utility of a given roads budget, the Zambian institutions will have to place a high priority on decreasing the **unit costs** of road works to levels common in neighbouring countries. RDA and the other institutions involved in the roads sector have to become reliable partners. This includes the stop of the extensive and intransparent black listing (see above, blacklisting should be limited to severe, usually individual cases), the keeping of proper financial planning methods (no over-commitment, no delaying of contracted works), and the maintenance of internationally accepted contract terms (allowance of advance payment). It further implies that RDA becomes more professional at the procurement and execution stages (see section on "Procurement procedures and project execution").

Fifthly, a **balance** has to be found between the **allocation of budget to the core and the non-core network**. All involved parties would agree that a suitable low cost solution has to be developed for establishing a basic road transport system for the vast and sparsely populated areas of Zambia and that a certain amount of the budget should be allocated to this end. It seems to be plausible that the provincial level of RDA should be strengthened and that a certain budget should be allocated to the provincial level. It has to be investigated in more detail whether the road activities should be carried out by RRUs or by private contractors (see section on "Rehabilitation and maintenance of secondary and tertiary feeder roads by force account").

2.5 Effects of the roads sector on poverty reduction and economic development

It is generally assumed that the roads sector is crucial for poverty reduction and economic development. The common impact chains are as follows:

On a micro-level, roads provide better access for individuals to economic and social facilities. Better access can mean a reduction in travel time or having a basic year round access. Access to economic and social services and institutions – health centres, schools, administration, and markets – is crucial for an improvement of living conditions in rural areas. In many rural regions in the world, also in Zambia, people living on the countryside have very limited such access or even no access at all during the months of rainy seasons.

On a macro-level, improvements in the roads system can stimulate the economic development of a country. Many economic sectors depend on good transport links (e.g. agricultural goods need to be transported to markets and customers). In a landlocked country like Zambia, trade is largely depending on road transport. For these macro-stimuli, major national corridors are necessary.

There is a large body of evidence showing that roads are crucial for poverty reduction and economic development. For case-studies about effects of roads sectors in various countries, Lebo/Schelling (2001), the Asian Development Bank's study (2006) on when rural roads benefit the poor, as well as the joint ADB, DFID, JBIC, and World Bank study on assessing the impact of transport and energy infrastructure on poverty reduction are useful resources. Evidence for the poverty-reducing effects can be found in Howe (1997) and the ODI (2000) study on transport and poverty.

2.6 Traffic development and macro-level effects

2.6.1 Traffic development

If roads were not used, road investments would not create any effects on poverty reduction and economic development. Therefore, the starting point for any impact analysis should be traffic development.

Since 2006, RDA counts the traffic at various points of trunk, main, and district roads throughout the country. These counting points are outside of the cities or other settlements. Not surprisingly, the

average annual daily traffic (AADT) is highest on the trunk roads (2009: 2,061 vehicles per day), second highest on main roads (2009: 591 vehicles per day), and on district roads third highest (2009: 214 vehicles per day) (see Table 6). The AADT on district roads seems, however, not to be representative. On the one hand, RDA has only 11 counting stations for this huge net, and on the other hand, the evaluators have seen some district roads with hardly any vehicles at all. The officer at RDA responsible for traffic counts could give no explanation about this high traffic level counted on district roads.

Table 6: Development of motorised traffic on trunk, main, and district roads

Type of road/AADT	2006	2007	2008	2009	AADT 2009/2006
Trunk roads (24 counting stations)	1,603	2,131	1,776	2,061	1.29
Main roads (16 counting stations)	585	732	491	591	1.01
District roads (11 counting stations)	187	190	130	214	1.14

Source: RDA and own calculations.

Since the start of the traffic counting in 2006, the traffic volume has increased in 2007, decreased in 2008, and again increased in 2009. The level in 2009 was higher than in 2006, indicating a general upward trend.

The high traffic volumes on trunk and main roads indicate that the investment in this bitumen road network has been economically very profitable. As a rule of thumb, the benefits of the road users surpass the costs of an upgrading investment to a bitumen standard at a traffic level of 200-300 motorised vehicles per day.[37] Therefore, the decision of the Zambian Government to invest in the trunk and main road network can certainly be justified. By increasing the total road budget, improving the quality of the rehabilitated or maintained roads, and by more efficient construction and spending, it should, however, also be possible to improve the condition of district and feeder roads.

The level of investment in the trunk roads is, however, not approved by all. The AICD Country Report for Zambia, for instance, argues that "over-engineering" took place on many roads in Zambia – by comparing the traffic volumes with the standard of the road. Simpler road standards, such as single bituminous surface treatment, would be a way to use funds more efficiently, according to the AICD study. However, the traffic volumes on trunk and main roads are very high and have increased in recent years. Therefore, the evaluators do not see over-engineering as a problem with trunk and main roads in Zambia. Individual cases at the district road level might be affected in this context, if these roads have been paved. This has, however, not been investigated by the evaluators.

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[37] AICD, The Burden of Maintenance: Roads in Sub-Saharan Africa, June 2008, p. 38.

Figure 2: Poverty incidence in relation to road traffic
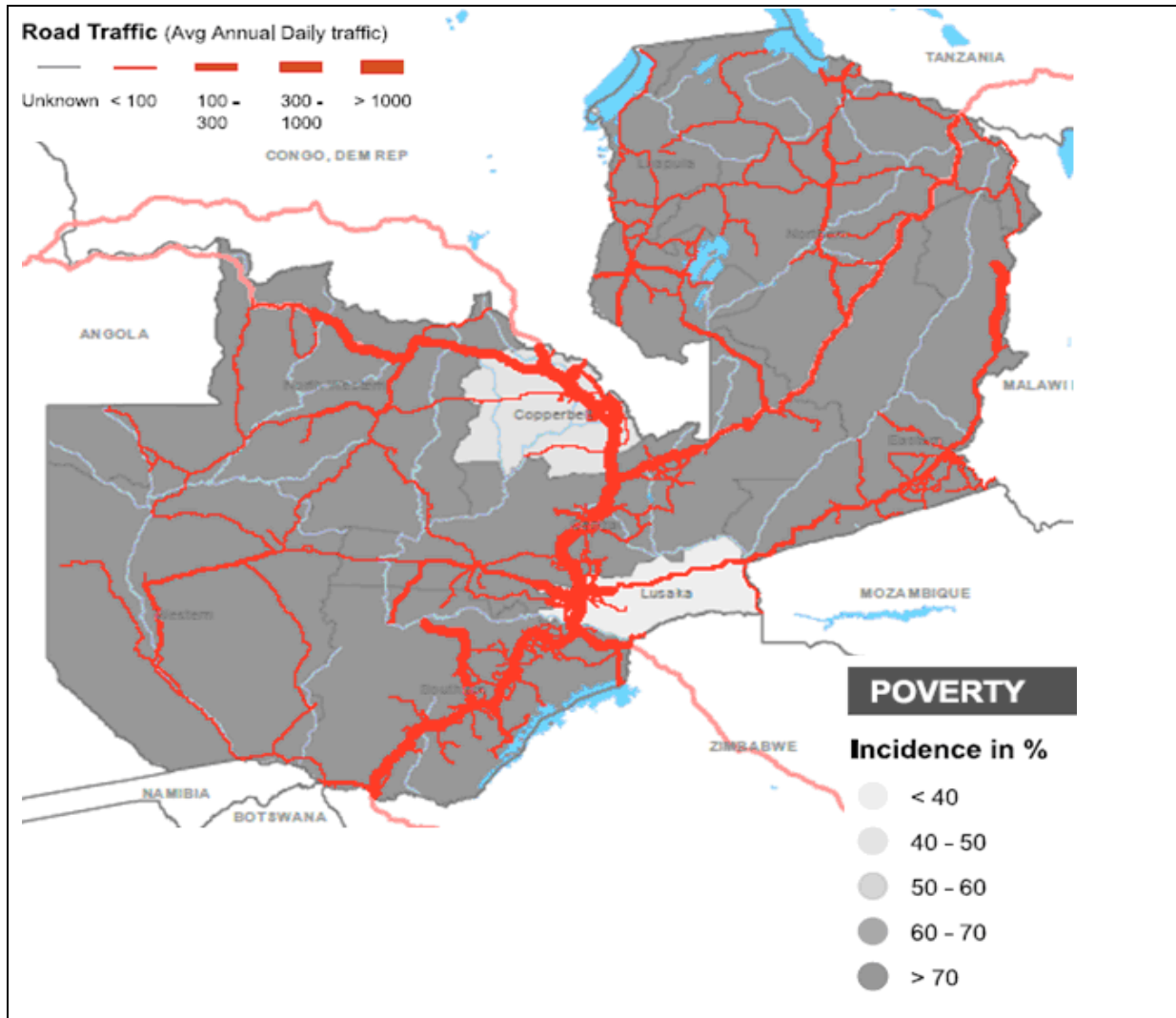
Source: AICD (2006).

Figure 2 shows the relation between the traffic volume and the poverty incidence in the country. It is clearly visible that the AADT is highest on the trunk road network between the Copperbelt and the Lusaka area, also extending southwards to Livingston. These main roads connect the economically most important regions in the country. In these areas, also the poverty incidence is lowest. The high traffic volume to the Copperbelt region is clearly linked to the mining activity in this province. Lusaka, the capital, is the economically most important region. The trunk road to Livingston in the south is the crucial transport link for tourism in Zambia. From the main trunk road between the Copperbelt, Lusaka and Livingston, the transit route to Zimbabwe in the south-east of Zambia is also experiencing high traffic volumes.

2.6.2 Impact on Zambia's economic development

Despite the investments in recent years, for the Zambian economy at large, studies such as the AICD Country Report Zambia suggest that the road infrastructure is still impeding stronger growth rates and higher investment. AICD found that the contribution of infrastructure to Zambia's strong economic growth in recent years has been relatively low. A positive but small change in growth per capita can be traced to road projects by comparing growth patterns in 2001-2005 to the 1991-1995 period (see Figure 3, left). Roads sector contributions to growth have, however, been stronger in other countries of the region. The AICD further found that raising Zambia's infrastructure to the level

of the leading nation in the region, i.e. Mauritius, could add 2.2 points to its per capita growth rate (see Figure 3, right).[38]

Figure 3: Contribution of infrastructure to GDP growth in sub-Saharan Africa
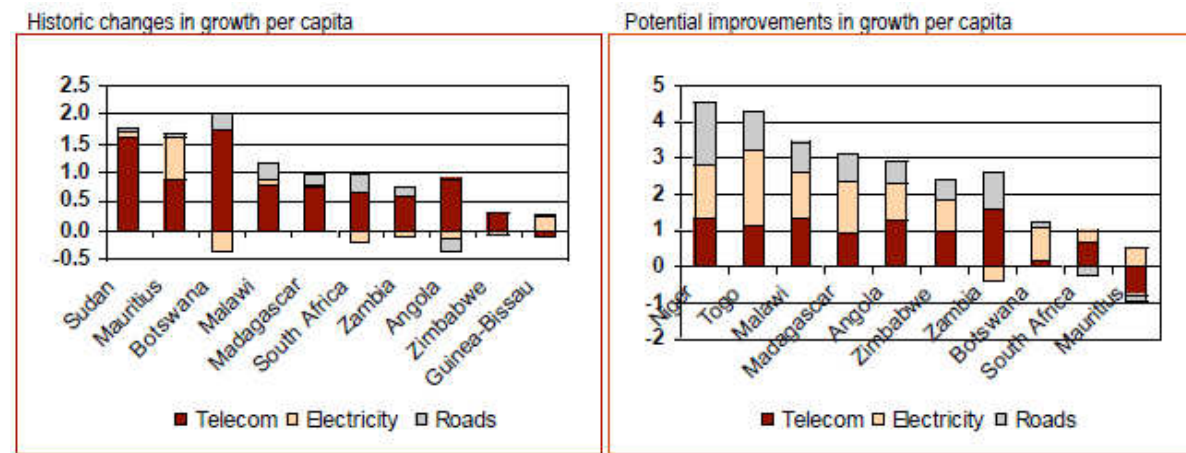
Source: AICD Country Report Zambia.

Such findings are supported by the Africa Competitiveness Reports: "Inadequate supply of infrastructure" remains since 2004 steadily among the top four problematic factors for doing business in Zambia. This suggests at the very least that improvements in the roads sector have not outpaced improvements in other influencing factors like e.g. access to finance.[39]

The Zambia Development Authority (ZDA) stressed that the high cost of doing business slows down private investment in the country. ZDA ascribes a significant part of these costs to high transport costs which are related to long travel times and Zambia being a landlocked country. According to ZDA, there are ample examples of private investment following road improvements.

Figure 4: Trade development
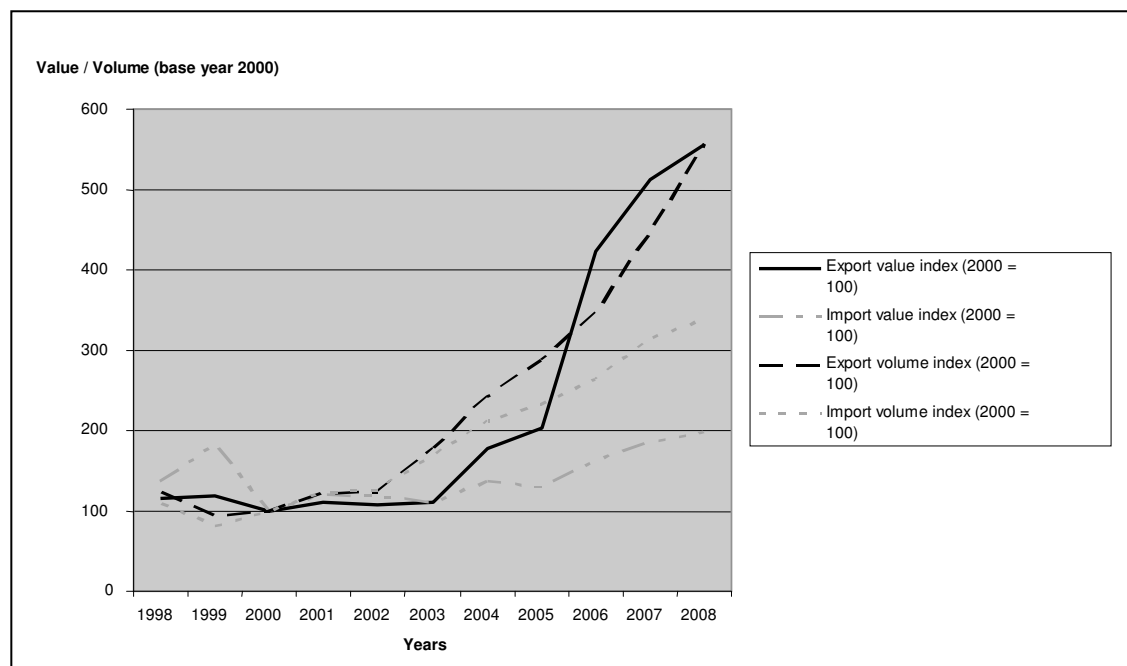
Source: World Bank data, own calculation.

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[38] AICD „Zambia Country Presentation", accessible at http://www.infrastructureafrica.org.
[39] See Africa Competitiveness Reports 2004, 2007, 2009.

A landlocked country like Zambia depends to a very large extent on roads for the export and import of goods. Therefore, it is fair to assume that better roads – including better trans-national corridors – contribute to trade, and thereby also to economic growth in Zambia. As was reported above, the Zambian government has invested a large share of the roads sector funds in the main trunk roads, which serve as trans-national corridors. Therefore, the development of the roads sector in recent years is certainly related to the trade developments. A further indicator that roads play a crucial role in trade is that the traffic figures developed positively in recent years on these corridors. A look at the trade development (Figure 4) shows that export and import volumes and values have been rising in recent years, particularly the export figures.[40] The rise in trade coincides with the period in which the roads sector received stronger funding. Better roads have probably contributed to this development, and most of the traded goods are transported on the road: 80% of the exports are transported on the road, the remainder on railways, only a tiny fraction by air transport.[41] Constraints for more efficient international road transport in Zambia have been the extensive border controls for a long time. Still in 2006, the controls increased travel times so much that the road traffic travels on average at little more than 10km/h.[42] The GRZ has since then taken some trade facilitation measures so that improvements can ensue.[43]

2.6.3 Impact on the agricultural sector

High potential for the economic development of Zambia is seen in agriculture due to the natural endowment of the country.[44] The AICD analysed to what extent the rural road network provides adequate access to high value agricultural land. 70% of Zambians depend on agriculture for their livelihood, but only 17% of these lived within 2 km of an all-season road in 2006. This share is only about half the African average. The ratio indicating the extent of realisation of agricultural potential was correlated with the degree of remoteness of these areas. For Zambia it turned out that by far the largest share of high value land (70-80%) is in remote areas. This shows the importance of a stronger investment by ROADSIP II in rural areas to create access to local markets and connectivity to the trunk roads.

The ZDA presented examples of changed production patterns due to road improvements in recent years. For instance, in the tobacco production in the greater Chipata area, previously, the agricultural produce was exported to Malawi for further value-adding activities. After road connections were improved, further processing of the tobacco harvest remained in Zambia. Thus, more added value and more economic growth could happen in Zambia.

2.6.4 Impact on the mining sector

The Zambian Copperbelt has some of the largest copper and cobalt deposits in the world. Mining is the country's biggest export earner and contributes, together with its related sectors, an important share to GDP growth.[45] Underinvestment, mismanagement, and poor infrastructure left much potential untapped. As a landlocked country, Zambia depends on good road connections to its neighbouring countries to access ports and export markets. A large share of the road network and of the traffic flows is concentrated in the Copperbelt region and its connection to the Lusaka area.[46] This illustrates the correlation between the roads sector and economic activity. The main trunk roads generally are in good condition (see section on "Attainment of the ROADSIP II indicators, assessment

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[40] Import / Export value indexes are the current value of imports (c.i.f.) converted to US dollars and expressed as a percentage of the average for the base period (2000). Import / Export volume indexes are derived from UNCTAD's volume index series and are the ratio of the import value indexes to the corresponding unit value indexes.

[41] CSO "The Monthly", Vol. 86, May 2010.

[42] AICD (2006): Zambia Country Report, p. 1.

[43] Ibid.

[44] Economic Intelligence Unit (2008) „Zambia Country Profile 2008", p. 20.

[45] Economic Intelligence Unit (2008) „Zambia Country Profile 2008", p. 15.

[46] See AICD interactive map on infrastructure in Zambia, accessible at http://www.infrastructureafrica.org.

of results"), so that ROADSIP II investments certainly contributed to mining and export activities. In the Copperbelt, also innovative arrangements like Public Private Partnerships (PPP) are starting in the roads sector, such as a 90 km road link between Chingala and Kitwe cutting through the Democratic Republic of Congo.

2.6.5   Impact on the tourism sector

The tourism sector is becoming an important foreign exchange earner and had double-digit growth rates in recent years.[47] It had been neglected for many years even though Zambia has the potential to catch-up with neighbouring countries in attracting tourists. To transfer tourists comfortably to the main attractions, which often are situated in remote areas (National Parks), a good road network is essential. It is reported that about three in four tourists travel by road in Zambia.[48]

A 2006 study by the MTENR[49] found that the poor condition of the road network is still a main constraint for further tourism development – 46% of Zambian businessmen in the hospitality sector stated roads quality as the main constraint. Also for tourism operators and handicraft traders, the poor transport infrastructure condition is a reason for the low tourist numbers. The study suggests that all-weather roads would be needed to and in the park, to allow tourist service to operate year round.

These findings are confirmed by a survey about the experience of tourists in Zambia in 2005.[50] About one in five tourists perceived the transport to and from national parks to be bad or even very bad and expressed accordingly the need for improved road conditions. In fact, among all suggested improvements, the road infrastructure ranked first.

A study by Mattoo and Payton (2007) concludes therefore that tourist flows would be 51% higher than existing levels if the roads infrastructure and the cost of doing business were at the level of South Africa.[51]

There is no evidence that the situation for tourist transport has much improved since these studies. However, the focus of ROADSIP II on investments in the trunk roads certainly has a positive impact on access to tourist sites, provided these are not too far away from trunk roads. If the sites are remote, the investment neglect of ROADSIP II in rural roads is detrimental to further tourism development.

2.7   Impact analysis based on LCMS 1998 and 2006 survey data

2.7.1   The transport situation in rural areas – descriptive statistics

The analysis of the LCMS data focuses on the rural areas in Zambia. The reason is that improvements on the micro-level in the access to economic and social facilities have much more potential in the rural areas compared to the situation for urban households (see Figure 5). In urban areas, on average more than 90% of the households in 2006 live within a less than 5 km range to facilities like schools, food markets, and health facilities, very similar to their situation in 1998. In rural areas, however, access to such services and facilities is much more varied. Here, the impact of new road projects would be more visible – assuming that these facilities would be provided in response to road projects. For example, only 51% of households live within the less than 5 km range to a food market which is a crucial access point for economic activity and thus has a poverty reduction potential.

[47] Mwape, F. (2008), p. 22 / Economic Intelligence Unit (2008) „Zambia Country Profile 2008", p. 22.

[48] Republic of Zambia (2006): „Livingstone Tourism Survey", Ministry of Tourism, Environment and Natural Resources.

[49] Ibid.

[50] Sinyenga, G. (2005): Nature-based tourism demand in Zambia, pp. 34.

[51] Mattoo and Payton (2007): „Service Trade and Development: The Experience of Zambia", Palgrave McMillan and The World Bank.

Within the rural areas, the proximity to services varies with the poverty of the households. On average, poor households are further away from the facilities than moderately poor and non-poor households. For example, only 46% of the extremely poor rural households live within 5 km to a food market, whereas 58% of the non-poor live in that range. For the other facilities, the picture is similar: among the extremely poor households, about 10% less than non-poor households live in proximity (<5km). Overall, the access situation in rural areas could be much more improved. For such improvement, roads and transport services would be a crucial factor.

Figure 5: Proximity to facilities in rural (left) and urban (right) areas
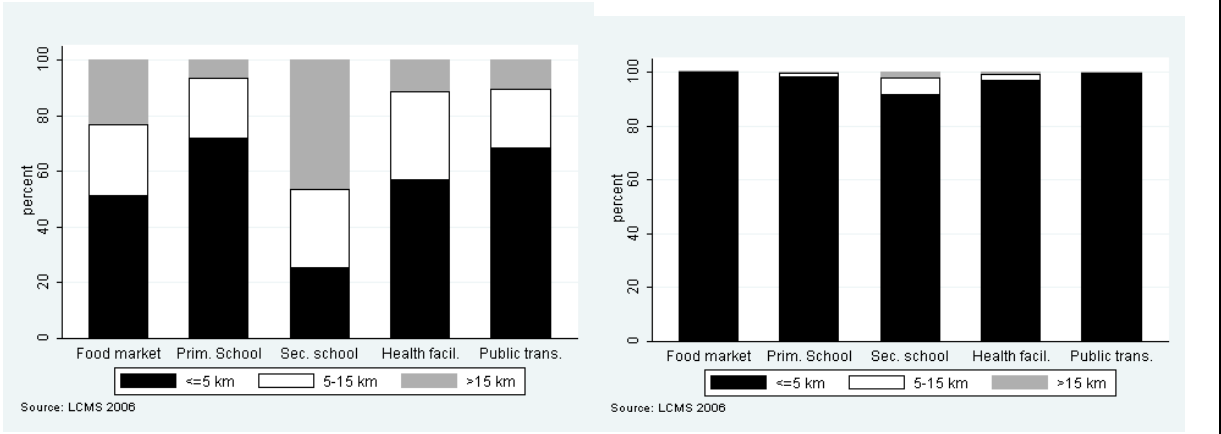
Compared to 1998, the situation in rural areas has slightly improved. Taking all rural households together, the percentage living within <5km to facilities has increased for almost each facility analysed. The most prominent change is regarding access to food markets where about 10% more live in the close range. However, a drastic improvement has not occurred.

Access to any facility in the rural areas is usually by foot. Walking is the predominant mode of travelling. This is evident from the LCMS data on households' ownership of transport assets and the mode of travel they choose to access a facility. Figure 6 shows that "foot" is the predominant mode of going to all facilities if the facilities are within a 5 km reach (left figure). In comparison, the share of public transport and bicycle increases when the facilities are far away (>15km, right figure). To some extent, therefore, public transport and bicycles are available in rural areas. But the relatively large share of walking – even for very large distances – means that a more comfortable way of travelling – which would only be possible on a passable road – is not very widespread.

Figure 6: Mode of travelling in rural areas at distance of <5km (left) and >15km (right)
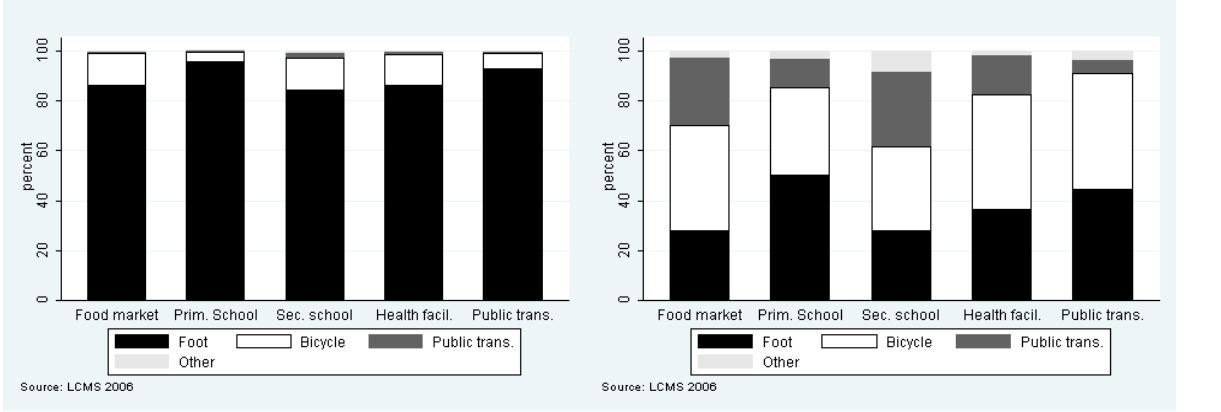
These findings are confirmed when looking at the ownership of transport assets in rural areas. About 45% of households owned a bicycle in 2006 (slightly less for the extremely poor), the ownership of

other transport assets is negligible. The share of households owning bicycles has increased by about 10% compared to 1998.[52]

The distance itself to the facilities is not the decisive issue – it could easily be travelled if the roads and the transport services were adequate and affordable. Therefore, the average speed of travelling in the rural areas is analysed by combining the findings on the distance in km with the time needed to reach facilities. Figure 7 presents the findings for distances below 5 km:

Figure 7: Travel speed in rural areas in min/km

Source: LCMS 2006
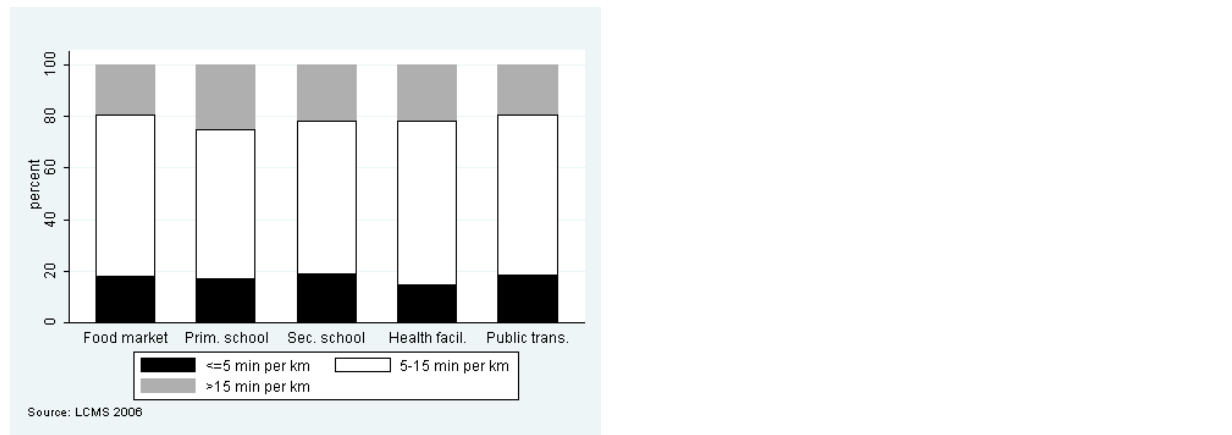
By far the largest share of rural households travels at a speed of 5-15 min/km to reach the different facilities like food markets, schools, health facilities, and public transport. These speeds translate into 4-12 km/h – the speed of pedestrians, bicycles, and possibly also slow motorised vehicles. Motorised vehicles would fall into this category only if the roads were in bad condition. Less than 20% are able to travel at less than 5 min/km, i.e. more than 12 km/h – which would mean smooth travel by means of a motorised vehicle. This analysis is restricted to facilities that are within <5km reach due to limitations of the LCMS data. The average travel speed in rural areas is about 13-14 min/km (i.e. 4-5 km/h) – the speed of walking.

Households were asked whether they needed a certain facility or not. Households that stated that they needed a facility but did not use it were asked why they did not go to the facilities. The reasons mostly mentioned were that it was too expensive to go or that the facilities were too far away. This is a clear indication of the weak transport infrastructure in rural areas. Figure 8 depicts these findings, by looking at the reasons for not using facilities for households in the distance of <5km (left figure) and >15km (right figure).

Figure 8: Reasons for not using facilities for households at <5km distance (left) and at >15km (right) distance

Source: LCMS 2006

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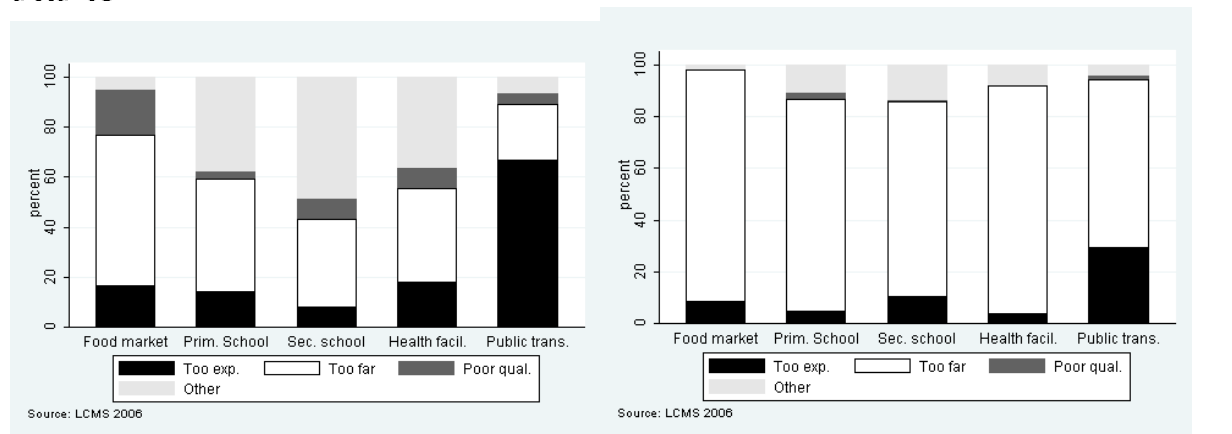
[52] The evaluators however doubt whether so many bicycles are in a usable state – during the field visits, not many bicycles were observed.

The above findings already suggest that the road and transport situation in the rural areas is not adequate to the needs of the households.

This is further confirmed by the households' priorities for facilities to be further improved or provided. In 2006, households were asked to rank different facilities which they would like to see improved or, separately, to be provided. Among the services that households would like to be provided, roads do not rank high. This indicates that some basic access is often available (although maybe not all year round or passable with a vehicle). On the contrary, roads are ranked as first priority among all facilities which rural households would like to see improved: about one in four households ranked roads as first priority, followed by education and health facilities. The comparison with 1998 is difficult because the questions were asked differently. It seems fair to assume, however, that the importance of roads for rural households has not decreased.

Of course, some road projects have taken place and improved the situation for the households living along the roads. In 2006, looking back at the year before the survey was carried out, 22% of the rural households reported that a road project in their area was done and – according to their subjective impression – improved their way of living. Again about 20% reported that transport services were improved and having a positive effect on their living conditions. It is interesting that the extremely poor rural households reported less road projects and transport services compared to the non-poor households. This shows that roads do not improve the living conditions of the very poor to the same extent as those of the less and the non-poor in rural areas. A comparison with 1998 is again difficult to make due to changes in the survey structure.

Concluding the descriptive analysis of the 1998 and 2006 LCMS data, the burden of reaching crucial facilities and services for rural households is obvious. No drastic improvements could be proven for the recent years; only a slight improvement has been realised between 1998 and 2006. There is thus high demand for further road projects in these areas. The high priority of the households for further road projects underlines this. The analysis also shows that poverty is associated with the transport and road situation, particularly in terms of proximity to facilities and public transport.

2.7.2 Estimating the effect of roads on living conditions – panel regressions

To go beyond the mere descriptive methods described above and as laid out in the methodology chapter above, the evaluators applied also analytical methods to the LCMS 1998 and 2006 datasets in order to draw conclusions about the effect of roads on the living conditions in rural areas. The goal was to analyse the effect of different types of road projects in rural areas. The LCMS survey distinguishes between the following types of projects, all of which were used as treatment variables in the analysis: Building of a new road (tarred or gravel); grading of a gravel road; tarring of a gravel road; the general category of any road project; and improvement or provision of transport service.

To test the independent effect of the main variables – the different types of road projects – other influencing variables have to be accounted for. For this purpose, the following important groups of characteristics of the households have been used as control variables (see Annex 4 for the regression results including all control variables): cooking mode (proxy for wealth); level of education of the head of the household; age, sex, marital status of the household head, and number of children.

The LCMS data[53] allow for analysing the effect of the treatment variables of different road projects on various outcome variables; these outcome variables represent the usually assumed impacts that road projects can have: share of households in poverty; school attendance rates; distance to public transport; expenditure patterns; and consultation of modern health facilities. Concerning the consultation of modern health facilities, it was analysed to what extent the visits to healers (traditional healers, spiritual healers, church healers) are substituted by visits to "non-healers", i.e. medical doctors, clinical officers, nurse/midwife, or community health workers.

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[53] Note that for the LCMS-panel-regression-analysis household data in one chief area were aggregated to form a panel although the households interviewed in each chief area were not identical in both LCMS years. See 1.3.2.3 for a description of the methodology.

The following Table 7 is a summary of the effects found through panel regressions. Statistically significant coefficients are marked in the table with *(p<0.05), **(p<0.01), and ***(p<0.001), and are highlighted in bold.

Table 7 shows several statistically significant effects, however not for all types of road projects, and not for all outcome variables. In detail, the following effects can be demonstrated, focusing on the strongest effects (** and ***).

A strong relation can be seen between building a new road and attendance rates in secondary schools. The coefficient of the treatment variable "building a new road" indicates that secondary school participation increases by 0.53 percentage points if the share of households in a chief area which indicated that a new road had been built increases by 1 percentage point. This effect is statistically significant both for the male and the female attendance rates. There are several other effects, significant at the 5 percent level, on primary school attendance, expenditure, and consultation of modern health facilities.

The picture looks different for households where a gravel road was graded. Here, a strong effect on reducing the share of households living in extreme poverty is found. If the share of households where a gravel road was graded increases by 1 percentage point, the share of households living in extreme poverty decreases by 0.18 percentage points. A corresponding rise in the share of moderately poor and non-poor could also be observed, but at a lower confidence level. The expenditure for public transport decreases along with grading gravel roads. Per capita and per adult equivalent expenditures very slightly increased. There are further effects, significant at the 5 percent level, on consultation of modern health facilities. The tarring of a gravel road had only statistically significant effects on distance to public transport and secondary school attendance rates.

In the general category of "any road project", significant effects were found on expenditures and on consultation of health services. In this category of road projects, if the share of households where any road project occurred increases by 1 percentage point, per capita and per adult equivalent expenditures increase by a very moderate 0.01 percentage points. The effects on visits to modern health facilities were stronger. Here, if the share of households with any road project increases by 1 percentage point, more sick people (0.22 percentage points) consult any health services (traditional or not), and the share of those that visited a modern health facility (medical doctors, clinical officers, nurse/midwife or community health workers) increases by 0.23 percentage points. Less significant effects could be demonstrated on secondary school attendance and the share of the extremely poor.

Finally, the provision of transport services was analysed. Here, a number of effects could be observed if the percentage of households where transport services improved increases by 1 percentage point: Secondary school attendance increases by 0.16 percentage points, the share of extremely poor households decreased by 0.16 percentage points, the expenditures for transport to school (+0.05 percentage points), per capita and per adult equivalent (each +0.01 percentage points), the share of sick people who consulted any type of health services (+0.28 percentage points) and the share of sick people that consulted a modern health facility (+0.28 percentage points) all increased.

The data underlying the education variables are considered to be more reliable than the data underlying the expenditure variables. Therefore, the effects that were found on expenditure are to be taken with care. Only two significant effects could be found concerning transport-related expenditure (work and school). On the one hand, gravel roads tend to reduce work-related transport expenditure, possibly due to shorter travel times. On the other hand, better transport services tend to increase expenditure for transport to school. This increase is probably related to the increase in attendance rates (particularly in secondary schools) and therefore more pupils using public transport.

The results on secondary school attendance are not surprising. This type of school is usually not available in villages, so that the rural population depends on transport and a good road network. For services which are more widely spread (e.g. primary schools), the dependence on transport is not so high.

Table 7: Summary of panel regressions for roads

	Primary school attendance rate	Primary School attendance rate - male	Primary school attendance rate - female	Secondary school attendance rate	Secondary school attendance rate - male	Secondary school attendance rate - female	Share of extremely poor households	Share of moderately poor households	Share of non-poor households	Distance to public transport	Expenditure for transport to school	Expenditure for transport to work	Expenditure per capita	Expenditure per adult equivalent	Share of sick who consulted	Share of sick who consulted non-healer	Share of sick who consulted healer	Market share of healers
Building of a new road (tarred or gravel)	**0.29*** **[2.05]**	0.26 [1.61]	0.23 [1.34]	**0.53*** ** **[4.57]**	**0.47** ** **[3.07]**	**0.46** ** **[2.82]**	-0.15 [-0.91]	0.12 [1.11]	0.03 [0.25]	-0.08 [-0.65]	0.32 [2.04]	-0.04 [-0.85]	**0.01*** **[2.35]**	**0.01*** **[2.25]**	**0.46*** **[2.13]**	**0.52*** **[2.36]**	-0.02 [-0.59]	-0.02 [-0.28]
Grading of gravel road	0.07 [1.22]	0.06 [0.95]	0.03 [0.49]	0.09 [1.73]	0.12 [1.96]	0.09 [1.53]	**-0.18** ** **[-2.86]**	**0.08*** **[2.02]**	**0.10*** **[2.02]**	-0.01 [-0.13]	0.01 [0.43]	**-0.14** ** **[-13.91]**	**0.01** ** **[3.16]**	**0.01** ** **[3.14]**	**0.21*** **[2.43]**	**0.22*** **[2.50]**	-0.00 [-0.35]	-0.01 [-0.27]
Tarring of gravel road	0.05 [0.50]	0.01 [0.05]	0.01 [0.06]	**0.20*** **[2.11]**	0.20 [1.69]	-0.10 [-0.77]	0.07 [0.55]	0.09 [1.11]	-0.16 [-1.69]	**-0.18*** **[-2.03]**	0.01 [0.21]	-0.09 [-0.93]	-0.00 [-1.01]	-0.00 [-0.98]	0.32 [1.90]	0.31 [1.82]	0.01 [0.51]	0.08 [1.41]
Any road project	0.08 [1.58]	0.06 [1.06]	0.04 [0.68]	**0.11*** **[2.59]**	**0.14*** **[2.59]**	0.06 [1.13]	**-0.14*** **[-2.48]**	**0.09*** **[2.38]**	0.05 [1.23]	-0.04 [-0.98]	0.01 [0.33]	-0.05 [-3.51]	**0.01** ** **[2.68]**	**0.01** ** **[2.68]**	**0.22** ** **[3.00]**	**0.23** ** **[3.06]**	-0.00 [-0.12]	0.01 [0.46]
Transport service provided/improved	0.06 [1.03]	-0.01 [-0.18]	0.10 [1.32]	**0.16** ** **[3.00]**	0.10 [1.50]	0.11 [1.73]	**-0.16*** **[-2.30]**	**0.15*** ** **[3.39]**	0.01 [0.18]	-0.05 [-1.00]	**0.05** ** **[3.00]**	-0.04 [-2.43]	**0.01** ** **[3.15]**	**0.01** ** **[3.29]**	**0.28** ** **[2.97]**	**0.28** ** **[2.96]**	0.00 [0.01]	-0.01 [-0.28]
Observations	478	476	478	478	478	477	478	478	478	468	190	142	478	478	468	468	468	443

t statistics in brackets
* p<0.05, ** p<0.01, *** p<0.001

To better relate the estimated effects of roads sector projects in rural areas with the overall improvements in the outcome variables, the following Table 8 gives an overview of these changes from 1998 to 2006:

Table 8: Development of outcome and treatment variables for roads in rural areas over time

Outcome variables		
	1998 mean value in %	2006 mean value in %
Primary school attendance rate	59.1	71.2
Primary school – male	60.2	71.6
Primary school – female	58.8	70.6
Secondary school attendance rate	13.8	23.6
Secondary school – male	15.1	26.3
Secondary school – female	12.6	21.4
Share of extremely poor households	66.0	47.6
Share of moderately poor households	12.3	25.7
Share of non-poor households	21.7	26.8
Distance to public transport	10.8	9.5
Share of sick who consulted any health service	35.3	68.8
Share of sick who consulted a professional health service	32.6	60.8
Treatment variables		
	1998 mean value in %	2006 mean value in %
Building of new road	1.0	3.7
Grading of gravel road	8.6	18.2
Tarring of gravel road	2.5	2.4
Any road project	11.8	21.2
Transport service provided/improved	5.5	19.1

Based on this table, the following analysis can be made, e.g. for the significant effect of building a new road on secondary school attendance rates (0.53%): The share of households in whose area a new road was built increased from about 1% in 1998 to about 3.7% in 2006. Since each percentage point increase in the share of households in whose area a road was built is related to a 0.53 percentage point increase of secondary school attendance rates, the overall contribution of new roads is an increase of about 1.4 percentage points for the time period 1998 to 2006. In total, the secondary school attendance rates increased in this time period by about 10 percentage points, so that the contribution of new roads is quite strong.

Another significant effect is the contribution of grading a gravel road on the share of households in extreme poverty (-0.18): The share of households in whose area a gravel road was graded increased from about 8.6% in 1998 to about 18.2% in 2006. Since each percentage point increase in the share of households in whose area a gravel road was graded is related to a 0.18 percentage point decrease of households in extreme poverty, the overall contribution of grading gravel roads is a decrease of about 1.7 percentage points for the time period 1998 to 2006. In total, the share of households in extreme poverty decreased in this time period by 18.4 percentage points. Here, the contribution of grading gravel roads is less strong, but still remarkable.

The same calculation for the significant effects of transport services provided/improved on consultation of modern health facilities shows that in the time period 1998-2006 the better transport services increased the consultation by 3.8% percentage points, which is relatively strong compared to the overall increase of 28.2 percentage points.

Concluding the findings of the panel regressions, it can be stated that for almost every type of road projects, some effects can be demonstrated. It is rather unlikely that reverse causality is actually responsible for a major part of the effects we found because roads are well known for their sparking-off-effects on development. Especially for the effects on school attendance and the visits to modern health facilities, it is hard to think of any alternative explanation that was not covered by the control variables. Therefore we are quite confident in our conclusion: In general, road projects are found to have some effects on secondary school attendance, poverty reduction, expenditures, and on consultation of modern health facilities.

2.7.3 Estimating the effect of roads on living conditions – propensity score matching

To check the results of the panel regressions for robustness, a second method was applied to the same datasets – propensity score matching. This method was applied separately to the 1998 and 2006 datasets, separately to each type of road project (treatment variable), and separately according to the level of poverty of the households in order to be able to say something about potential distributional effects. In every such analysis, the changes in the outcome variables (e.g. school attendance rates, poverty, etc.) are compared between households where a particular type of project occurred (treatment group) and households that are similar but where no such road project occurred. The similarity of the households which are compared is reached by matching the two groups on the same list of control variables as for the panel regressions. In contrast to the panel regressions, the results refer to the individual household level, and not to aggregates of households in a chief area. A summary of the statistically significant effects is shown in Table 9; all results are presented in Annex 5.

Looking at all rural households together in the 2006 dataset, for all types of road projects a statistically significant reduction in the share of the extremely poor households along these roads can be observed together with an increase in the share of non-poor households. To illustrate: The share of extremely poor households in the treated group (where a road project occurred) decreases by 4-12 percentage points, whereas the share of non-poor households increases by 4-9 percentage points. Also for all types of road projects, the distance to public transport decreases. Depending on the type of project, the reduction is by 2-4 km. Also health effects can be demonstrated, although not in relation to all types of road projects. For grading and tarring of gravel roads, as well as for "any road project" and improvement/provision of transport services, the share of sick people who consults a modern health facility increases, whereas the "market share" of traditional healers decreases.

The results for the 1998 dataset are similar but less strong. It is, however, difficult to compare the 1998 results to the 2006 results because the time period observed for whether road projects occurred or not differs (one year in the 2006 case, five years in the 1998 case). For most types of road projects, the share of extremely poor households decreases also in 1998 – by 4-7 percentage points, and the share of non-poor households increases by 4-9 percentage points. The overall share of extremely poor households in 1998 was still significantly higher by about 20 percentage points compared to 2006 (by comparing and averaging the poverty rates of the different groups in the analysis for 1998 and 2006). The distance to public transport decreases by 5-8 km, depending on the type of road project.

Sub-sample analyses for extremely poor households, moderately poor households, and non-poor households were conducted separately. These analyses show similar effects compared to the above described effects on all rural households. Here, expenditure is used as a proxy for poverty reduction. The effects in this detailed analysis are stronger for the extremely poor than for the non-poor – expenditures are found to increase in some cases. Yet, since the results are relatively similar, the road projects seem to benefit all groups and strong distributional effects between groups are not found.

Table 9: Summary of statistically significant effects for all rural households – propensity score matching roads

Grading of gravel road

Share extremely poor	0.39	0.43	-0.04	-2.63	Share extremely poor	0.58	0.63	-0.06	-3.32
Share non-poor	0.36	0.30	0.06	4.30	Share non-poor	0.29	0.25	0.04	2.58
Distance to public transport	4.80	7.33	-2.53	-7.22	Distance to public transport	3.48	8.66	-5.17	-14.42
Share cons and visited nonhealer	0.63	0.58	0.05	2.19					
Share cons and visited healer	0.00	0.02	-0.01	-3.33					
Share healer	0.01	0.03	-0.03	-3.99					

Tarring of gravel road

Share extremely poor	0.33	0.44	-0.12	-3.46	Distance to public transport	0.99	9.07	-8.08	-23.19
Share non-poor	0.39	0.29	0.09	2.69	Expenditures transport work	1512.99	352.93	1160.06	2.02
Distance to public transport	3.13	7.17	-4.03	-8.38					
Share cons and visited healer	0.00	0.01	-0.01	-6.15					
Share healer	0.00	0.02	-0.02	-6.24					

Any road project

Share extremely poor	0.39	0.43	-0.04	-3.30	Share extremely poor	0.58	0.64	-0.07	-4.03
Share non-poor	0.36	0.30	0.06	4.85	Share non-poor	0.29	0.24	0.04	3.06
Distance to public transport	4.70	7.53	-2.83	-8.26	Distance to public transport	3.14	8.79	-5.66	-16.62
Share cons and visited nonhealer	0.62	0.58	0.05	2.42					
Share cons and visited healer	0.01	0.02	-0.01	-3.30					
Share healer	0.01	0.04	-0.03	-4.04					

Transport service provided/improved

Share extremely poor	0.38	0.42	-0.04	-2.66	Prim school attend rate female	0.73	0.64	0.08	2.93
Share non-poor	0.36	0.32	0.04	3.01	Share extremely poor	0.57	0.62	-0.04	-2.03
Distance to public transport	3.10	7.15	-4.05	-13.72	Distance to public transport	1.43	7.61	-6.18	-18.10
Expenditures per adult equiv	149468.90	112304.92	37163.99	2.01	Expenditures transport work	820.48	396.33	424.15	1.98
Share consulted	0.64	0.59	0.05	2.60	Share consulted	0.50	0.36	0.14	4.28
Share cons and visited nonhealer	0.63	0.57	0.06	2.86	Share cons and visited nonhealer	0.48	0.33	0.15	4.58
Share healer	0.02	0.03	-0.02	-2.13					

In comparison to the panel regressions, the effect on poverty is stronger when using propensity score matching. The effect on secondary school attendance is, however, less strong. Generally, the results of the panel regressions are considered to be more reliable. It needs to be taken into account, however, that our panel regressions are based on averages of households in each chief area. Therefore, when weighing the results of applying one method against the results of the other, this evaluation does not want to attach too much value to the exact size of the effects, e.g. on poverty reduction. It rather seems important that the results of both econometric methods point into the same direction. Accordingly, as an overall conclusion, the analytical analysis of the LCMS datasets shows that indeed effects of road projects on improving the living conditions in the rural areas of Zambia can be demonstrated, particularly on poverty, secondary school attendance, and visits to modern health facilities.

2.8 Micro-level impact study in the Southern Province

2.8.1 Introduction and methodology

The LCMS data analysis showed that roads have an impact on the living conditions of the poor. The LCMS analyses are extremely valuable since they are based on countrywide datasets and are therefore representative for Zambia as a whole. It depends, however, on the analytical method chosen, how clearly these effects can be demonstrated. To illustrate on a micro-level what the impact of a road project in Zambia can be, a comparative outcome/impact study was carried out by the Zambian Statistical Office (CSO) for this evaluation in the Southern Province.

The point here is to depict the potential that road projects have for rural areas. Field visits to rural areas in the Southern Province showed great differences in the quality of rural roads, depending on whether routine and periodic maintenance had been done in recent years. Due to the budget constraints of RDA and the priority in the implementation of ROADSIP II, only a part of the rural road network is well maintained. Consequently, two comparable regions were selected, one in which a link-road to a tarred road has been rehabilitated and well maintained, and one in which the link-road was not rehabilitated and not well maintained.

The two roads are situated in the Siavonga and Choma Districts (see Figure 9 below and Photo Documentation in Annex 1). Both districts are rural districts. The roads and the adjacent areas are comparable and suitable for the purpose of this study. Both are important rural roads for their areas. Agriculture, subsistence or small-scale crop production is the main economic activity. In terms of distance to major towns and trunk roads, both areas are comparable. Their geographic proximity means that agricultural produce and agricultural potential are comparable. Both areas are not connected to the national electrical power net.

In the Siavonga District, the road chosen for this analysis is a part of the so-called "bottom road" (District Road D501). It leaves the main road going from Kafue to Siavonga (M 15) at the village of Sikoongo. From here, it goes towards the south-west, passing along the villages of Lusitu, Jambo and reaching the area around Changa in a distance of about 43 km from Sikoongo. From Changa, road conditions permitting, there are connections possible to Siavonga in the south, Mazabuka in the north-west and Gwembe in the south-west. In the following, we will call this road Siavonga road and the surrounding area Siavonga area.

In the Choma District, the road is a half-loop departing from and returning back to the trunk road T1 from Lusaka to Livingston. It leaves T1 at Chisekesi and returns at Muzoka after about 52 km. At about the middle of the road, near the hospital and the school of Kanchomba, a direct connection to the trunk road is available, but its condition is very bad. In the following, we will call this road Choma road and the surrounding area Choma area.

The crucial difference between the two areas (defined as the strip of 5 km on both sides of the roads at a distance of 5 km off the main road) is that the Siavonga road is in very bad condition. No

rehabilitation has been done in recent years and maintenance has been confined to spot-wise improvement, due to a lack of budget. The result is a poor earth road which is usually not completely passable during and for a certain time after the rainy season (on average 4 months per year according to the Director of Works in Siavonga) mainly because the shoulders of the Siamwinga bridge across the Lusitu river have been washed away during the rainy season in 2008 (see picture in Annex 1) as well as several smaller river crossings. In March 2010, the evaluators could visit only the first few kilometres of the road starting from Sikoongo. At the end of April 2010, the road was passable only up to the Siamwinga bridge (crossing the Lusitu river at km 27 from Sikoongo). The bridge was impassable and the river bank was not yet passable. At that time, the road was passable again south-west of the Siamwinga bridge to Changa (16 km). The western part of the area around Changa could, however, be reached on different road links. Average travel speed at the end of April was low on the first 27 km due to the bad road condition (approx. 25 km per hour).

On the Chisekesi-Muzoka road, in comparison, smooth travelling was possible along the entire road, also crossing several small rivers. Here, the road has been rehabilitated in 2008 and continuously maintained thereafter. In the Choma area, 28% of the households stated that road improvements (gravelling) took place within the last 5 years and 98% stated that the road is useable all year round. In contrast, in the Siavonga area, only 3% observed road improvements (clearing of the path) in the last years, and only 44% stated that the road is useable all year round. The 33 households that stated that the road would not be passable all year stated on average that they cannot use the road on 118 days a year.

Figure 9: Roadmap of the Southern Province with project roads
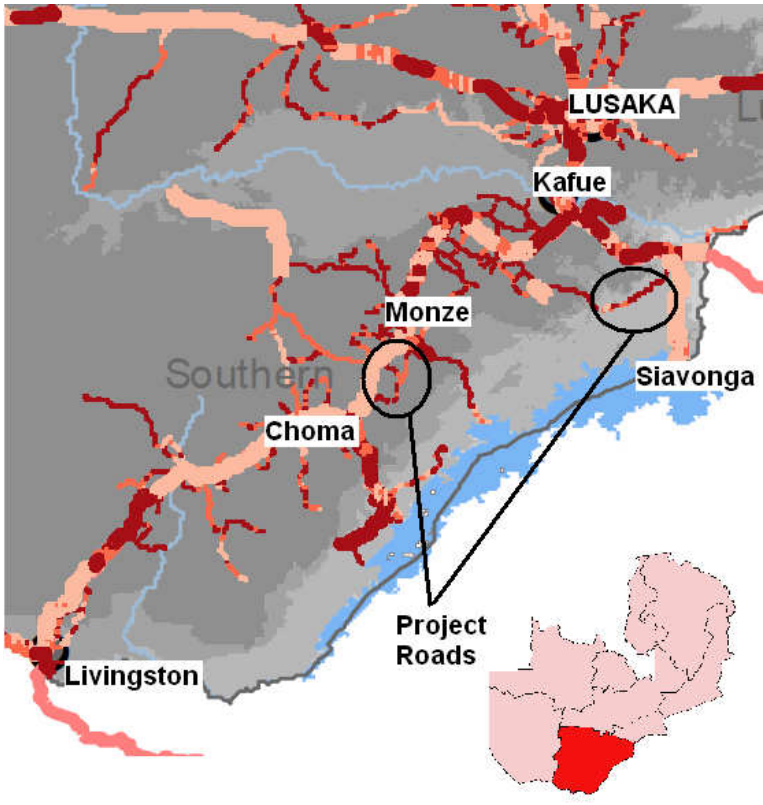
The study included household interviews along the two roads, selecting a representative sample of households in a corridor of 5 km along both sides of the roads. In the Choma area, 275 households were interviewed, in the Siavonga area 148. The interview questions included the general living conditions as well as transport-specific questions and were in line with the LCMS survey as much as possible. In addition to household interviews, the public passenger operators and goods operators

were interviewed about their businesses. The traffic was analysed by means of traffic counts and origin-destination questionnaires.

2.8.2   Access to facilities in the Choma and Siavonga areas

The LCMS analysis showed that a crucial characteristic of rural Zambia are the long distances to facilities (see Figure 5). This is also the case in the two chosen areas in Choma and Siavonga, as can be seen in Figure 10. Of course, the specific local conditions imply that the proximity is different to the national averages. As a general tendency, the situation in the Choma area is roughly the same as the national average, the conditions in Siavonga area are worse. This is particularly the case for the average distance of all surveyed households to secondary schools (Choma area: 10 km, Siavonga area: 36 km), to public transport (2 km, 19 km). In addition to the LCMS analysis, also the distance to input markets was surveyed. Here, the situation is better in the Siavonga area (17 km) than in the Choma area (31 km).

Figure 10: Proximity to facilities along Choma (left) and Siavonga (right) project roads
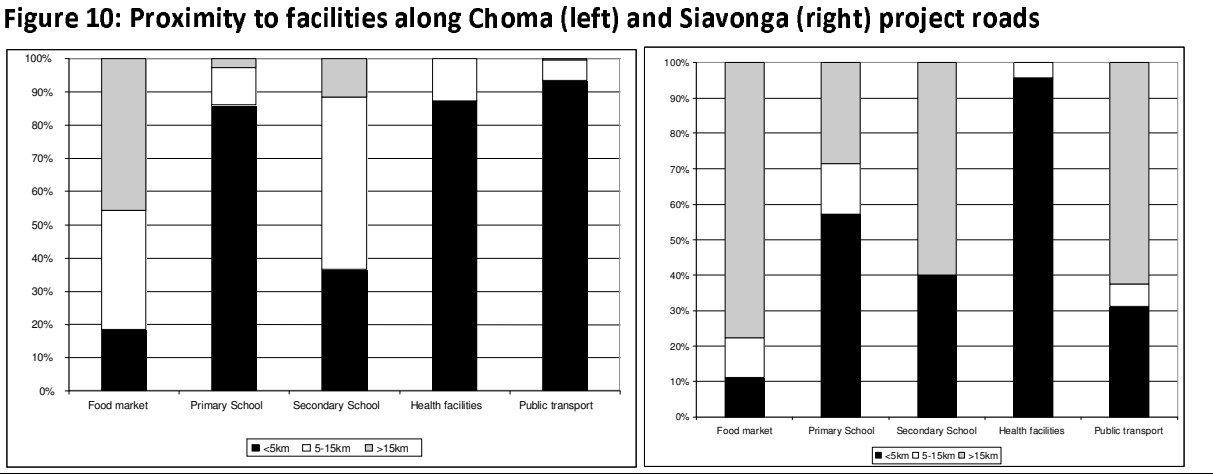
As is the case for rural areas in all of Zambia, also in the two project areas, the predominant mode of travel is walking (see Figure 11 and Figure 12, and compare Figure 6). Only at the longer distances of more than 15 km distance to the facilities, the importance of public transport and also bicycles increases.[54]

Figure 11: Mode of travelling in Choma at <5km (left) and >15km (right)

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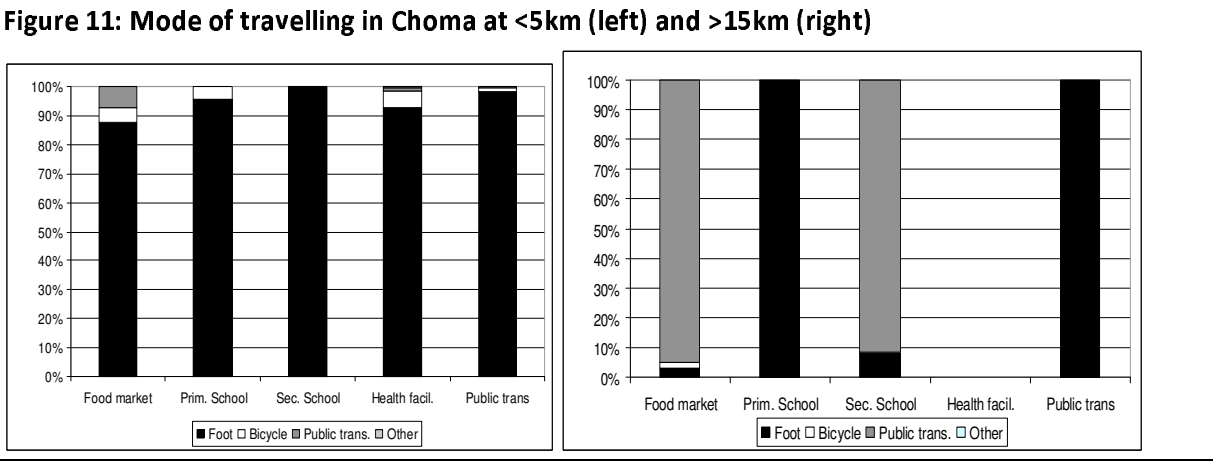
[54] The number of observations for some of the analyses was very low, so that the averages presented are not as reliable as national averages.

Figure 12: Mode of travelling in Siavonga at <5km (left) and >15km (right)
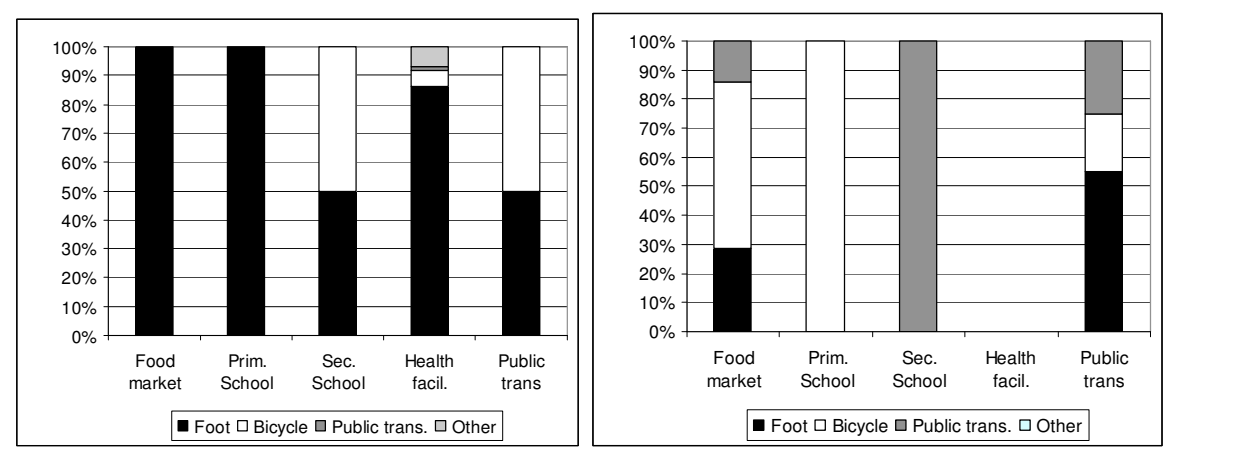
At each road, the traffic has been counted at two different points each for a period of 3 days (Table 10). It is striking that the non-motorised traffic is much higher than the motorised traffic. This is due to the poverty of the rural population that very often is not able to afford the fares of public motorised transport. There exists, however, quite some motorised traffic on the Choma road, especially motor bikes and pick-ups and small trucks. This is a clear indication of more activity on the maintained and all year round useable road in this area. On the other hand, you see hardly any motorised vehicle on the Siavonga road (only 1 four wheeled vehicle per day at Lusitu and 4 per day at Changa West).

Table 10: Average daily traffic on Choma and Siavonga roads

Type of traffic	Choma road Kanchomba	Choma road Ndondi section	Siavonga road Lusitu	Siavonga road Changa West
Pedestrians without load	44	90	69	50
Pedestrians with load	22	1	43	39
Bicycles	14	30	66	10
Animal/human carts	14	3	7	3
Motor bikes	8	6	3	1
Pickups/minibuses 4wd cars	7	0	0	2
Small trucks (canter)	6	11	1	1
Tractors	2	0	0	1
Buses (2-axle trucks- 7 ton)	4	0	0	0
Trucks more than 10 ton	1	0	0	0

The road users were asked about their purpose of travelling. Very similar patterns emerged for both roads (see Figure 13). The most important reasons to travel are to visit relatives (22% in Choma and 32% in Siavonga) and to go to the market (24% in Choma, 23% in Siavonga). These reasons are followed by family events (15%/10%), hospital (10%/12%) and work (12%/12%). Less important are the reasons of going to school, public events, and going to church.

Figure 13: Purpose of travel on the Choma (left) and Siavonga (right) road

Legend:
- ■ WORK
- □ MARKET
- ▨ SCHOOL
- ▣ HOSPITAL
- ⊠ VISIT RELATIVES
- ⊠ PUBLIC
- ◩ FAMILY EVENT
- ☑ CHURCH
- ◩ OTHER
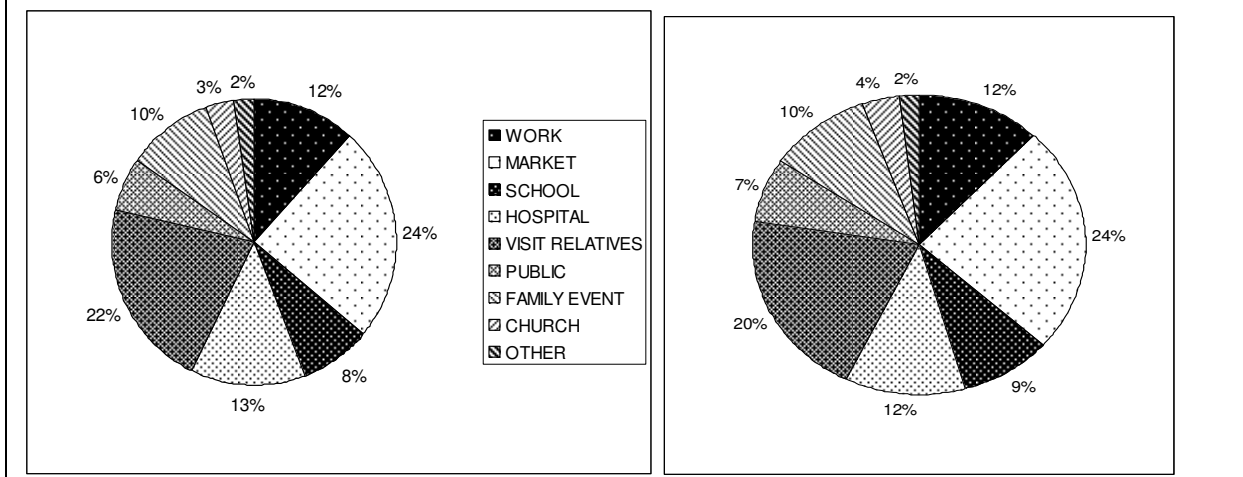
Similar to the LCMS analyses, households were asked for what reasons they would not go to a facility they need. Here, a clear difference emerges between the two areas (see Figure 14). While in the Choma area, a variety of reasons emerges for not using facilities, in Siavonga, where the road conditions are worse, the most important reason is that facilities are too far away.

Figure 14: Reasons for not using facilities in Choma (left) and Siavonga (right)
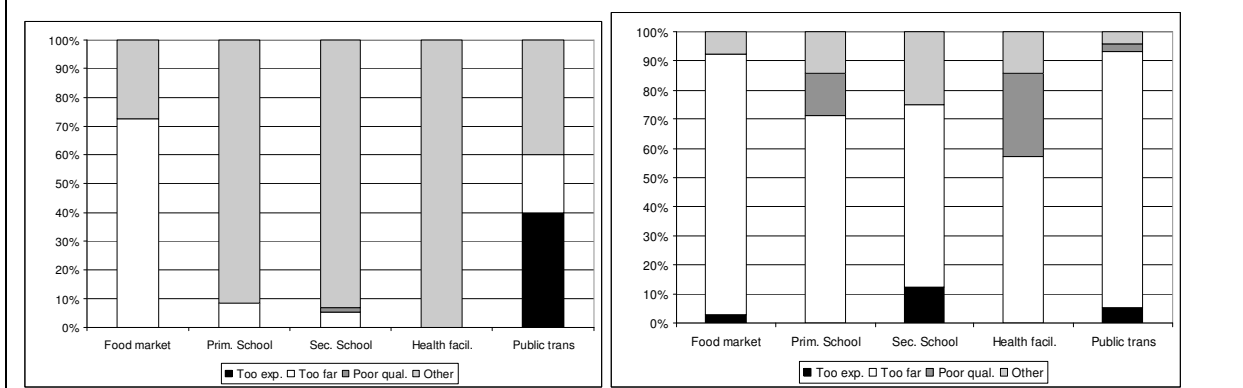
The long distances to facilities, the predominance of walking, and the distance as reason for not using facilities are all indications that the road condition – particularly in the Siavonga area – is not adequate to the needs of the households. This is further confirmed by the households' statements about the main problem for their villages. Bad roads were the problem which was stated most often in both areas, by 87% in Choma and by 96% in Siavonga. Lack of water, electricity, and sanitation were also frequently mentioned, but by far not as often as bad roads. Basically every household (99%) in both areas stated that they would like to have their roads further improved. The positive impacts anticipated along with further improvements of roads are to save time (49% of households in Choma, 20% in Siavonga) and to improve their business environment (27% in Choma and 70% in Siavonga).

The specific impact of the road conditions on business are analysed in more detail by looking at public transport operators, goods transport operators, agricultural businesses and non-agricultural businesses. Here, the differences between the two areas – related to the road condition – emerge more clearly.

2.8.3 Passenger transport operators

Since rural households usually do not own a motorised vehicle, the availability of public transport is very important to provide connectivity for households. Public passenger transport is usually by open van or by small truck. The public transport situation in the Choma area is significantly better than in the Siavonga area. While in the Choma area, on the better road, a dozen operators could be identified, only two were operating on the Siavonga road. The availability of public transport in Siavonga is furthermore reduced by the number of weeks during which no transport is possible. Such disruptions are usually because of the bad road conditions during the rainy season. The households state that the average length of disruption of the Siavonga road is about three months. In Choma, the operation is usually possible for the whole year. The households along the roads were asked about the availability of public transport. Whereas in Choma, some kind of public transport is available each day for almost every household, this is the case for only 7% in Siavonga. This big difference is again obvious by looking at the average distance to the next public transportation point which is only 2 km in Choma but 12 km in Siavonga. These differences come along with the differences in the road condition. The availability of transport, particularly in Siavonga, is not adequate to the needs of the households.

Despite these differences between the two regions, the expected impacts of improved roads and the current challenges the operators face remain similar. Almost all operators stated that improved roads would reduce the maintenance costs and would lead to reduced fares (better roads lead to faster transport and more possible routes per day, so that sometimes operators reduce their prices). About half of all operators would increase the number of services on their routes. The majority of operators stated that accidents are a major challenge. Since heavy traffic cannot be the reason for accidents on these roads, it must be the general road condition. Bad roads and bad condition of bridges were named as other major challenges.

2.8.4 Goods transport operators

The situation of goods transporters, crucial for the marketing of agricultural produce is very similar to that of passengers transport. On the Siavonga road, however, no goods transport operators are active. Goods transporters use vans or small trucks. The capacity of the average transport on the Choma road is 2 tons – the relatively good road condition permits to transport such a weight of goods. The types of goods transported are mostly agricultural output, groceries, and fruits. The annual disruptions are at about the same length as for the passenger transporters. Also the number of operators is very similar.

Main challenges for goods transports are again bad roads, bad condition of bridges, and the risk of accidents. If roads were improved, so the operators stated, their maintenance expenses would go down, also the fares would be reduced, whereas most of them would increase the number of services on their routes.

2.8.5 Agricultural businesses

To assess the impact of the road condition on the economic development of the regions, the households were asked transport-related questions about their agricultural businesses. In the Choma area, 80 households reported to have at least one agricultural business, some of these 80 households indicated that they have more than one such business, so that a total of 153 agricultural businesses was counted among the 275 households that were interviewed. In the Siavonga area, 69 households reported at least one agricultural business, 89 such businesses were counted in total among the 148 households that were interviewed. Since the two areas are rural, more households might be involved in some kind of agricultural activity, even if they did not answer this question accordingly. The businesses are usually small-scale farming – mostly growing of vegetables, staple crops, and cash crops. Most businesses employ less than 3 people and are regionally oriented. The village or the

district centre is the source for the supplies. Customers are often also in the villages, in the surrounding areas, but also large companies, state-owned companies, and traders are among the customers.

The difference between the two areas becomes again apparent when looking at the time needed for supplies to reach the business. In Choma, more than 70% of supplies can reach the business within less than half a day. This is only the case for 23% in Siavonga. 37% of the supplies to businesses in Siavonga need more than one week, whereas it takes as long only for 3% in Choma.

Households were asked about the reasons why their business volume increased or decreased in recent time. Here, the answers are similar for both regions. Almost no household stated that new roads were the reason why the business improved – most likely because no new roads have been constructed. However, 44% in Choma and 69% in Siavonga stated that the deterioration of roads was the reason why their business volume decreased. The main limiting factor to business is the lack of good transport, followed by limited access to loans.

Concerning the way in which the road condition affects businesses, about 70-80% stated that better roads would make it easier for customers to reach the businesses and that bad roads made it difficult for customers to reach the businesses in the past. The access situation for suppliers was considered to be of less importance, likewise the effect of roads on prices. The road improvements needed are clear, particularly in the Siavonga area: two in three businesses stated that road maintenance needs to be improved. The second most important improvement would be more public transport; the third most important improvement would be to widen the roads. In the Choma area, each category of improvements was considered to be of roughly equal importance, indicating that the general condition is already quite good and further improvements depend on the specific needs of the businesses.

2.8.6   Non-agricultural businesses

The situation for non-agricultural businesses is very similar. Compared to agricultural businesses, however, there are not as many non-agricultural businesses. In the Choma area, 27 households reported to have at least one non-agricultural business. Some of these 27 households indicated that they have more than one such business, so that a total of 38 non-agricultural businesses was counted among the 275 households that were interviewed. In the Siavonga area, 32 households reported at least one non-agricultural business. In total, 33 such businesses were counted among the 148 households that were interviewed. Here again, the actual number of such businesses might be higher as some might not have been reported during the interviews. The businesses are mostly retail businesses employing less than three people. They are equally regionally oriented as the agricultural businesses.

The situation in Siavonga is worse also for this type of business. Again, more than 70% of the supplies can reach the business in Choma within less than half a day, whereas this is the case only for 1/3 in Siavonga.

If the businesses improved in recent time, the reason was usually not that any new roads had been constructed. Here, it was rather that there was an increase in settlement or a better competitive environment. However, in cases where the business decreased, the road condition played an important role in the Siavonga area: Here, 60% of the households that have a non-agricultural business stated that deteriorating roads have been the reason. In the Choma area, in contrast, only 15% pointed to roads. In both areas, however, roads are considered to be the major limiting factor to their businesses (73% in Choma, 45% in Siavonga).

Like for the agricultural businesses, the effect of the road conditions on the businesses is through the accessibility of customers to the businesses. Better maintenance, more public transport, and wider roads were all stated as important ways to improve the road situation.

2.8.7 Conclusion: Differences in living conditions and role of road improvements

The comparison of the two roads in the Choma area and in the Siavonga area showed what potential road improvements can have for otherwise similar regions. Of course, it has to be acknowledged that the road improvements in Choma might also have been the response to more economic activity in that area. However, we assume that the road improvements also led to more goods and passenger transport, better connectivity and thereby more potential for development. The findings are in line with the analyses of the LCMS data. Those analyses also showed the potential that roads can have, e.g. on reducing poverty, increasing secondary school attendance rates, and consultation of modern health facilities. The bottom-line is that the roads sector has a positive impact in the rural areas in Zambia.

2.9   Concluding assessment of the impact findings

The past chapters presented different analyses of the impact of the roads sector. Impacts have been analysed both at the macro-level and at the micro-level. Several general findings emerge:

- On the macro-level, it was not feasible to demonstrate the specific effects of the roads sector by means of econometric analysis. However, the findings presented (trade, mining, agriculture, tourism) are all very plausible and suggest that improved roads contribute to the development of Zambia. Indications for the importance of the roads sector are, for instance, the large share of export and import goods transported on the roads along with the large increase in trade volumes.

- On the micro-level, the econometric analyses of LCMS data showed that in cases where a road project took place, statistically significant effects can be demonstrated on reducing the share of households living in extreme poverty, and on increasing the secondary school attendance rates, and the consultations of modern health facilities. Some are very strong effects based on reliable data, such as the effect on secondary school attendance rates. It was, however, not possible to demonstrate significant effects for each of the different road types on all outcome variables. This calls for some modesty when presenting the impact of the roads sector. Still, as a general assessment, many effects could be demonstrated. As the impact analyses concentrated on the rural areas where an over-proportional part of the Zambian poor are living, these results are of special importance for improving the livelihoods of the poor.

- It is important to stress that many of the statistical results are valid only for cases in which a road was built. It could be demonstrated, for instance, that where a road project occurred, the share of extremely poor households decreased by 4-12 percentage points. This does not yet say anything about the share of households in the entire country that saw their road being improved. Some indication about the general scope of the impacts of the roads sector can be taken from the information that 22% of rural households reported in the LCMS 2006 data that some road project was carried out during the year before 2006 in their area. The overall works done therefore had a positive effect, but certainly not throughout the entire country at the same time.

- The econometric analysis differentiated several times between the extremely poor, the moderately poor, and the non-poor. As a general conclusion, no significant distributional effects can be demonstrated. Also the effects at the macro-level suggest that roads have an impact on all levels of households' wealth. The poor do benefit, but probably not disproportionally high. Again, it should be mentioned, however, that our impact analyses were carried out for rural areas where the poor are over-represented.

- Some important further analyses would be warranted to demonstrate in more detail the impact of roads in rural areas where agriculture is the predominant economic activity. Roads serve to bring the produce to the markets so that with better roads, changes in the production pattern and increasing turnover on the markets can be assumed.

- Despite all positive effects that could be demonstrated, the impact analyses also showed that the road and transport situation is still – despite all projects and improvements – inadequate and continues to be a constraint for development: Walking remains the predominant mode of travel, travel speed is low, road projects still rank very high among the desired projects by the locals, and bad roads in many cases have been the reason why businesses did not develop as wished.

- Previous chapters showed that the efficiency of the road works was not as high as desired – due to high and rising unit costs and due to deficiencies in the quality of works. Related to the impact findings, this means that the effects observed could have been even more widespread (by using money more efficiently and thereby carrying out more road projects in more areas) and also stronger in individual cases (when a road would last longer and have better quality).

The general assessment of the impact of the ROADSIP II programme is therefore certainly positive, but more would have been possible in recent years, and more is still needed to overcome all constraints that the roads sector still presents for the further development of Zambia.

3 Findings: Water Supply and Sanitation

3.1 The institutional and organisational setup of the WSS sector

Initial sector specific policy and institutional reforms undertaken by GRZ go back to the 1990s, aiming at decentralisation and commercialisation in the water sector. These reforms created a supportive environment for sector development, especially in the urban areas. Some of the major reforms concern the formulation of the National Water Policy (1994), the Water Supply and Sanitation Act No. 28 of 1997, the establishment of the first CUs (1998)[55], in charge of WSS particularly in urban areas, and the creation of the National Water Supply and Sanitation Council (NWASCO, 2000) as an independent regulator. Since 2000, the reforms were carried further by founding the Devolution Trust Fund (DTF, 2003) to promote peri-urban WSS, the adoption of the National Decentralisation Policy (2004), and, last but not least, the formulation of the National Rural Water Supply and Sanitation Programme (NRWSSP, 2007, 2009) and the National Urban Water Supply and Sanitation Programme (NUWSSP, draft version 2009). Even though several key sector reforms regarding the institutional framework have already been implemented quite a long time ago, the WSS sector is still in a reform process. Presently, the development of a financial mechanism within the framework of the NUWSSP aiming at overcoming the still persisting shortcomings (CU performance, quality of infrastructure, coverage rates etc.) in the urban water sector is under discussion. The new Water Resource Management Bill (2010), the last outstanding major reform to complete the legal sector framework, is on its way, but still pending. The bill would for the first time assign the right to use groundwater exclusively to government authorities. Until today, it is still quite common that households in better-off areas use their own boreholes to extract ground water free of charge. In general, over the last years, the main focus with respect to institutional reforms was clearly on decentralisation and commercialisation in urban areas and therein on safe water provision while providing access to adequate sanitation is certainly the challenge for the near future (NRWSSP 2009 and see below).

The two most important ministries with respect to WSS are the MEWD and the MLGH.[56] The MEWD has the overall responsibility for the water sector and the corresponding policy formulation. Through its Department of Water Affairs (DWA) it is also in charge of water resources planning, management and development, including water resources assessment. In the course of the sector reformation, in 1999, the responsibility for the provision of WSS was transferred from the MEWD to the MLGH. Thus,

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[55] In 2010, 92% of all urban areas are served by CUs.

[56] Other ministries related to the water sector are the MoH, MACO, MoE, MTENR, MCDSS and the MMMD.

the MLGH, through its Department of Housing and Infrastructure Development (DHID), presently has the responsibility for delivering WSS services.

Following the seven sector principles (see box), the MLGH delegates the provision of WSS services to the provincial Local Authorities (LAs). The LAs, in turn, are mandated to provide water and sanitation services to the consumers either directly or by forming CUs. Most of the LAs indeed opted for establishing CUs so that only a negligible share of drinking water provision in urban areas is done by the LAs themselves. Therefore, on the operational level, mostly CUs, which are owned by the LAs, are responsible for urban water and sanitation service provision. The catchment areas of the CUs were, however, drawn along political, respectively provincial borders which means that a well-balanced customer solvency composition and topographic differences were not the criteria for defining catchment areas. Consequently, due to different soil compositions, some CUs are facing significantly higher costs for exploring ground water and consequently have to charge higher tariffs than others (e.g. North Western Water and Sewerage Company), and poorer provinces (e.g. the Western

> The National Water Policy (1994) contains the **seven sector principles** which have been the basis for implementation of the water sector reforms. These principles are:
> - Separation of water resources and executive functions from water supply and sanitation (WSS);
> - Separation of regulatory and executive functions within the water supply and sanitation sector;
> - Devolution of authority to local authorities and private enterprises;
> - Achievement of full cost recovery for the water supply and sanitation services (capital recovery, operation and maintenance) through user charges in the long run;
> - Human resources development leading to effective institutions;
> - Technology appropriate to local conditions; and
> - Increased GRZ spending priority and budget spending to the sector

Province) struggle to cross-subsidise poorer consumers through the block tariff system (see Chapter 3.4.1). Such a system can only work sustainably in the long run if an inter-provincial cross-subsidising mechanism, which is currently under discussion within the NUWSSP dialogue, subsidises poorer provinces. This is so far not the case partly due to the fact that just three CUs are able to cover basic operation and maintenance (O+M) costs (see Chapter 3.4.1).

Due to the geographical and socio-economic setting of the rural WSS sector, the implementation of a comparable commercialised approach for providing WSS services was unrealistic at least in the short run. The decentralisation and commercialisation strategy for the urban sector was therefore complemented by a self help 'bottom-up' approach in rural areas. Operational responsibilities for providing WSS services in rural areas were delegated to D- and V-WASHEs[57]. Due to the lack of operational resources, the implementation of this bottom-up approach was surely the right way to go. For more details on the institutional setup, please refer to the graphical WSS sector overview in Annex 2.

With respect to the shift of responsibility for WSS service provision from the MEWD to the MLGH, one of the main problems was and still is that this change did not involve a simultaneous or consecutive transfer of staff. Since then, the MLGH has not been able to build up an adequate operational resource level in terms of number of staff and required qualifications (DANIDA 2007, 2010 draft). The disparity concerning relevant competencies and capacities continues to persist between the two ministries, hampering effective sector development. Furthermore, the devolution of authority to local government entities has brought about a series of capacity challenges with respect to rural WSS. A large number of staff who formerly worked for MEWD/DWA on rural WSS has opted to join CUs and, hence, has left district councils without the technical capacity to deal with rural WSS (JSR, p. 98, 2009). In addition to that, CUs were forced to take up staff of LAs, resulting in even larger numbers of staff with comparatively high remuneration. Due to these limitations, a lack of implementation progress regarding the decentralisation of competencies to LAs is observed (MDG Progress Report, p. 29, 2008). To counter this adverse development, additional temporary capacity

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[57] WASHE – Water, Sanitation, and Hygiene Education.

building measures are necessary (e.g. establishment of Provincial Support Teams) and are also supported by CPs (JSR, p. 71, 2009).

In sum, on paper, the institutional setup seems to be appropriate for rural and urban areas and clearly defines responsibilities. However, this does not guarantee smooth functioning in the practical day to day business. Besides of serious capacity shortcomings in the MLGH and the LAs, the MEWD and the MLGH still have disputes about their respective responsibilities. The issue of drilling boreholes for water supply might serve as an illustrative example as this has led to a continuous debate on the assignment of responsibilities between the two ministries (NWASCO, p. 12, 2008/2009) which also became apparent during the evaluation period. More precisely, the MEWD planned to assign Chinese companies a short-dated contract for 6,000 boreholes to be drilled under its supervision over the next three years.[58] This initiative, which was not concerted with the water sector roadmap outlined in the FNDP and the NRWSSP, posed major challenges to sector development discussions, especially regarding the ongoing alignment process of aid delivery (NRWSSP, 2007). After intense discussions, the assignment is now planned, in line with the division of competencies between the two ministries, under the supervision of the MLGH as a Private Public Partnership and is outlined in the draft SNDP, the follower of the FNPD. Even though the ambitious project will now be supervised by the MLGH or may even not be implemented at all, the conflict illustrates the competence skirmish between the ministries.

The water sector is supported by a large number of CPs and NGOs. The biggest CP contributors to the water sector are the AfDB, the World Bank, Germany, Japan, Ireland, the United Nations (UN), Denmark, and China. In addition, NGOs like Water Aid, Care International, World Vision, etc. substantially support the sector (GTZ & World Bank, 2009; JSR, p. 31, 2009). CP coordination, harmonisation, and alignment to GRZ policies seem to have made huge progress over the last few years. Almost all multi- and bilateral CPs have been aligning their activities under national policies. Despite this progress, however, a variety of different modalities regarding procurement, tendering, the role of consultants, etc. still exists, which implies that CP support is still heterogeneous and not completely harmonised.

3.2   Financial flows to the WSS sector

3.2.1   Background

The WSS sector is financed by contributions from GRZ, through user fees, and through project aid. Project aid is either provided through government channels (on-budget) or directly to the projects, for instance in the case of technical assistance and NGO support (off-budget).

In principle, the WSS sector (as the power sector) is supposed to be revenue generating. In the very long run this implies that the WSS sector in Zambia should be able to generate enough revenues to operate fully cost covering (incl. O+M costs and depreciation). In the short run, at least O+M costs should be covered which, however, is, if at all, only realistic in the urban sector as rural households only pay minor fees in cash or in kind for basic investment (usually boreholes with hand pumps) and maintenance. In urban areas instead, revenues are generated through user fees for water consumption. Yet, as only three CUs are able to cover their O+M costs through user fees (see Chapter 3.4.1), major contributions from GRZ and CPs will still be necessary to provide and expand services for quite a long time.

Due to complicated and improvable reporting procedures, no reliable data on the revenues of the CUs was available at the time of the evaluation. Only a rough approximation based on information provided by NWASCO was possible. It thus has to be kept in mind that the following assessment is biased insofar as funds generated by user fees in urban areas, which are collected by the CUs, do not

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[58] Post Zambia Online, 05.03.2010.

appear in the tables implying that local contributions are comparably underweighted. Finally, due to its small share in the overall water sector budget, expenditures for Water Resources Management schemes are ignored in the following.

3.2.2   Financial contributions to the water sector

Contrary to sectors such as education and health, GRZ only allocates a minor share of the national budget to the water sector (see Table 11). Between 2002 and 2007, the overall sector budget, which comprises GRZ and CP contributions, more than doubled from USD 48 million (2002) to USD 111 million (2007), yet the overall budget also developed accordingly during this time period (increase from USD 1,421 million in 2002 to USD 3,178 million in 2007). The increase is a result of an overall good economic situation and, more importantly, of an increase in CP spending. The total of funds that CPs have provided to the sector through government channels (on-budget) between 2002 and 2007[59] amounts to approximately USD 264 million. Compared to the USD 160 million provided by the Zambian Government this figure indicates that CPs financed more than 60% of all contributions to the water sector, leaving aside CU revenues of course. However, due to challenges related to reporting mechanisms, the maintenance of databases, and efforts to capture sectoral funds, reporting exact budget figures which can distinguish between GRZ and CP support is difficult and not always clear-cut (draft PER, 2010) which implies that figures should rather be interpreted as good approximations than as exact numbers. Taking this into account, the most recent figures indicate a significant increase in GRZ's financial contributions to the WSS sector. Whereas in 2009 the allocations to the WSS sector accounted for 1.4% of the national budget (USD 56 million in constant 2008 prices, ZMK 236 billion), the share increased to 3% in 2010 (USD 107 million in constant 2008 prices, ZMK 504 billion).[60] The MLGH and the MEWD attribute this increase to the budget support process. However, these increases in financial contributions do not necessarily translate into higher expenditures as actual disbursement rates have actually been much lower than financial contributions in the past. Therefore, the rise in contributions should be interpreted with caution, and should not be taken as a definite signal for an increased priority that GRZ assigns to WSS.

With respect to the revenues of the CUs, a rough calculation based on NWASCO data on total billing for water and collection efficiency suggests that aggregate revenues amounted to approximately USD 46 million in 2007/08. This implies that revenues from user fees were higher than total GRZ spending on the water sector in 2007, and that total revenues together with GRZ spending were approximately equal to CP on-budget water sector spending in 2007.

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[59] No figures are available for 2004.

[60] According to information received shortly before the final draft of this report, the positive development continued in 2011, where again 3% of the total budget (ZMK 610 billion) were allocated to the WSS sector, representing a nominal increase of 159% compared to 2009.

Table 11: Contributions to the water sector (disbursed, in USD)

	2002	2003[61]	2004[62]	2005	2006	2007
Budget	1,421,280,027	1,639,704,386	1,920,218,317	2,443,912,068	2,939,776,067	3,177,507,481
Total water sector	48,495,905	58,080,925	116,981,007	141,670,117	62,966,956	111,497,969
GRZ water sector	17,199,200	45,914,578		41,279,504	19,426,050	35,112,592
CP water sector	31,296,705	12,166,347		100,390,613	43,540,906	76,385,377
GRZ share in water sector	35.5%	79.1%		29.1%	30.9%	31.5%
CP share in water sector	64.5%	20.9%		70.9%	69.1%	68.5%
GRZ provision in water sector in overall budget	1.2%	2.6%		1.7%	0.7%	1.1%
CP provision in water sector in overall budget	2.2%	0.7%		4.1%	0.7%	2.4%
% Water share in overall budget	3.4%	3.4%	6.1%	5.8%	2.2%	3.5%

Source: Draft PER (2010), GTZ & World Bank (2009), Blue Book.

With regard to actual expenditures, between 2002 and 2006, only around 10% of the GRZ funds allocated to the WSS sector were effectively disbursed. In 2007, the share of disbursed funds increased to approximately 25% of allocated GRZ funds. As Table 11 and also the following tables just reflect actually disbursed funds to the WSS sector this implies that allocations to the sector were considerably higher. The improvement in actual expenditures in 2007 is, among others, ascribed to better reporting and monitoring standards which in turn are attributed to GBS (draft PER 2010, interviews). Recent data suggests that the release rate further increased to 40% in 2010. Yet, the persisting gap between allocated and disbursed GRZ funds is still large and can be explained by the inherent lack of institutional capacities and the fact that allocated financial resources are often shifted to other politically more prioritised sectors. A gap can also be observed between allocated and disbursed on-budget CP funds. Yet, this gap can mainly be explained by inadequate end of fiscal year reporting procedures, meaning that even though CPs may have spent their funds as allocated, they did not report (exact) figures to the MoFNP which thus leads to an underreporting of project aid.

In addition to the on-budget contributions of CPs, several multilateral and bilateral programmes by CPs and NGOs[63] were and are not provided through government channels (off-budget) and do therefore not appear in the national budget. An example of such a programme is the Water Sector Reform Programme by the German Technical Cooperation (USD 30 million) which supports the commercialisation process within urban areas. This implies that the figures provided in Table 11 do also not include the off-budget WSS sector contributions of CPs and NGOs which again leads to an underreporting of total CP support to the sector. An estimation of all external funds (CP on- and off-budget contributions) allocated to the water sector suggests that those funds amount to about 90% of the WSS sector budget (JSR, p. 31, 2009). Therefore, despite the recent positive developments regarding the contributions of GRZ, CP project aid remains the prevailing mode of financing for the sector, excluding again the revenues generated through user fees in urban areas.

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[61] "For 2003, most of the financial support provided by the CPs cannot be identified as they were combined with investments for roads and included in the Budget as a single lump sum." (GTZ & World Bank, 2009)

[62] In 2004, the financial support from CPs was combined with resources from GRZ to a single lump sum so that it is not possible to differentiate between CP and GRZ contributions based on the information provided in the budget.

[63] CARE International implements EU financed support to the sector.

3.2.3 Expenditures disaggregated

Having analysed the total financial contributions to the water sector, this chapter aims at disaggregating the expenditures more thoroughly by focusing on who receives the funds and what they are spent on.

As can be seen in Table 12, in 2007, more than 70% of the national budget expenditures were channelled through the account 'loans and investments' through the MLGH (USD 82.4 million) followed by funds to the MEWD and the MoFNP with approximately 6% each (MEWD: USD 7.1 million, MoFNP: USD 7.5 million). Direct transfers to the MLGH were comparably small with USD 1.6 million. Apart from that very minor residual funds were allocated to the other water sector related ministries (e.g. the Ministry of Agriculture and Cooperatives (MACO)) and to the provinces.

Table 12: Disaggregated total expenditures (USD million)

	2002	2003	2004	2005	2006	2007
LI[64]-MLGH	21.2	30.4	53.1	101.7	45.2	82.4
LI-MoFNP	13.4	12.3	55.7	24.5	0	7.5
MEWD	4.3	4.1	1.5	4.2	6.8	7.1
MACO	5.4	9.4	1.4	1.3	3.3	4.7
MLGH	2.8	0.3	1.4	3.8	1.2	1.6
COMT	0.9	0.5	1.1	2.6	2.4	3.5
Provinces	0.6	1.1	1.7	2.8	3.5	3.4
WS	0	0	1.1	0.8	0.5	1.3
MTENR	0	0	0	0	0	0
Totals	48.5	58.1	117.0	141.7	63.0	111.5

Source: Draft PER, 2010, Blue Book.

The above-mentioned disaggregated expenditures made under the National Budget can be sub-categorised as follows: investments, personal emoluments, general administration and other recurrent costs (Table 13). It can be seen that investments, which are mainly used to improve WSS infrastructure, account for more than 85% of sector allocations on average. Typically, such investments are financed by CPs while GRZ focuses on financing recurrent costs on the ministerial and LA level. More precisely, CP activities relating to urban WSS have largely focused on upgrading and maintaining infrastructure and supporting CUs in improving their services. In rural areas, activities concentrate on drilling or maintaining (new) boreholes.

Table 13: Allocations authorised to the water sector by category (USD million)

	2002	2003	2004	2005	2006	2007
Investments	41.2	50.4	111.7	133.1	49.8	96.2
Personal Emoluments	1.8	3.1	2.2	2.7	2.9	3.8
General Administration	1.6	1.4	0.6	1.2	1.4	2.5
Other Recurrent Costs	3.9	3.2	2.5	4.7	8.8	9.0
Total	48.5	58.1	117.0	141.7	63.0	111.5

Source: Draft PER, 2010, Blue Book.

To sum up, even though reporting mechanisms regarding financial flows have substantially improved, the availability of data is still fragmentary. Nevertheless and leaving aside the revenues generated by user fees, it can be concluded that the main financial burden is covered by CPs. Despite recent

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[64] LI – Loans and Investments.

increases in financial contributions, GRZ is only allocating a minor share of the national budget to the water sector indicating that GRZ ownership is not very high.

3.2.4 Crowding-out?

As the water sector is largely financed by CPs' financial contributions, the question arises whether project aid, which is the dominant aid modality in the WSS sector in Zambia, led to a crowding-out of GRZ investment, more specifically a reduction in the financial commitment of GRZ to the sector.

In the literature, the question whether development aid is a substitute for sectoral spending by recipient governments has been subject to intense discussions over the last years. The results of theoretical and empirical research draw a heterogeneous picture of the so-called crowding-out[65] (or, as the case may be, crowding-in) effects of project aid (World Bank, 1998a; World Bank, 1998b; S. Lahiri and P. Raimondos-Moller, 2000; Lu, C. et al, 2010). Lu et al. (2010) estimate that health sector development assistance to sub-Saharan governments reduced government sectoral spending significantly. For every granted USD, government spending was on average reduced by USD 0.43, although, in turn, aid to the non-governmental health sector had a positive and significant effect on government health sector spending. Ooms et al. (2010) argue, with respect to Lu et al. (2010), that explicit country-specific policy choices can explain crowding-out which are, however, hardly transferable to other countries. While the crowding-out effects of project aid have been extensively discussed in the literature, further research on the influence of GBS on the spending behaviour of recipient governments is necessary. Recent theoretical research on the effectiveness of GBS focuses on the crowding-out effects on the private sector. For GBS being the preferable mode of aid delivery in terms of preventing crowding-out private sector engagement, the research identifies the following preconditions, among others: the endowment of the recipient country with own resources has to be high compared to foreign aid in the respective sectors, and the interests of donors and recipients need to be aligned (Cordella, T., Dell`Aricia, 2003; Vandeninden, 2008; Haaparanta, 2010). However, conclusive empirical evidence on this question is still missing.

For the Zambian WSS sector, the evaluation team was not able to find any evidence for or against a crowding-out effect of project aid. The idea to generate at least some circumstantial evidence by means of a comparison of budget allocations to the WSS sector in GBS and non GBS receiving sub-Saharan countries did not lead to any deeper insights regarding the crowding-out question. Countries were too different in their characteristics, no reliable data on the composition of the WSS sector financing was available, and in the rough data which is available no trace of a pattern could be found which might allow to distinguish WSS financing in countries with lots of GBS (project aid) from those without.

Nevertheless, it seems to be worthwhile to present our rudimentary country comparison because, if at all, the information allows one conclusion: As measured by governments' budget allocations, the WSS sector does not seem to have a high priority in any of the countries, with Botswana being an exception to the rule.

Table 14 shows a broad overview, including population size, access to water, and income group, for the countries chosen for the comparison from 2002 to 2007. Among the selected countries, five are GBS receiving, namely Zambia, Kenya, Burkina Faso, Ghana, and Mali[66], and two are non GBS receiving countries, namely Botswana and Namibia. As only three sub-Saharan countries never received GBS (Namibia, Botswana, and Swaziland[67]), the analysis is necessarily restricted in terms of the number of countries that could be used for the comparison.

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[65] Or aid fungibility.

[66] The GBS receiving countries besides Zambia were selected randomly.

[67] Due to data restrictions, Swaziland was not included in the analysis.

Table 14: Country overview 2002 to 2007

Countries	Population (Mio.) (2009)	Access to improved water source (%) (2009)		Income Group[68]
		Urban	Rural	
Zambia[69]	12.6	87	41	LIC
Kenya	38.5	85	49	LIC
Burkina Faso	15.2	97	66	LIC
Ghana	23.4	90	71	LIC
Mali	12.7	86	48	LIC
Botswana	1.9	100	90	UMIC
Namibia	2.1	94	88	UMIC

Source: Beynon, J. and Dusu, A. (2010): Budget Support and MDG-Performance (draft paper), World Development Indicators, 2009, and Zambia LCMS 2006.

The two non GBS receiving countries, Botswana and Namibia, are obviously in a more advanced stage of development as they can be characterised as upper-middle-income countries while all GBS receiving countries are low-income countries. Furthermore, Botswana and Namibia have exceptionally high water supply coverage rates, especially in rural areas, and are also far smaller in terms of population size compared to the GBS receiving countries selected. Independent of population size, the GBS receiving countries have urban water supply coverage rates well above 80% while the coverage rates in rural areas vary between 41% for Zambia and 71% for Ghana. All in all, the table already suggests that it is difficult to compare the countries as basic country characteristics are quite heterogeneous.

Table 15 summarises the estimates of the share of the total budget allocated to the water sector for the seven countries analysed from 2002 to 2007. Due to the fact that national budget figures are usually allocated to ministries[70] and not to sectors, an exact budgetary sector attribution is difficult. This implies that sometimes, for instance, water sector spending cannot be separated from the contributions to the energy sector, making the reported budget figures for the different countries difficult to compare. Therefore, a detailed cross-country budget analysis is next to impossible which is why broad sectoral budget figures and incomplete time series are reported. Nevertheless, the numbers give a first indication of the water sector share in comparison to the total budget, something which is most likely related to the priority a respective government assigns to the sector.

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[68] LIC – low-income country, UMIC – upper-middle-income country.

[69] Analysis refers to World Development Indicators for the sake of standardised presentation. In the following, the analysis will refer to Zambian household surveys which lead to deviating coverage rates.

[70] For countries like Botswana, several ministries share the responsibilities for the water sector.

Table 15: Estimates of the share of the total budget allocated to the water sector (in %)[71]

Country	2002	2003	2004	2005	2006	2007	2008	2009
Countries receiving GBS								
Zambia	1.2	2.6	--	1.7	0.7	1.1	--	1.4
Kenya	--	1.4	1.4	1.5	1.9	1.7	2.4	1.4
Ghana	2.5	2.2	1.3	2.2	2.6	--	--	--
Countries receiving GBS: regional spending on rural water supply and sanitation, share of total national budget (in %) (Source: PER report Ghana, 2007)[72]								
Burkina Faso	1.3	1.5	1.0	1.6	2.8	--	--	--
Ghana[73] [74]	<1	<1	<1	<1	--	--	--	--
Mali	1.1	0.7	1.2	1.9	2.8	--	--	--
Non GBS receiving countries								
Botswana[75]	--	--	--	5.4	5.1	4.9	--	--
Namibia[76]	<2	<2	<2	<2	<2	<2	<2	<2

Source: National budget figures.

In a nutshell, Table 15 shows that all countries commit comparably low shares of the national budget to the water sector and that the shares have remained more or less constant over the last years. Botswana is an exception as the country is allocating approximately 5% of the national budget to the water sector. Even though the Botswanian budget figures include expenditures for energy as well, the water sector share is likely to be higher than for the other countries. A reason for this deviation could be the considerably higher and therefore more costly infrastructural water and sanitation standards provided, especially to the rural population. Furthermore, when interpreting the above figures it should be kept in mind that low government contributions to the sector are not necessarily a bad sign, e.g. if service provision is already fully cost covering and coverage rates are high. Yet, all GBS receiving countries show substantial deficits in terms of access to safe water and probably to sanitation facilities as well, especially in rural areas. No adequate sewerage systems seem to be in place in any of these countries, indicating that future investment necessities will be high. Therefore, considerable sectoral investment deficits are likely to be present, at least for the GBS receiving countries. Similar to Zambia, no precise information on user fees or project aid to the sector was available for any of the analysed countries.

In addition, with Table 16 it can be analysed whether government allocations to the water sector differ if ODA and/or GBS account for a significant share of the recipient country's GDP. Except for Botswana, obvious structural differences between government allocations to the water sector

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[71] Sources: PEFA reports, Budget Speeches, Sector Reviews etc., revenues of CUs are ignored.

[72] Report No. 36384-GH, Ghana, Public Finance Management Performance Report and Performance Indicators 2006 External Review of Public Financial Management – Volume II, June 2006, World Bank.

[73] Water Sector Budget Figure 2009: 0.87%.

[74] Due to a lack of governmental financial commitment to the water sector, several CPs are pulling out of the sector.

[75] Budget figures include expenditures for energy and water affairs.

[76] Ministry of Agriculture, Water and Forestry Dept.

cannot be identified, neither between GBS and non GBS receiving countries, nor between less or more developed countries, nor between countries with small and large populations.[77]

Table 16: Country overview regarding GBS and ODA 2002 to 2007

Countries	GBS/ODA both disbursed (%) (average)	GBS/ODA both committed (%) (average)	GBS disbursed / GDP (%) (average)	GBS committed/ GDP (%) (average)	ODA disbursed/ GDP (%) (average)
Zambia	5.65	9.78	1.17	1.64	26.80
Kenya	1.85	2.31	0.09	0.17	4.90
Burkina Faso	10.42	29.83	1.69	3.81	18.00
Ghana	8.19	25.09	1.24	2.71	20.50
Mali	7.69	16.13	1.33	2.18	20.30
Botswana	--	--	--	--	0.70
Namibia	--	--	--	--	2.70

Source: Beynon, J. and Dusu, A. (2010): Budget Support and MDG-Performance (draft paper).

In sum, no evidence was found for or against the existence of crowding-out, although the more general theoretical and empirical evidence suggests that CP engagement can lead to crowding-out of governmental sector expenditures. However, what can be concluded is that in most countries the WSS sector does not rank high in governments' spending. About the reasons for this can only be speculated. One reason might be that no matter whether there is investment into the water sector or not, people will always have some sort of access to water. Therefore, governments' spending for WSS will simply transform into improvements in quality and/or quantity, but never into something as visible as e.g. first time access to the electricity grid.

Given the comparatively low government priority for WSS, some hypothetical conclusion on what would be the effect of less project aid for the WSS in exchange for more GBS can be drawn after all: It is likely that shifting funds from project aid to GBS would rather decrease and not increase the overall contribution to the water sector in Zambia. Beside our comparative country analysis, some support for this hypothesis was given by evidence collected during the mission in Zambia: GRZ frequently shifted budgets already allocated to the WSS sector to other sectors (see Chapter 3.2.2), which is why it is presumed that a shift from project aid to GBS would give more leeway to GRZ resulting, in the end, in lower financial contributions to the sector.

3.3 WSS performance development

3.3.1 Background

The FNDP WSS Key Performance Indicators (2007) and the sector related MDGs *(Goal 7, Target 10)* envision a safe water supply coverage of 75% and adequate sanitation facilities for 60% of the Zambian population by 2015.[78] With respect to GBS, the WSS sector was represented within the Performance Assessment Framework (PAF, 2007) with the performance indicator: "water supply coverage in rural areas", even though the WSS sector receives only limited funds from the National Budget. For the revised PAF 2009-2011, the water sector drew level with the other sectors by gaining

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[77] Budget allocations for many sub-Saharan countries (Uganda, Malawi, Mozambique etc.) indicate that the same pattern persists since the 1990s.

[78] The two MDG 7, Goal 10 indicators are represented as Key Performance Indicators within the FNDP.

two additional indicators: "water supply coverage in urban areas" and "per capita storage of water". The WSS sector was the only sector which was allocated additional indicators in the latest PAF. The targets for safe water coverage were set at 41% for 2007, 45% for 2008 and 49% for 2009. For 2010 (2011), the goal is to reach a water supply coverage of 40% (50%) in rural areas and 68% (68%) in urban areas. At least according to some of the data sources, some of these goals are not very ambitious as they have been fulfilled already. The SNDP, the successor of the FNDP covering the years 2011 to 2015, specifies the current sector goals for rural and urban areas to be achieved by 2015. These include access rates of 75% for safe water and 60% for safe sanitation in rural areas and access rates of 80% for safe water and 60% for safe sanitation in urban areas.

However, due to unreliable data sources, no conclusive assessment of current coverage rates can be made. As a consequence of this lack of adequate information, different information sources are reporting deviating coverage rates (see Table 17). Referring to the estimates, the current access rates to safe water for all of Zambia vary between 57% and 60% and the access rates to sanitation vary between 64% and 87% which, however, is likely to be an overstatement of the actual access rates as the estimates cannot differentiate between acceptable and unacceptable pit latrines (see below).

More precisely, when comparing the LCMS 1998 and 2006 data on safe water supply and sanitation, the information suggests that the water supply coverage remained unchanged at 57% for the whole of Zambia. While access to safe water slightly improved in rural areas from 37% to 41%, the safe water supply coverage in urban areas apparently declined from 91% to 87%. This is due to the fact that high urban population growth and migration into cities made it difficult for CUs to keep up with expanding services to (peri-)urban residents. Referring to the LCMS information, the urban population grew from 6,314,080 to 7,612,472 people between 1998 and 2006 which means that even though access rates decreased, in absolute terms, an additional 1 million people gained access to safe water sources in urban areas. The baseline data of the SNDP, which only recently became available, confirms the trend of an increasing coverage rate in rural areas and a decreasing coverage rate in urban areas: In 2009, 53% of the rural population and 74% of the urban population had access to safe water supply.

Table 17: Access to safe water and sanitation

	Total %		Urban %		Rural %	
2006 - 2009	Water	Sanitation	Water	Sanitation	Water	Sanitation
LCMS (2006)	57	87[79]	87	99[80]	41	81[81]
MDG Report[82] (2008)	60	64				
NWASCO (2008/2009)			73	43[83]		
1998 - 2005						
LCMS (1998)	57	81[84]	91	99[85]	37	71[86]
NWASCO (2004/2005)			67	34		
FNDP (2000)			86	37	33	4[87]

Sources: LCMS, 1998, 2006; Zambia MDG Progress Report 2008; NWASCO Annual Report 2008/2009.

The NWASCO data draws a different picture for water supply coverage rates in urban areas. Referring to the NWASCO annual reports, coverage rates in urban areas increased from 67% in 2004/2005 to

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[79] Excluding traditional shared pit latrines would reduce the access rate to 15%.

[80] Excluding traditional shared pit latrines would reduce the access rate to 36%.

[81] Excluding traditional shared pit latrines would reduce the access rate to 2.2%.

[82] The MDG Progress Report relies on the LCMS data.

[83] Excluding traditional shared pit latrines.

[84] Excluding traditional shared pit latrines would reduce the access rate to 17%.

[85] Excluding traditional shared pit latrines would reduce the access rate to 45%.

[86] Excluding traditional shared pit latrines would reduce the access rate to 1.9%.

[87] Referring to the FNDP, safe sanitation facilities are just own flush toilets, i.e. own pit latrines are excluded.

73% in 2008/2009 (NWASCO Sector Report, 2008/2009). With respect to the absolute number of people being served, this figure increased by approximately half a million, from 3,270,745 to 3,737,703, between 2005 and 2009. In parts, the deviation between the LCMS and the NWASCO estimates can be explained by using different catchment areas and deviating definitions of safe water. While the NWASCO data does not include some of the poorly served informal peri-urban settlements, the definition of safe water is stricter as only piped water is considered as being safe while the LCMS also includes protected wells. Thus, the two data sources are only partly comparable.

With respect to sanitation, the LCMS estimated that access rates to sanitation facilities increased slightly from 81% to 87% between 1998 and 2006 for all of Zambia. With respect to toilet facilities, the data indicates that nearly all households in urban areas and also a relatively high percentage of rural households (81%) have access to at least some sort of toilet facility which needs, however, not to be safe. As it cannot be differentiated between acceptable (unshared pit latrines with a slab[88]) and non-acceptable pit latrines (all shared forms of pit latrines) in the LCMS, the figures clearly overstate actual access rates.[89] This presumption is supported by the information provided by NWASCO and the FNDP. While the NWASCO estimates indicate that access rates to sanitation increased from 34% in 2004/05 to 43% in 2008/09 in urban areas, the FNDP (2000) suggests that access to sanitation facilities was at only 4% in rural areas in 2000.

With the data sources available, it is clear that it is difficult to assess whether or not the different indicators specified in the FNDP and the PAF are actually met. This problem, which is more pronounced in rural areas, will remain at least until the rollout of the WSS Management Information System (MIS). With respect to information from the MLGH, the rollout of its rural WSS MIS can be expected in the near future. The MIS will contain, inter alia, important information on WSS coverage rates (incl. GPS data) and information on the O+M status of boreholes.

Even though it is difficult to assess the progress with respect to the PAF indicators with the data available, the coverage development was part of the PAF dialogue.[90] Referring to the LCMS and the NWASCO data, it seems to be realistic that at least the water supply goals for 2010 will be met while it is clear that it will be difficult to reach the MDG targets, especially for sanitation.

To sum up, the different data sources show that the information regarding actual access rates to safe water and adequate sanitation is far from being reliable, especially for rural areas. Therefore, the WSS MIS will be highly useful for monitoring progress in WSS access rates in the future. The data presented indicates, however, that rural areas in Zambia are significantly lagging behind the development in urban areas in terms of access to safe water and adequate sanitation facilities. For a more detailed discussion on the use and impact of water and sanitation facilities, see Chapter 3.6 and the following chapters.

3.4 The operational level of the WSS sector

3.4.1 The urban WSS sector

The decentralisation strategy for developing WSS services in urban areas resulted in the formation of 10 operating CUs[91] by the LAs to have the primary responsibility for developing and managing water supply, sanitation and sewage services on a commercial basis (National Decentralisation Policy, 2002; National Water Policy, 2004; Water Supply and Sanitation Act, 2007). The CUs have been established in all provinces, mainly with the support of the CPs (JSR, 2009; NWASCO Annual Report 2008/2009).

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[88] The LCMS distinguishes between shared and unshared pit latrines, but contains no information about the slab.

[89] For a further discussion on safe water supply and adequate sanitation definitions see chapter 3.6.1.

[90] Due to the fact that the MIS was not rolled out before the latest PAF agreement, also no baseline values were included.

[91] A new CU, Luapula WSC was formed for Luapula province, but is yet to become operational.

As already referred to, and in contrast to the medium and long term vision of cost covering operations, Figure 15 shows that, on average, CUs are not even able to cover their basic operation and maintenance costs by user fees. Compared with 2002, when the average O+M cost coverage rate was at 60%, the progress achieved was rather impressive up to 2007/08, although there always was a high variation between different CUs. However, the cost coverage rate declined between 2007/08 and 2008/09, partly due to the occurrence of some extraordinary expenditures. As already mentioned, the variance is high; currently only 3 CUs out of 10 (Mulonga Water and Sewerage Company (WSC), Southern WSC, North Western WSC) are able to cover their basic O+M costs (NWASCO Annual Report 2008/2009).

Figure 15: O+M cost coverage (in %)
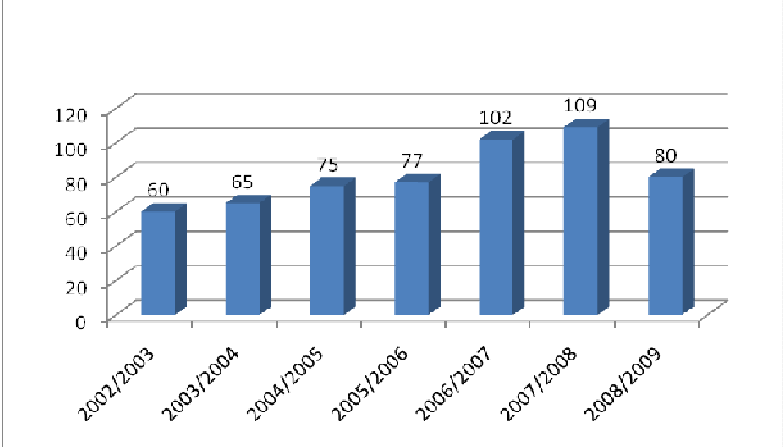
Source: NWASCO Annual Reports.

Nevertheless, according to NWASCO (2008/2009), the CUs have recorded some improvements in service delivery, as evidenced by better service coverage, more hours of supply, and higher metering ratios, among others (see Figure 16). However, it can also be seen in the figure that some major problems remain with respect to service delivery. First of all, unaccounted for water (UFW), which can be related to the dilapidated water infrastructure, is still extremely high with close to 45% and has only slightly improved over the last years. Second, the metering ratio is only slightly above 50% even though, for this indicator, improvements over time are clearly visible. Third, the collection efficiency of about 80% is better when compared to the metering ratio and UFW, but it is still far from an acceptable level. And fourth, the sanitation coverage of about 30% is still very low and has also not increased tremendously over the last years. It is obvious that the first three points are clear indicators of high inefficiencies contributing largely to the low O+M cost coverage rate. That foregone revenues, which are also referred to as hidden costs, are extremely high in Zambia, even compared to other sub-Saharan countries, is also reported by the AICD (2008).

Figure 16: NWASCO Benchmarks (2004 – 2009)
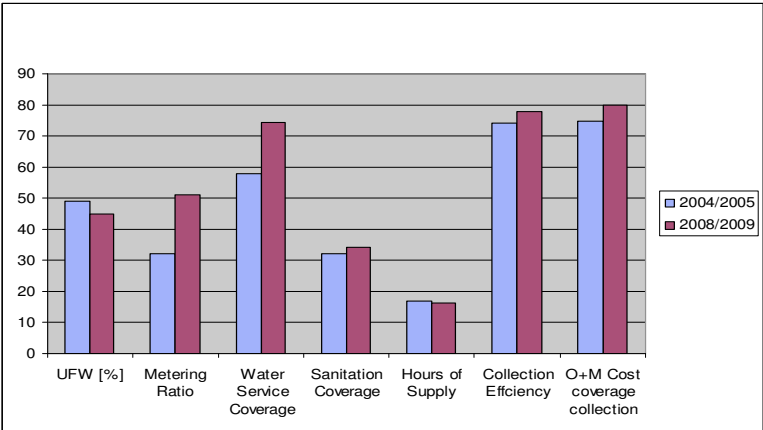
Source: NWASCO Annual Reports.

These problems show that exclusively via increasing tariffs, achieving cost coverage would not only be difficult, but would also not be sensible. Inefficiencies should be eliminated first or at least at the same time. Nevertheless, it is important that water tariffs reflect the economic costs of water as well which is why CUs continuously increased tariffs over the last decade. The tariff system itself is such that a block tariff system is applied with the aim of cross-subsidising poorer households with low water consumption by charging the better-off households who also consume more water higher tariffs. In reality, however, the cross-subsidisation mechanism of the block pricing system is limited. This is due to the fact that the difference between the lowest and the highest tariff band is quite small and therefore not sufficient to cross-subsidise the poor. Of course, it has to be taken into account that the possibility of cross-subsidisation is limited due to the low O+M cost coverage rate as well. The average tariff for the lowest band is ZMK 1,290/m³ (1-6 m³) and ZMK 1,772/m³ for the highest (>60 m³) which is a difference of about EUR 0.08[92] per m³ (NWASCO, p. 41, 2008/2009). According to NWASCO (2007, p. 35), "taking into consideration the sufficient amount prescribed by the WHO of 30 litres per person per day, households in Zambia spend about 3% for both water and sanitation services." Compared to that, the majority of high income earners pay a maximum of 5% of their income on water (NWASCO, p. 5, 2007).

Besides of the more technical limitations discussed, the fact that consumers are lacking the understanding, that the full cost of services should be covered by user fees, causes problems for collection efficiency as well (NWASCO, 2007). The MLGH (2010) reports that consumers rather spend money on food, electricity, transport, and mobile phones than on water. Furthermore, a significant number of higher-income households withdraw from cross-subsidising the poor (by paying block tariffs) as they possess own boreholes from which they draw their water free of charge, something which is still legal in Zambia.

Due to the commercialised focus of the CUs, expanding services to peri-urban areas, which, until very recently, had been lacking nearly any kind of WSS infrastructure, was not competitive and residents had to buy comparably expensive and low-quality drinking water from informal water vendors. Therefore, for assisting CUs to facilitate WSS service deliveries to peri-urban areas, the DTF was established in 2002, supporting CUs by subsidising initial investments in so-called water kiosks. Due to the DTF, in which CPs and GRZ pool their funds, the water supply coverage could at least almost keep up with the rapidly growing peri-urban compounds. With respect to sanitation, however, just very minor improvements can be reported for urban areas in general, and especially for peri-urban areas. Due to a NWASCO regulation, CUs have to invest 8% of their revenues ('ring-fenced funds') in sanitation, yet those funds have at least until now not been sufficient for improving the sanitary situation considerably. As peri-urban areas are frequently flooded for several months during the rainy season and available sanitation systems are far from being adequate, annual cholera outbreaks occur which are aggravated by the high population density in those areas (see Chapter 3.9). Discussions about adequate standards for sanitation systems are still ongoing, albeit several pilot studies testing adequate toilet and waste disposal systems have been implemented.

Even if CUs would continue to increase tariffs and collection efficiency, the necessary infrastructural investments (rehabilitation of pipe and sewerage network, installation of meters etc.) would require significant additional sources of funding. Replacing the dilapidated infrastructure and expanding adequate water services to 80% and proper sanitation systems to 70% of the urban and peri-urban population would require roughly USD 1 billion until 2015[93] (draft PER 2010; SNDP; MLGH, 2010), which obviously cannot be borne by CUs alone. Therefore, under NUWSSP negotiations, recommendations on financing mechanisms and associated organisational structures and arrangements are currently under discussions (MLGH 2010).

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[92] Exchange rate: 4 August 2010.

[93] This is the equivalent of 6 to 8% of per capita GDP (draft PER 2010, p. 13).

3.4.2 The rural WSS sector

The operational responsibilities for providing WSS services in rural areas lie with the D- and V-WASHEs). The system itself is supposed to be community-driven with the V-WASHEs being sub-components of the Village Development Committees. The MLGH provides special grants, besides of CPs' earmarked project aid, in support of WASHE activities to Rural Water and Sanitation Units through the LAs. However, the (marginal) district plan lump sum grants are usually not earmarked for sub-sector use and are therefore not a reliable source of finance. Thus, most of the investments in rural areas, which focus on the drilling of new boreholes, are financed by CPs through the MLGH and the LAs. Following the NRWSSP, 3,900 new boreholes have been constructed during the last three years.[94]

In order to standardise borehole construction, the MLGH sets certain quality standards within the NRWSSP framework by specifying a limited set of hand pumps which should be installed (e.g. India Mark II).[95] This procedure should simplify nationwide spare part provision and allows for standardised community training programmes. Furthermore, it most likely will lead to more uniformity in unit costs which varied significantly in the past.

More precisely, the cost margin varies between EUR 2,300 for so-called emergency drillings and EUR 20,000 for fully-fledged borehole constructions (Table 18). Yet, it should be noted that the indicated prices just reflect rough estimates by different CPs who use different methods of calculating these costs. This could lead to major differences, last not least due to variance in the attribution of fixed and overhead costs. Some of the variance might be driven as well by differences in the modalities used by CPs and NGOs for contracting drilling companies and differences in hardware quality (use of improved wear parts etc.). An in-depth analysis of actual causes of variance in unit costs was not carried out by the evaluators.

Table 18: Unit costs for rural boreholes

	Unit costs in EUR[96]
GRZ[97]	average: 8.000
Donors	12.000 - 20.000
Emergency Drillings	2.300 – 3.000
Private (urban) Boreholes	*> 2.000*

Source: CP estimates.

The constructed boreholes are handed over to the communities and are administered by water point committees (V-WASHEs). The communities are supposed to contribute in some way to borehole investments (working hours, materials or small amounts of money). They are also expected to provide funding for O+M investments. An elaborate maintenance plan assures that at least basic maintenance work can be organised by the communities themselves. As a result of the CP alignment process, to guarantee an adequate supply of spare parts, JICA's rural water sector O+M programme (Sustainable Operation & Maintenance System (SOMAP)) has been adapted for the entire sub-sector. Spare parts are made available for reasonable prices on the district level. During the evaluation mission, no shortage of spare parts was reported. The communities indicated that the prices for smaller spare parts are perceived to be fair. The Area Pump Menders are trained on the district level to support the repair of broken water points and act as a distributor of spare parts while minor maintenance repairs are carried out by water point committee caretakers (JSR, p. 97, 2009).

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[94] Draft water chapter of the Sixth National Development Plan.

[95] For instance, the MLGH refused an offer of USAID to provide drinking water to rural schools because they wanted to use a different than the NRWSSP standard hand pump.

[96] In prices of 2009.

[97] NRWSSP, final draft, April 2007.

In addition to the quality of borehole construction itself, effective community participation has emerged as a key factor for sustainable safe water supply. Community commitment is fostered by intensive training measures, comprising inter alia the following topics: organising water point committees (incl. revenue collection for O+M), adequate usage of hand pumps, health and hygiene components, etc. Nevertheless, due to a lack of financial and personnel resources on the district level, follow-up trainings can usually not be carried out, endangering the sustainability of improved water supply. Due to a lack of commitment, some communities struggle to finance even minor maintenance operations. Funding for major rehabilitation measures constitutes a considerable problem for all. Nevertheless, besides of the problems regarding the financing of major rehabilitation measures, the water point committees visited during the evaluation mission assessed the V-WASHE approach to be successful. As for the urban water sector, however, major subsidies to improve and expand services to the rural sector are required. Due to the lack of personnel resources on the district level, the low coverage rates and the fact that a permanent exchange with and education of the target group is necessary, expanding services to rural areas might be even more challenging than in urban areas.

While the costs for urban sanitation should in principle be covered by the user fees collected by the CUs for water consumption, rural sanitation costs are intended to be covered by households themselves. Nevertheless, the national hand washing campaign (NRWSSP, 2009) which focuses on encouraging rural households to build pit latrines at their own expenses has not effectively been rolled out yet. With respect to the provision of so-called adequate sanitation facilities for rural areas (unshared pit latrines with a slab), the positive expected impacts on the living conditions may also be endangered due to nitrite and nitrate (yellow water) aquifer (ground water) infiltration in the long run (see Chapter 3.9). UNICEF will take the responsibility to roll out a programme for constructing pit latrines.

3.5   Effects of access to improved WSS on livelihoods

Having access to improved water supply and sanitation is presumed to have various positive effects on household welfare. The typical impact channels of water supply and sanitation focus on health benefits and time savings for fetching water (first round effects), the latter with particular importance for rural areas (Bartram et al., 2005; Hutton et al., 2006). Access to safe drinking water and adequate sanitation is closely linked to the health situation of households in developing economies. Worldwide, about 2 million deaths per year are reported to be caused by water borne diarrhoeal diseases (UN, 2008; World Bank, 2010). Less diseases and closer drinking water facilities are in turn supposed to lead to more time for income generating activities and to higher school attendance rates (Hutton et al., 2006; World Bank, 2008c). Furthermore, women are expected to benefit most from the time savings as the burden of fetching water falls disproportionately on them, also in Zambia (Hutton et al., 2006; DHS 2007; World Bank, 2008b).

The empirical evidence shows that piped water infrastructure reduces child mortality, mainly through reducing diarrhoea (Curtis and Cairncross, 2003; Fewtrell et al., 2005; Zwane and Kremer, 2007). For the rural and peri-urban poor, however, safe drinking water is usually provided through community-level infrastructure which seems to be less effective in reducing diarrhoea (Zwane and Kremer, 2007; Kremer et al., 2009; World Bank, 2008b). The reason for this finding is that the water is often not safely transported or stored so that the initially clean water is again contaminated. Point-of-use water treatment can therefore be necessary and effective for improving the quality of household drinking water (DHS, 2007; Zwane and Kremer, 2007; World Bank, 2008b; Kremer et al., 2009). Due to these contamination problems, several studies indicate that hygiene improvements through the provision of adequate sanitation or hand washing might lead to stronger positive effects on child health compared to the effects of safe water alone (Esrey, 1996; Root, 2001; Fewtrell et al., 2005; World Bank, 2008b). With respect to time savings, a study by the GTZ (2008) for Zambia reported improvements especially for girls in peri-urban areas due to improved access to water.

3.6 Descriptive analysis based on LCMS 1998 and 2006 survey data

3.6.1 The water and sanitation sector in the LCMS

The analysis of the LCMS data focuses on the rural and peri-urban areas in Zambia where an over-proportionate share of the poor population is living. The reason is that access to improved WSS is much lower in those areas compared to urban environments where access to such facilities can be considered as acceptable. Therefore, the potential impact of providing access to safe water and/or adequate sanitation is likely to be considerably higher in rural and peri-urban areas.

Within the LCMS, it can be differentiated between various water sources: river/lake/stream, unprotected well, water bought from vendors, protected well, pumped water, borehole, public tap, and own tap. Among those water sources, the following can be classified as safe and unsafe, along the UN/WHO definition for safe water (2004):

Table 19: Classification of water sources

Improved facilities	Non-improved facilities
Protected wells	Rivers
Pumped water	Lakes/streams
Boreholes	Unprotected wells
Taps	Water vendor

Source: LCMS, 2006.

Whereas the definition of safe water is certainly adequate for (peri-)urban areas, it needs to be adapted for the analysis in rural areas. Due to the fact that piped/tap water can barely be found in rural areas and more importantly, that protected wells[98] are more prone to contamination than boreholes, a simple analysis of the effect of safe water according to the LCMS definition (Table 19) is likely to lead to biased results. The reason why protected wells are considered to be less safe compared to boreholes is that they are not sealed and usually covered by removable slabs which means that for fetching water, the well needs to be uncovered offering several contact points for contamination, e.g. through dirty buckets, wire ropes, insects, etc. Therefore, it was decided to analyse the effect of boreholes separately and in addition to the effect of safe water according to the LCMS definition.

With respect to sanitation and referring to the DHS (2007) and the WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation (2004), improved sanitation technologies are defined as follows: flush toilet, ventilated improved pit latrine, traditional pit latrine with a slab, or composting toilet. In order to fulfil the requirements of an improved facility, the toilet can only be used by members of one household (i.e., it is not shared) and, in addition, the waste has to be separated from human contact.[99]

The toilet facilities included in the LCMS are: own flush toilet inside the house, own flush toilet outside the house, communal/shared flush toilet, own pit latrine, communal pit latrine, neighbours' pit latrine, bucket/tin/other container, aqua privy, and other. Thus, using the LCMS categories available and taking the UN/WHO definition of adequate toilets into account, safe toilets were defined as flush toilets, unshared pit latrines, or aqua privies.[100]

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[98] Protected wells are — like boreholes — not widely used in peri-urban areas.

[99] Differing from these definitions, the LCMS only considers own flush toilets to be safe, which are, however, barely available in rural areas.

[100] The only information missing in the LCMS questionnaire is whether the pit latrines have slabs or not.

3.6.2 Poverty and access to safe water in rural and peri-urban areas

As became apparent in Chapter 3.3, more than half of the rural population draws water from an unimproved source according to the LCMS while twice as many (peri-)urban residents (87% compared to 41%) had access to safe water in 2006. However, access to safe water sources is also connected to household income as can be seen in **Figure 17** which depicts the water supply source used by households in rural areas along poverty quintiles. The figure shows that progress in terms of improving access to safe water in rural areas has been unequal. For the poorest households (1st quintile), in 2006, the predominant sources of safe water supply were boreholes (25%) followed by protected wells (8%). In 1998, just 15% had access to boreholes, 13% used protected wells while another 3% used public taps. Even though access to safe water sources remained more or less unchanged over time (2%-increase), in the poorest two quintiles, the 'relatively unsafe' safe water source 'protected wells' was replaced by boreholes. In comparison, 66% of the richest quintile had access to safe water in 2006 which also came from far better infrastructure in terms of taps and boreholes compared to the poorest two quintiles. The predominant water sources used by the comparatively richest households were boreholes (29%), own taps (18%), public/other taps (8%), and protected wells (11%). Furthermore, access to safe water for the wealthiest rural residents also increased by about 25 percentage points between 1998 and 2006.

Figure 17: Source of water supply by consumption quintile in rural areas of Zambia
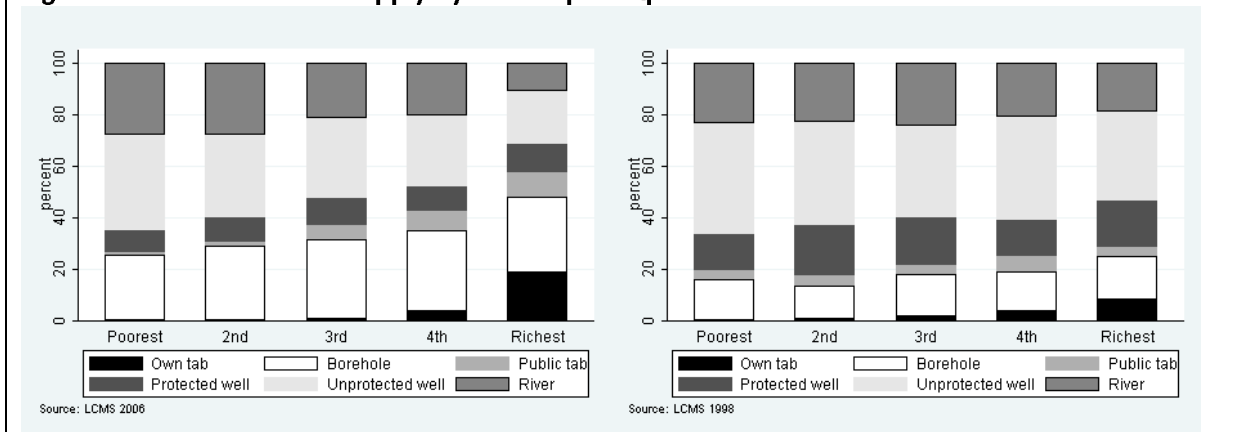
For peri-urban areas, **Figure 18** shows that access to safe water is correlated with poverty as well. More precisely, while slightly more than 60% of the poorest peri-urban residents (1st quintile) had access to safe water in 2006, for the richest peri-urban residents, this figure was close to 100%. Compared to 1998, access to safe water has remained fairly constant for the richest households while in the poorest quintile, even a slight deterioration in access rates can be observed.

Figure 18: Source of water supply by consumption quintile in peri-urban areas of Zambia
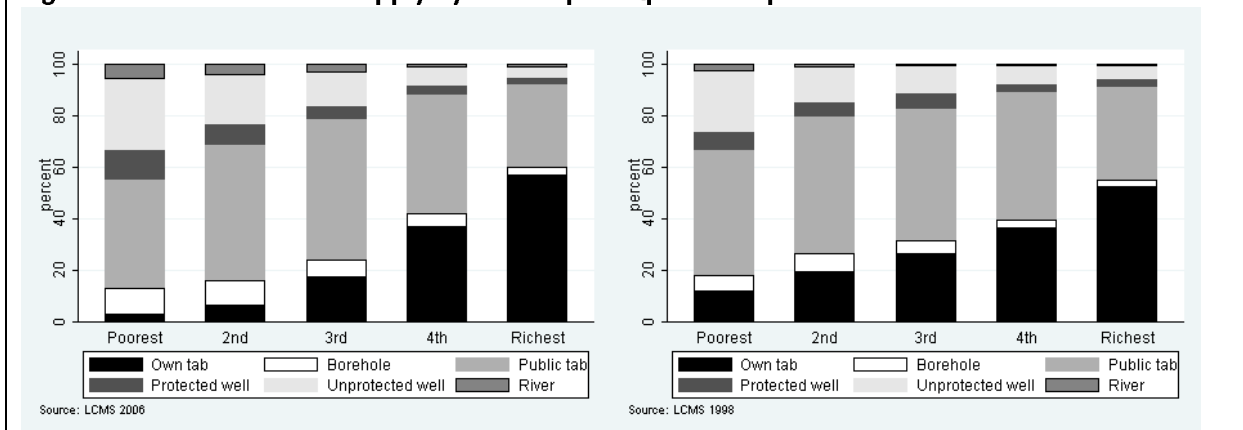
Figure 19 displays the percentage distribution of households by access to safe drinking water and by poverty for the different provinces in Zambia. The figure indicates that there seems to be a correlation between access to safe water and poverty on the province-level as well. Comparably richer provinces like Lusaka and the Copperbelt can be classified as having good access to safe water while in poor remote provinces like Serenje and Shangombo, only a low percentage of households has access to safe drinking water. Yet, it can also be seen that in some of the poorest provinces (e.g. Shesheke) access to safe water supply is better than in some richer provinces (e.g. Lufwanyama) reflecting, most likely, the preference of CPs to target especially some of the poorest areas.

Figure 19: Percentage distribution of households by access to safe drinking water sources and poverty
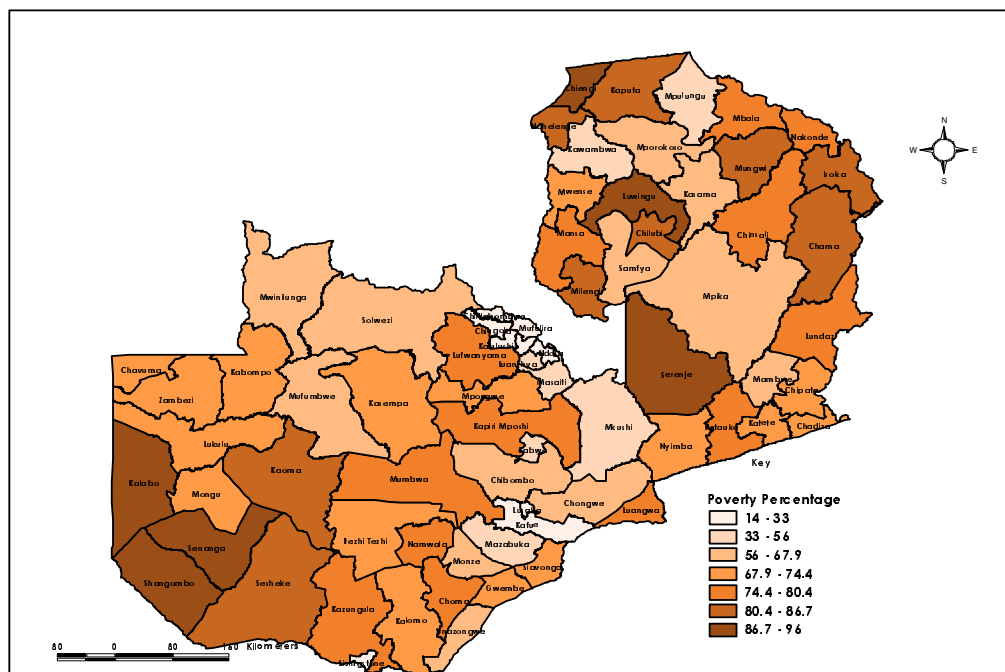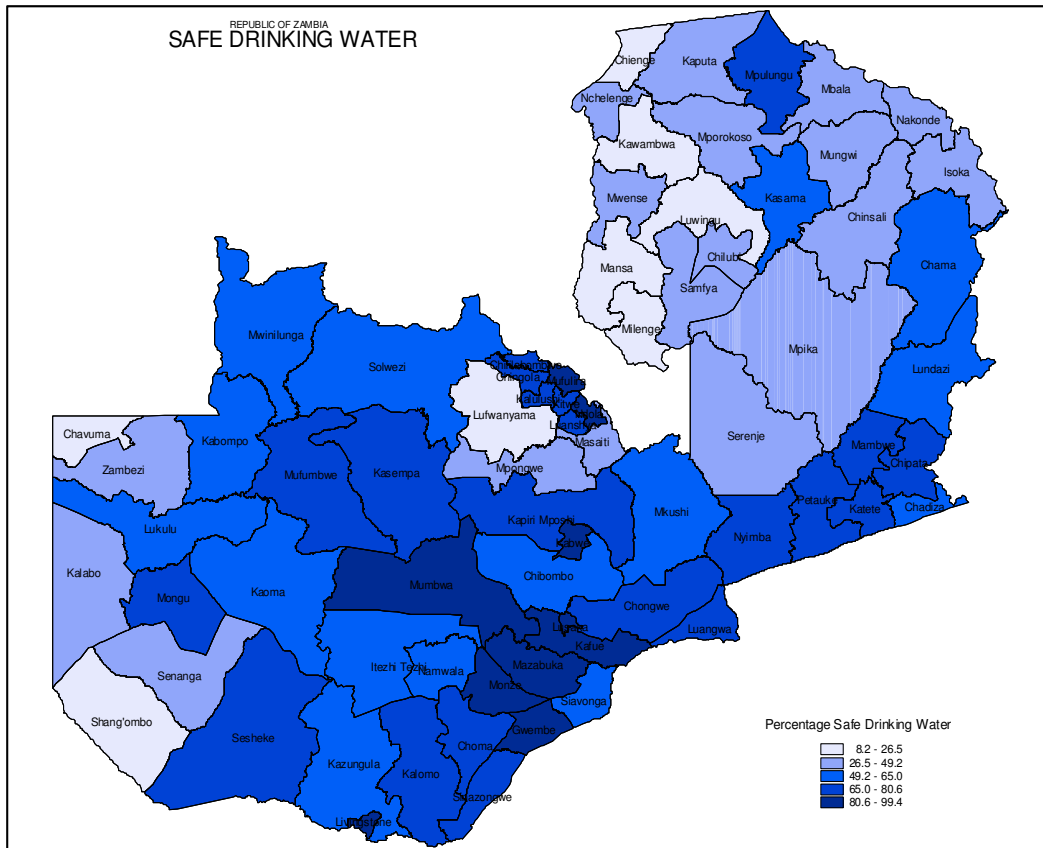
The findings thus indicate that indeed, a correlation between access to safe drinking water and poverty exists. What causes what is less clear, however, as it may not only be the case that having access to safe drinking water leads to higher household welfare, but also that richer provinces and households are more likely to receive or just have access to safe water. The issue of causality will be addressed in more detail in the impact analysis below.

3.6.3 Treating water

In case households do not have access to safe drinking water, water treatment (e.g. boiling water or adding chlorine) is one of the best precautionary measures that can be taken to avoid water borne diseases. However, even though water treatment is crucial for ensuring adequate water quality, just very few households in Zambia take these precautions. Table 20 displays the percentage of households treating their water in rural and urban areas differentiated according to whether they have access to safe water or not. As protected wells are considered by the evaluators to be less safe than boreholes, for this analysis, safe water supply just refers to boreholes or taps.

Table 20: Water treatment in rural and urban areas

	Households with access to safe WS	Households without access to safe WS
2006		
Rural	24.58%	21.98%
Urban	57.65%	56.32%
1998		
Rural	22.89%	11.65%
Urban	41.20%	32.62%

Source: Own calculations based on LCMS 1998 and 2006.

As can be seen in Table 20, in 2006 only slightly more than 20% of households not having access to safe water supply in rural areas treated their water compared to 56% in urban areas. Interestingly, the share of households having access to safe water, but treating their water nevertheless, is higher than the share of those not having access to safe water. While the difference between rural and urban areas can probably be explained by differences in income and hygiene education, the latter indicates that even households having access to a better water source see a necessity to still treat their water. One explanation for this finding may be that the initially clean water is again contaminated between the source and the actual consumption so that water treatment remains necessary which would be in line with the literature (see Chapter 3.5). Nevertheless, the figures show that the number of households not treating their water even though it cannot be considered as clean is substantial in rural areas. In urban areas, the situation appears to be somewhat better, yet a considerable scope for improvement remains in those areas as well.

3.7 Impact analysis based on LCMS 1998 and 2006 survey data

3.7.1 Background

While Chapter 3.3 already indicated that the progress achieved with respect to improving access to safe water supply and sanitation has been low, it still has to be analysed whether in cases where households have access to safe water and adequate sanitation facilities, positive effects on the living conditions of the households can be found. Therefore, the potential effects of WSS on health and time savings (first round effects) as well as on education and poverty (second round effects) are analysed and discussed in the following.

The LCMS data allows for analysing the effects of various combinations of safe water supply and adequate sanitation (treatment variables) on a set of outcome variables which correspond to the above mentioned possible impact channels: diarrhoea prevalence, school attendance rates, share of households in poverty, and expenditure patterns. The same control variables have been used as for the empirical analysis in the roads sector (see Annex 6 for the regression results including all control variables).

3.7.2 Estimating the effect of safe water and adequate sanitation on living conditions in rural areas – panel regressions

Table 21 summarises the effects of the various WSS interventions on the outcome variables using the fixed effects panel regressions on chief area level. Statistically significant coefficients are marked in the table with *, **, and *** and are highlighted in bold.

As can be seen in the table, several treatment variables show statistically significant effects, however not for all types of WSS interventions and not for all outcome variables.

Table 21: Summary of panel regressions for WSS in rural areas

	Attendance rates:						Share of :			Expenditure per:	
	Primary school	Primary School - male	Primary school - female	Secon- dary school	Second. school - male	Second school female	extremely poor households	moderately poor households	non-poor households	capita	adult equivalent
1. Water Supply Share of hh with access to borehole	**0.17***	**0.23****	0.13	0.08	0.06	0.04	**-0.23****	**0.16****	0.07	**0.68****	**0.74****
	[2.60]	**[3.14]**	[1.70]	[1.40]	[0.88]	[0.66]	**[-3.50]**	**[3.41]**	[1.36]	**[4.61]**	**[4.99]**
Share of hh with access to safe water supply	**0.17****	**0.24****	0.09	0.05	0.02	-0.03	-0.11	0.01	0.10	0.11	0.11
	[2.94]	**[3.67]**	[1.29]	[0.93]	[0.25]	[-0.53]	[-1.72]	[0.28]	[1.96]	[0.78]	[0.78]
2. Sanitation Share of hh with access to safe toilet	**0.19***	**0.20***	**0.28****	**0.19****	**0.17***	**0.23****	-0.10	**0.14***	-0.04	0.27	0.29
	[2.60]	**[2.40]**	**[3.11]**	**[3.02]**	**[2.09]**	**[3.07]**	[-1.28]	**[2.59]**	[-0.66]	[1.50]	[1.59]
3. Combined Effect Share of hh with access to borehole and safe sanitation	**0.18***	**0.20***	**0.22***	0.05	0.08	0.08	**-0.28****	**0.22****	0.06	**0.68****	**0.74****
	[2.04]	**[2.04]**	**[2.07]**	[0.69]	[0.79]	[0.85]	**[-3.13]**	**[3.54]**	[0.81]	**[3.29]**	**[3.57]**
4. Water Treatment Share of hh treating drinking water	0.16	0.13	0.16	0.10	0.20	0.04	**-0.59****	**0.20****	**0.39****	**1.17****	**1.19****
	[1.68]	[1.21]	[1.44]	[1.19]	[1.90]	[0.41]	**[-6.55]**	**[3.19]**	**[5.55]**	**[5.20]**	**[5.28]**
Observations*	478	476	478	478	478	477	478	478	478	478	478

* – number of chief areas (1998 + 2006)
t statistics in brackets
* p<0.05, ** p<0.01, *** p<0.001

Due to an unspecific health-related LCMS question which only asked for the <u>main</u> sickness/injury of household members within the last two weeks prior to the survey, no reliable or interpretable first round health effects e.g. on diarrhoea prevalence could be found. Relying on the LCMS health data would imply a diarrhoea prevalence rate of below 1% for 2006 which is by far an underestimation. For instance, the DHS 2007 data indicates that the diarrhoea prevalence rate in Zambia is at 17%. This outcome variable is therefore ignored for the LCMS analysis. Nevertheless, diarrhoea as an

indicator for water borne diseases is captured in the analysis of the DHS 2007 data (see Chapter 3.8). Furthermore, rural health centres in the Eastern Province, Chipata District, reported drastic drops of diarrhoea with blood incidences[101] due to improved drinking water to the evaluation team.

In addition to this limitation, it is also hardly possible to find interpretable results on the other first round effect 'time savings' as the LCMS just provides information on whether access to water and sanitation improved and whether the intervention saved time or not. No information can be obtained on how much time was saved and what the intervention was which makes further analyses difficult.

The picture is clearer for the second round effects. A strong relation can be seen between the provision of boreholes – as one of the cleanest water supply sources – and the primary school attendance rates of boys, the share of households living in extreme poverty, and household expenditures. More specifically, if the share of households having access to boreholes increases by 1 percentage point, boys' school attendance rate increases by 0.23 percentage points according to the estimation results while the share of households living in extreme poverty is reduced by 0.23 percentage points. When analysing the effect of all water sources that are considered as safe by the LCMS, which includes the contamination-prone 'protected wells' as well, the observed effects weaken and just the significant positive effect on boys' primary school attendance remains. This supports the initial assumption that having access to water from boreholes is considerably better compared to water from protected wells as the effects mostly disappear when using the aggregate category 'safe water'.

Strong effects can be observed for sanitation as well. Having access to safe toilets has positive effects on primary and secondary school attendance. For safe sanitation, it is interesting to see that girls seem to benefit more with respect to school attendance compared to boys when having access to safe sanitation. The reason for this finding may be that girls benefit disproportionately from fewer illnesses in the household as they often have to care for the sick. Why this is not the case for clean water is subject to speculation, but it may be due to the fact that first, potential time savings due to less time needed for fetching water are not included in the effect of 'boreholes' or 'safe water' and second, adequate sanitation facilities may have a stronger effect on reducing illnesses compared to clean water. More precisely, the results indicate that if the share of households having access to safe sanitation increases by 1 percentage point, boys' primary school attendance rate increases by 0.20 percentage points while the attendance rate of girls increases by 0.28 percentage points. In addition, boys' secondary school attendance rate increases by 0.17 percentage points and the girls' rate by 0.23 percentage points, respectively. Admittedly, the reasons behind the different effects found for girls and boys are not fully understood. It cannot be ruled out that regarding school attendance we pick up an effect of improved sanitation in schools which is correlated with improved water supply and sanitation of households nearby.

Having access to both, boreholes and safe toilets, seems to reduce extreme poverty even more effectively. Besides of the positive effects on primary education and household expenditures, extreme poverty is reduced by 0.28 percentage points per 1 percentage point additional access to both, water supply and sanitation. The effect on secondary education becomes insignificant, however.

Besides of the mere provision of infrastructure, e.g. boreholes and safe toilets, the importance of understanding and utilising basic hygienic principles are reflected in the extremely strong effects of water treatment on reducing poverty and raising household expenditures. If the percentage of households treating their water increases by 1 percentage point, the share of extremely poor households decreases by 0.59 percentage points and even the share of the non-poor goes up by 0.39 percentage points. In those regressions, the type of water source is controlled for as well, as the effect of treating water will naturally depend on the type of water source available (Jalan and Ravallian, 2003).

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[101] Diarrhoea with blood is considered to be one of the diseases that can most easily be attributed to contaminated drinking water.

Table 22: Development of outcome and treatment variables for WSS over time

	1998 mean values [%]	2006 mean values [%]	Difference [%]
Outcome Variables			
Primary school attendance rate	59.1	71.2	+12.1
Primary school attendance rate male	60.2	71.6	+11.4
Primary school attendance rate female	58.8	70.6	+11.8
Secondary school attendance rate	13.8	23.6	+9.8
Secondary school attendance rate male	15.1	26.3	+11.2
Secondary school attendance rate female	12.6	21.4	+8.8
Extreme poverty	66.0	47.6	-18.4
Moderate poverty	12.3	25.7	+13.4
Non poverty	21.7	26.8	+5.1
Treatment Variables			
Borehole	14.1	27.7	+13.6
Safe water	35.2	40.5	+5.3
Safe toilet	58.1	67.7	+9.6
Borehole and safe toilet	7.2	18.2	+11.0
Water treatment	10.8	19.5	+8.7

Source: LCMS, 1998, 2006, own calculations.

Although the list of covariates is already comprehensive as it is controlled for access to electricity etc. (Appendix 6), some other potentially influential variables such as access to roads have not been included. In case boreholes were constructed in areas which have been very well connected to a good road network due to convenience reasons, the positive effects on income and education would have been overestimated, even though the estimated effects of access to roads on the outcome variables have been comparably smaller (Chapter 2.7.2). Due to the mentioned limitations, the estimated effects should not be seen as exact estimates, but more as an indication for the directions of impact. Furthermore, even though the poverty reduction effects of WSS are a result of careful econometric analyses and are contingent on a number of important control variables that also have an effect on income, it cannot be completely ruled out that reverse causality remains a problem in this case. This would imply that the effects on poverty reduction are potentially biased and may be considerably lower than indicated by the regression results.

In order to compare the estimated effects from the panel regressions to the changes that occurred with respect to the treatment and outcome variables, Table 22 depicts the mean values of all relevant variables for 1998 and 2006 and their changes over time using the LCMS data. Table 22 shows that at least for the second round outcome variables, the mean values increased for all rural residents between 1998 and 2006. In the following, the aim is to illustrate how much of the changes in outcome variables (like school attendance and poverty) between 1998 and 2006 can approximately be attributed to the changes in access to WSS (treatment variables).

For calculating the aggregate effects of the WSS interventions on the outcome variables, the average increase in the treatment variables is multiplied with the calculated net effect on the outcome variables from the panel regressions. For instance, for boreholes, Table 22 shows that the share of

households in the chief areas having access to boreholes increased from 14.1% in 1998 to 27.7% in 2006, implying an increase of 13.6 percentage points. Multiplying this change by the effect of having access to boreholes on extreme poverty (-0.23) yields a net effect of 3.13 percentage points. Relating this change to the drop in extreme poverty between 1998 and 2006 by 18.4 percentage points implies that there has been a considerable contribution to poverty reduction through the provision of boreholes according to these estimates. Similar calculations can be made for other treatment and outcome variables. For instance, according to the estimates, girls' primary school attendance rate increased by 2.42 percentage points due to the improvements in access to both, boreholes and safe toilets, which again is a sizeable effect compared to the general increase of 11.8 percentage points (Table 22).

To sum up, the effects show that safe water (incl. water treatment) and adequate sanitation lead to positive second round effects on education and poverty reduction in rural Zambia with the limitations discussed above. It is interesting to mention that the only significant effects on girls' school attendance can be attributed to access to safe toilet facilities as the combined effect of safe water and adequate sanitation is also likely to be driven by the sanitation component.

3.7.3 Estimating the effect of safe water and adequate sanitation on living conditions in rural areas – propensity score matching

Analogous to the roads sector analysis, propensity score matching was used as a second method to check the results of the panel regressions for robustness. This method was again applied separately to the 1998 and 2006 datasets, separately to each type of WSS intervention (treatment variable), and separately according to the level of poverty of the households. A summary of the statistically significant effects is shown in Table 23, all results are presented in Annex 7.

The results for the 2006 PSM (Table 23) analysis confirm the positive water and sanitation effects on education. All relevant interventions lead to an increase in primary and secondary school attendance rates. To illustrate: Having access to safe water and/or sanitation raises the primary school attendance rate by 3.55 – 6.47 percentage points, whereas the secondary school attendance rate increases by 4.33 – 9.12 percentage points, respectively. Safe sanitation has again the strongest effect on school attendance rates, especially for girls. Except for boreholes, all interventions lead to a decrease in extreme poverty (between 3.09 – 11.45 percentage points depending on the intervention). And again, the strongest effect on poverty reduction can be attributed to water treatment.

The results for the 1998 data are quite similar. However, while the effects on school attendance rates are slightly stronger, less significant effects on poverty can be found. For all types of interventions, the attendance rates increase by 4.27 – 15.24 percentage points for primary and by 5.86 – 12.14 percentage points for secondary school attendance.

As for roads, the separate analysis for the different poverty levels of the households (extreme poverty, moderate poverty, no poverty) show similar effects compared to the above described results for all rural households, although the effects are weaker. Interestingly, however, the effects of WSS in this more nuanced analysis are stronger for the extremely and moderately poor than for the non-poor. For the non-poor households nearly no significant effects of access to improved WSS could be found.

Table 23: Summary of statistically significant effects for all rural households – propensity score matching WSS

2006

1998

1. treatment: borehole

	Treated	Controls	ATT	Tstat		Treated	Controls	ATT	Tstat
Primary school attendance rate	73.14	68.57	4.57	3.33	Secondary school attendance rate	20.81	14.50	6.31	3.65
Prim school attend rate male	72.72	69.23	3.49	1.97	Second school attend rate male	24.02	16.54	7.48	2.94
Prim school attend rate female	74.16	69.18	4.98	2.82	Second school attend rate female	18.37	13.37	5.00	2.33
Secondary school attendance rate	28.73	24.40	4.33	2.78	Moderately poor	10.29	12.67	-2.38	-2.30
Second school attend rate female	27.85	23.68	4.17	2.02					

2. treatment: safe water source

	Treated	Controls	ATT	Tstat		Treated	Controls	ATT	Tstat
Primary school attendance rate	73.31	69.76	3.55	2.33	Primary school attendance rate	65.94	61.67	4.27	2.66
Prim school attend rate male	73.38	69.47	3.91	2.21	Prim school attend rate female	66.93	61.02	5.91	2.89
Secondary school attendance rate	29.90	25.37	4.53	2.86	Secondary school attendance rate	21.08	15.22	5.86	4.36
Second school attend rate male	33.82	24.99	8.83	3.62	Second school attend rate male	23.38	17.13	6.26	3.32
Second school attend rate female	29.08	24.89	4.19	1.98	Second school attend rate female	19.05	11.34	7.71	4.71
Extremely poor	38.31	43.62	-5.31	-3.94	Non-poor	26.26	23.47	2.79	2.39
Non-poor	34.50	31.03	3.47	2.85					

3. treatment: safe toilet

	Treated	Controls	ATT	Tstat		Treated	Controls	ATT	Tstat
Primary school attendance rate	72.29	65.82	6.47	3.12	Primary school attendance rate	65.65	50.40	15.24	7.33
Prim school attend rate male	72.31	66.34	5.97	2.22	Prim school attend rate male	65.96	51.30	14.66	5.40
Prim school attend rate female	73.11	64.73	8.39	3.10	Prim school attend rate female	66.07	50.27	15.80	5.75
Secondary school attendance rate	26.42	17.30	9.12	4.73	Secondary school attendance rate	19.58	7.43	12.14	8.76
Second school attend rate male	29.54	20.81	8.72	2.87	Second school attend rate male	21.99	8.84	13.16	6.26
Second school attend rate female	24.62	16.70	7.91	3.25	Second school attend rate female	17.76	6.46	11.30	6.42
Extremely poor	41.04	45.01	-3.97	-2.26					

4. treatment: borehole & safe sanitation

	Treated	Controls	ATT	Tstat		Treated	Controls	ATT	Tstat
Primary school attendance rate	75.82	70.03	5.79	3.98	Primary school attendance rate	70.21	65.59	4.62	2.10
Prim school attend rate male	74.87	70.22	4.65	2.40	Prim school attend rate female	70.85	65.10	5.75	2.10
Prim school attend rate female	77.06	70.03	7.04	3.79	Secondary school attendance rate	26.86	17.79	9.07	3.97
Secondary school attendance rate	33.14	27.06	6.08	3.50	Second school attend rate male	29.96	20.66	9.29	2.87
Second school attend rate male	34.96	29.42	5.54	2.33	Second school attend rate female	24.71	15.88	8.83	3.10
Second school attend rate female	32.57	26.55	6.02	2.59	Expenditures per capita	63612.25	41631.62	######	2.24
Extremely poor	37.56	40.65	-3.09	-2.18	Expenditures per adult equiv	69448.42	47278.93	######	2.23
Non-poor	35.24	32.56	2.68	1.96					

To sum up, both methods (panel and PSM) confirm that having access to safe water and sanitation leads to an increase of primary and secondary school attendance rates in rural areas. Furthermore, water and sanitation interventions (incl. water treatment) seem to have a positive impact on reducing poverty even though, as was mentioned above, reverse causality may be an issue for the effect of WSS on poverty reduction.

3.7.4 Estimating the effect of safe water and adequate sanitation on living conditions in peri-urban areas – propensity score matching

In addition to the analysis for rural areas, propensity score matching was also applied in peri-urban areas. For the fixed effects panel regressions this was not possible due to too few observations. As PSM is applied at the individual level, however, the number of observations is sufficient for analysing the effects in peri-urban areas as well. A summary of the statistically significant effects is shown in Table 24, all results are presented in Annex 8.

The 2006 PSM results for the peri-urban areas are partly inconsistent with the assumed impact channels. While the share of children going to school increases with having access to safe toilets (7.83 percentage points for primary schools; 8.89 percentage points for secondary schools), the share surprisingly decreases when having access to safe water sources (5.03 percentage points for primary school; no significant effect for secondary schools). The reason why the results for peri-urban areas are less clear cut than those for rural areas may be that the socio-economic living conditions are far more complex and some factors having an effect on health, education, or income, e.g. population density, migration, floods and stagnant water during the rainy season, cannot be controlled for.

However, the effects of water and sanitation interventions on poverty are in line with the previous analyses. Poverty decreases with improved access to safe water and toilets. For example, the share of extremely poor households decreases by 5.97 percentage points and the share of moderately poor households by 5.34 percentage points, if safe water is available.

The positive effects of treating water are again verified by the results. Households who treat their water are, on average, less poor and have more children attending secondary school compared to households who do not treat their water. When looking at the peri-urban households in the 1998 dataset, the results are mainly validated, i.e. water and sanitation interventions increase school attendance rates and lower extreme poverty.

Table 24: Summary of statistically significant effects for all peri-urban households – propensity score matching WSS

2006   **1998**

1. treatment: safe water source

	Treated	Controls	ATT	Tstat		Treated	Controls	ATT	Tstat
Primary school attendance rate	78.8	83.84	-5.03	-2.02	Secondary school attendance rate	32.93	23.4	9.54	2.32
Extremely poor	9.23	15.21	-5.97	-2.63	Second school attend rate male	35	21.63	13.37	2.5
Moderately poor	16.59	21.93	-5.34	-2.3	Extremely poor	32.25	46.34	-14.09	-3.54
Non-poor	74.17	62.86	11.31	4.19	Non-poor	47.75	39.18	8.57	2.34

2. treatment: safe toilet

	Treated	Controls	ATT	Tstat		Treated	Controls	ATT	Tstat
Prim school attend rate female	81.25	73.43	7.83	2.38	Primary school attendance rate	76.48	65.54	10.95	3.37
Secondary school attendance rate	52.69	43.8	8.89	2.32	Prim school attend rate female	76.15	65.28	10.87	2.76
Second school attend rate male	54.26	39.63	14.63	2.51	Secondary school attendance rate	34.68	17.6	17.08	5.14
Expenditures per capita	212251.45	172434.4	39817.1	4.42	Second school attend rate male	36.54	24.6	11.94	2.26
Expenditures per adult equiv	234120.46	193645.3	40475.2	4.39	Second school attend rate female	33.23	13.81	19.41	4.69
Moderately poor	17.71	22.95	-5.24	-2.84					
Non-poor	70.48	65.13	5.35	2.47					

3. treatment: safe water & safe sanitation

	Treated	Controls	ATT	Tstat		Treated	Controls	ATT	Tstat
Expenditures per capita	227415.21	206043.9	21371.28	3.11	Secondary school attendance rate	37.55	23.88	13.67	4.9
Expenditures per adult equiv	250124.82	228572.6	21552.23	3.06	Second school attend rate male	39.3	28	11.3	2.73
Extremely poor	9.41	11.98	-2.57	-2.23	Second school attend rate female	34.72	21.36	13.36	4.06
Non-poor	74.21	69.72	4.5	2.91	Extremely poor	34.1	39.11	-5.01	-2.4
					Moderately poor	19.96	16.37	3.59	2.08

4. treatment: water treatment

	Treated	Controls	ATT	Tstat		Treated	Controls	ATT	Tstat
Secondary school attendance rate	56.99	52.1	4.88	2.5	Extremely poor	24.47	32.08	-7.61	-5
Second school attend rate male	59.55	54.16	5.38	2.03	Non-poor	56.52	48.24	8.28	4.94
Expenditures per capita	256050.6	205747.8	50302.84	7.11					
Expenditures per adult equiv	281807.25	227999.8	53807.49	7.47					
Extremely poor	6.46	9.7	-3.24	-3.4					
Moderately poor	13.88	16.4	-2.53	-2.25					
Non-poor	79.66	73.89	5.77	4.37					

3.8　Impact analysis based on DHS 2007 survey data

3.8.1　The water and sanitation sector in the DHS

Compared to the LCMS, the DHS uses similar categories for safe, respectively unsafe water sources (river, borehole, protected well etc.). The difference between the surveys is, however, that the DHS subsumes the water sources protected well/borehole in yard/plot in one category. The collectively used borehole is not recorded at all which makes it difficult to compare the two data sources and to correctly describe the water supply situation in rural areas using the DHS data.

The toilet facilities included in the DHS 2007 are presented in Table 25 and are even more disaggregated than the LCMS categories, allowing again for a differentiation between safe and unsafe sanitation facilities. The categorisation of safe and unsafe facilities is, as the LCMS categories, in line with the WHO/UNICEF (2004) definitions.

Table 25: Classification of toilet facilities

Improved facility (not shared)	Non-improved facility
Flush/pour flush to piped sewer system	Any facility shared with other households
Flush/pour flush to septic tank	Flush/pour flush not to sewer/septic tank/pit latrine
Flush/pour flush to pit latrine	Pit latrine without slab/open pit
Ventilated improved pit latrine (VIP)	Hanging toilet/hanging latrine
Pit latrine with slab	No facility/bush/field
Composting toilet	Other

Source: DHS, 2007, p. 25.

3.8.2　Estimating the effect of safe water and adequate sanitation on living conditions in rural areas – propensity score matching with DHS data

Similar to the LCMS, the DHS data allows for analysing the effects of different water supply and sanitation interventions on the outcome variables diarrhoea prevalence, school attendance rates, and the share of households in poverty. The statistically significant effects are highlighted in bold in Table 26.

Compared to the prior LCMS analyses, the DHS results show the same impact directions of access to safe water and adequate sanitation for education and poverty. In addition, the DHS data offers better opportunities for analysing the effect on health, more precisely diarrhoea. Due to the fact that protected wells and boreholes are subsumed in one category, however, the effect of really safe water sources, i.e. boreholes, is likely to be underestimated. Nevertheless, the results show significantly positive effects on reducing diarrhoea with blood incidences for children younger than 60 months, the type of diarrhoea that is most likely to be indeed water borne. According to the results, households who have access to safe water sources have approximately half the incidence rate (1.79%) compared to those who do not have such access (3.41%). Although the statistical results for the aggregate category 'infant diarrhoea with and without blood (Diarrhoea <=60 months)' are insignificant, it can be seen that the prevalence rate of around 17% is substantial implying that diarrhoea is still a major health problem in Zambia.

Table 26: Summary of statistically significant effects (bold writing) for all rural households – propensity score matching WSS with DHS

Safe water

	Treated	Controls	ATT	Tstat
Diarrhea <=60 months	17.77	16.6	1.18	0.61
Diarrhea w/o blood <=60 months	15.99	14.41	1.57	0.86
Diarrhea with blood <=60 months	**1.79**	**3.41**	**-1.62**	**-2.21**
Primary school attendance rate	80.19	76.58	3.61	1.84
Prim school attend rate male	78.79	76.52	2.27	0.9
Prim school attend rate female	80.76	76.82	3.94	1.55
Secondary school attendance rate	**31.57**	**23.71**	**7.87**	**2.68**
Second school attend rate male	**30.88**	**21.85**	**9.02**	**2.4**
Second school attend rate female	29.99	26.95	3.04	0.74
Extremely poor	**41.57**	**54.64**	**-13.07**	**-6.27**
Moderately poor	**32.92**	**28.8**	**4.11**	**2.08**
Non-poor	**25.51**	**16.56**	**8.96**	**5.54**

Safe sanitation

	Treated	Controls	ATT	Tstat
Diarrhea <=60 months	14.44	16.34	-1.9	-0.85
Diarrhea w/o blood <=60 months	11.97	12.9	-0.93	-0.45
Diarrhea with blood <=60 months	2.47	3.62	-1.15	-1.17
Primary school attendance rate	84.32	81.5	2.82	1.12
Prim school attend rate male	85.86	82.11	3.75	1.19
Prim school attend rate female	84.26	82.02	2.24	0.68
Secondary school attendance rate	**39.18**	**29.17**	**10.01**	**2.22**
Second school attend rate male	37.36	28.92	8.44	1.52
Second school attend rate female	**40.07**	**24.72**	**15.35**	**2.53**
Extremely poor	**24.35**	**45.99**	**-21.64**	**-8.29**
Moderately poor	**38.15**	**31.22**	**6.92**	**2.51**
Non-poor	**37.5**	**22.79**	**14.71**	**6.04**

Safe water & safe sanitation

	Treated	Controls	ATT	Tstat
Diarrhea <=60 months	15.4	19.62	-4.21	-0.95
Diarrhea w/o blood <=60 months	15.03	16.68	-1.65	-0.38
Diarrhea with blood <=60 months	**0.38**	**3.36**	**-2.98**	**-2.82**
Primary school attendance rate	**89.78**	**80.52**	**9.26**	**2.21**
Prim school attend rate male	**92.73**	**77.63**	**15.1**	**2.86**
Prim school attend rate female	87.33	79.45	7.89	1.31
Secondary school attendance rate	56.03	43.17	12.86	1.84
Second school attend rate male	48.2	31.46	16.74	1.81
Second school attend rate female	59.87	47.59	12.28	1.25
Extremely poor	**6.62**	**28.55**	**-21.93**	**-5.73**
Moderately poor	23.53	21.08	2.45	0.52
Non-poor	**69.85**	**50.37**	**19.48**	**4.42**

The poverty reduction effects of safe water and sanitation from the LCMS regressions are confirmed by the DHS analysis. While 42% of the households having access to safe water are living in extreme poverty, 55% of the households not having such access are considered as poor. The results for safe sanitation and the combined effect of safe water and safe sanitation show similar results. Also educational effects can be demonstrated. The share of pupils attending secondary school with access to safe water (32%) is significantly higher than the share of those who just have access to unsafe water sources (24%). An even higher difference is reported for the treatment variable safe sanitation. The share of children attending secondary school when having access to safe sanitation (40%) is 10

percentage points higher compared to those who do not have such access (30%). Surprisingly, the combined effect of safe water and safe sanitation shows positive effects on primary school attendance while the effects on secondary school attendance are rendered insignificant.

3.9   Case study on micro-environmental impacts of WSS

Apart from the effects of WSS on livelihoods, it is clear that the types of WSS systems used can have a considerable effect on the micro-environmental conditions in the surrounding areas. Thus, in addition to the empirical impact analysis, a case study on the adequacy and the effects of the water supply and sanitation systems used in Zambia on micro-environmental conditions has been undertaken, the findings of which are summarised in the next sections.

3.9.1   Drinking water supply and waste water purification

Ground water pumps

In general, the maintenance and training of the user community are key to the life time of a pump and the impact of the drinking water gained from a ground water pump on the collective health of a community. Basic aspects such as the understanding that a pump should always be used standing in 90° to the pump's bar, or that the pumping place and the septic tank need to be protected against animals by an adequately high and strong fence, or that the entire surrounding of a pump has to be absolutely free of stagnant water are crucial for the long term functioning of a ground water pump. One of the biggest challenges of a ground water pump's user community is to find and maintain a sustainable functioning of a fair collective reinvestment system for the maintenance and the spare parts of a pump. Equally important is the understanding of the pump minder(s) that defects should be repaired early not to provoke secondary and often much more expensive damages on the pump system. All these different 'soft' components of a drinking water supply project from ground water depend strongly on a continuous, frequent and conscientious training of the pump minder and the user community and seem to be at least as important for the success of a sustainable and long term on-going provision of a community with safe drinking water as the material of the pump itself.

Teams that install and supervise ground water pumps in the communities often pronounced the need of 'low cost' and 'easy to handle' analysis kits that could help them to know the main chemical and microbiological parameters of each pump's water resources. The fact that there are only two laboratories capable of doing this kind of analyses in the whole country, both of them in the capital region, make many analyses difficult or even impossible to conduct. An adequate response to this problem could be the equipment of the supervision teams of ground water pump projects with portable photovoltaic analysis kits.

Ground and drinking water protection

The quality of drinking water gained from an aquifer strongly depends on the surface water that infiltrates from the surrounding of a ground water borehole and the purification capacity of the soil matrix of the aquifer. Especially the infiltration of nitrate and other toxic substances from pit latrines or septic tanks used for the evacuation of 'grey' and 'yellow' water from households without adequate (decentralised) purification systems can constitute a serious threat to the quality of the ground water. For this reason, European legislations prescribe ground water protection zones around and stream upwards from every ground water extraction point in which potentially contaminating activities are limited by law. In this context it is important to know the flow behaviour of the ground water extracted as aquifers in karstic underground (as is the case in the region of Lusaka) can flow much faster than aquifers in sandy or clayey soil. The fact that ground water flows very slowly should not lead to the assumption, however, that nitrate and other toxic compounds infiltrated into the aquifer will be eliminated with time; it just takes a long time until they will get to the next drinking water borehole – and an equally longer time to be removed from the aquifer once these compounds have contaminated a ground water borehole.

Unfortunately, at present only very little awareness can be observed about the problem of ground water contamination through infiltration of contaminated surface water among the Zambian population and authorities. The same can be said about the problem of contamination of stagnant rain water through excreta during the rainy season, which exposes big parts especially of the peri-urban population of Lusaka to an increased collective health threat (e.g. endemic cholera outbreaks).

Low cost water purification, rain water and waste water drainage

There exist different designs of 'low cost' and 'easy to maintain' water purification systems, both decentralised and centralised (end of pipe solutions with drainage systems), but it has to be pointed out that especially in peri-urban areas in low-income countries, conventional centralised approaches to waste water management have generally failed to address the needs of communities for the collection and disposal of domestic waste water and faecal sludge from on-site sanitation. However, there is proven effectiveness of very simple and economical decentralised drinking water purification systems that can be applied especially in rural zones to sterilise surface water contaminated by coli bacteria with PET bottles through sun radiation.

Another problem for the Lusaka region is – due to the up-coming of water closets in private households in the urban zone and the chaotic planning in the many fast growing peri-urban zones – that drainage systems of rain water and waste water are often designed in a much too small scale for the heavy precipitations during the rainy season with too little inclination to ensure the effective discharge into the purification plant.

3.9.2 Sanitation

Inadequate sanitation facilities

Human excreta are – amongst others – composed of nitrate, mainly contained in the urine, and phosphor, mainly in the faeces. Both compounds are essential fertilizers for agricultural production, but while phosphorus compounds adhere strongly to the soil matrix and are therefore highly immobile in the aquifer, nitrate is highly water soluble and an effective toxin for fishes and other aquatic fauna as well as humans and therefore represents a potential contamination for the aquifer and the drinking water gained from it.

Traditional and improved pit latrines, VIP latrines, sanplat latrines, and septic tanks – as they are generally constructed in Zambia – let the liquid part of excreta infiltrate into the surrounding soil matrix and the underlying aquifer and therefore constitute a long time threat to the collective health of the communities living around theses sanitary systems and consuming the ground water as drinking water. For this reason, it is more than questionable that some of the above mentioned sanitary systems (i.e. septic tanks, pour flush latrines, VIP latrines, urines diversion latrines, compost latrines, improved single-pit latrine) are considered in different strategic planning documents of GRZ (e.g. NUWSSP 2009 – 2030) as improved technologies, although they let the liquid fraction of the excreta sludge infiltrate.

Another type of latrine, mainly used in the peri-urban zone of Lusaka, comprises a storage tank which extends from 60 to 80 cm under the ground to app. 50 cm above the ground as part of the superstructure of the latrine. From time to time during the rainy season this tank is emptied directly into the streets, contaminating the stagnant rain water in the streets and causing endemic cholera outbreaks in these areas of the town. It is clear that this type of latrine is absolutely inadequate in all respects.

Excreta recycling

An intelligent and convenient solution for sanitation problems both in peri-urban and rural zones could be EcoSan latrines that automatically separate urine from faeces, store them in separate tanks that do not allow the toxic substances to infiltrate into the aquifer, and which – by sterilising them – make the excreta re-usable as fertilizer for agricultural production. Conventional EcoSan systems

have the disadvantage that they are way too expensive for the use in poor peri-urban areas, but it has to be pointed out that the EcoSan concept is not linked to a specific design of latrines and can also be achieved in an adopted form of 'low cost' EcoSan latrines especially developed for peri-urban contexts in sub-Saharan Africa.

In contrast to other regions in Africa or Asia, in Zambia the re-use of human faeces and urine seems to be a taboo, what makes a circle resource management directly within the private households difficult to promote. On the other hand, it is observed that a few groups of excreta recyclers exist in the bigger towns of Zambia, collecting, drying, and selling human excreta from private household pit latrines or WC's, or from public drying plants for evacuated excreta from hydraulic aspiration trucks. Thus, although the large-scale evacuation of pit latrines by "ordinary" citizens is unlikely in the Zambian social and cultural context, the large-scale management of private household's latrines and the recycling of the human excreta through well trained, organised and legally recognised professional manual toilet emptier groups could be an option to lead the Zambian excreta management to a more sustainable and healthier collective sanitary system.

3.10   Concluding assessment of the impact findings

In the past chapters, different analyses and results on the impact of safe water and adequate sanitation were presented. The following general findings emerge:

-   The econometric analyses of the LCMS and DHS data indicate that access to safe water and adequate sanitation has significant effects on health, particularly on reducing diarrhoea with blood incidences for children below the age of 60 months, on increasing school attendance rates of girls and boys, and on reducing the share of households living in extreme poverty. The effects were strongest if households had access to both, safe water and adequate sanitation, while effects of safe water in rural areas could only be identified for boreholes, implying that boreholes (beside piped water which is hardly available) are the only really safe source of drinking water in such areas. It can, however, not be ruled out that reverse causality plays a role at least for the effects of WSS on poverty reduction. Furthermore, some poverty effect might be picked up which is actually attributable to the degree of remoteness as access to roads was not introduced as a control variable.

-   Due to survey limitations, health effects could not be estimated with the LCMS data and are not entirely reliable for the DHS analysis either. This is unfortunate as health effects are the most directly attributable effects of WSS. More detailed survey instruments are therefore needed to allow for estimating the impact of access to improved WSS on diarrhoea in Zambia in the future. The same holds for the other potential first round effect 'time savings'.

-   In addition to the effect of improved water supply and sanitation infrastructure, sizeable impacts of water treatment could be found on the livelihoods of rural households as well. This suggests that water treatment can – at least in the short run and as long as no adequate WSS systems are available – be useful for improving especially the health situation of the population.

-   With respect to differential effects of WSS for extremely, moderately, and non-poor households, stronger effects emerged for the extremely and moderately poor compared to the non-poor suggesting that some distributional effects exist. Yet, the effects are not very different from the effects found in the combined analysis for all households indicating that differential impacts are probably not very pronounced.

-   For safe sanitation, the analyses suggest that girls benefit more when it comes to school attendance compared to boys indicating differential gender effects. The reason for this result may be that girls benefit disproportionately from fewer illnesses in the household as they often have to care for the sick. However, this is only one potential explanation.

- It is important to note that positive impacts of WSS are only possible if households have access to safe water and/or adequate sanitation. This implies that for a sizeable percentage of the population, the estimated effects are not existent. In general, while access to safe water is at an acceptable level in urban areas, access to adequate sanitation is considerably lower. In rural areas, access rates are not only low, but improvements have also been rather slow. Yet, the quality of infrastructure provided in rural areas has made progress over the last years with the share of households having access to boreholes increasing. However, more progress in the quality of water sources can be recorded for the more wealthy quintiles of the rural population.

- Finally, the case study in rural and peri-urban areas clearly showed that the type of toilet facility available has an effect on the micro-environmental conditions in those areas. If adequate toilet facilities were used, nitrate and nitrite infiltration could be prevented which is important for ensuring adequate environmental conditions in the long run.

4 Findings: Power

4.1 The power sector in Zambia

Zambia is a country which is richly endowed with various natural energy sources such as woodlands, forests, coal, and especially hydropower. The country's hydropower potential is estimated to be as high as 6,000 MW which compares to a total installed capacity of no more than 1,631 MW (ZESCO, 2010).[102] With over 99 percent, most of Zambia's electricity is generated from hydropower stations with the major sources being three large dams, namely Kafue Gorge, Victoria Falls and Kariba North Bank Power Stations, located on the Kafue and Zambezi rivers, respectively. With such a high potential for hydropower generation, Zambia could in fact be an exporter of electricity. Instead, in recent years it was importing electricity mainly from the Democratic Republic of Congo while still experiencing power shortages during peak hours.

The straightforward explanation for this finding is, of course, that power supply is not meeting demand. However, this excess demand is only apparent since the recovery of the mining industry after the year 2000. Before, the demand for power in Zambia was basically unconstrained by production capacity as production in the mines went down considerably in the 1970s due to low copper prices and management issues (Whitworth, 2010). Thus, even though non-mining demand increased fairly steadily over the years, it never rose that high that additional capacity would have been needed. Therefore, there has been no major addition to generation capacity in Zambia since the 1970s. However, due to rising demand from the mines over the last years this picture has changed and now additional capacity is needed.

Due to the low demand for electricity in the past, there was also no real incentive to charge tariffs which covered not only the operating, but the full costs of electricity generation. Thus, tariffs remained at levels which allowed for the coverage of operation and maintenance costs, but no additional return which could be used for new investments in the future was generated. Even today, power tariffs in Zambia are with USD 0.03 to USD 0.04 per kWh among the lowest in Africa (AICD, 2010, see also Figure 20).

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[102] See http://www.zesco.co.zm/ for detailed information on capacities.

Figure 20: Comparison of electricity tariffs across Africa
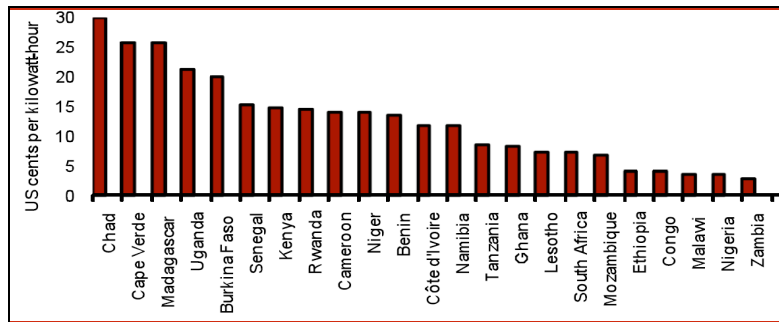
Source: AICD (2010).

In order to address the issue of excess demand, principally, there would be three options. The first one would be to import the additionally needed capacity from neighbouring countries such as DRC. As production costs in DRC are even lower than those in Zambia, this could even be a sensible strategy in more than only the short run. However, with such a large amount of untapped power generation potential, in the long run, opportunities for Zambia would be lost. The second option would be to address the demand side by increasing tariffs and being more diligent with metering power consumption. While this would not affect the demand from the mining industry, it could have an effect on domestic demand. However, as will be discussed below, still only 20% of the population is connected to the power supply system which implies that additional capacity would be needed if more households were connected to the system. Nevertheless, increasing tariffs is necessary, but mainly because they are not covering full costs. That leaves as the third option installing additional capacity which, however, requires high investments. Indeed, four major dams are currently planned which would contribute an additional 1,400 MW to the already installed capacity.[103] However, as power tariffs have been too low over the last years for generating any returns, investments, which are estimated by the World Bank to be as high as USD 2 billion, would either have to come from the public or the private sector or, of course, from the donor community. As most sectors in Zambia can be considered as under-funded, public investment at least on a large scale is unlikely. In fact, only a negligible amount of the budget (less than 1 percent) is flowing into the energy sector. Beside donor-financing this leaves the private sector as the main source of finance which of course will only invest if tariffs are such that an acceptable rate of return can be earned. Thus, the key requirement for attracting private investment seems to be an appropriate tariff level.

4.2 Institutional setup

The energy sector has been subject to various reforms since 1994 when the first National Energy Policy was formulated. Subsequent reforms included the Energy Regulation Act (1995) under which the Energy Regulation Board (ERB) was established and the Electricity Act (1995) which permits private investment in the sector. In 2003, a Rural Electrification Act was formulated, establishing the autonomous Rural Electrification Authority (REA) and finally in 2007, a revised National Energy Policy was approved.

The power sector is dominated by ZESCO, a state-owned company established in 1970. Other relevant players include the Copperbelt Energy Corporation which is a private company that purchases power from ZESCO and supplies it to the copper mines. The ERB has a mandate to oversee the energy sector which includes approving power tariffs, licensing energy utilities, and investigating consumer complaints. The Government announced in 2009 that electricity tariffs would increase to

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[103] See, for instance, the World Bank Project Appraisal Document (PAD) for the "Increased Access to Electricity Services Project" (2008) for more information.

full cost covering levels by 2011 (MTEF, 2009).[104] In 2009, average tariffs were already increased by 36%, and in 2010 another increase of 25% followed.[105] The tariffs paid by the mining industry are also considerably below a full cost recovery level. However, as the tariffs have been agreed upon in long-term power purchasing contracts, the government has to renegotiate these contracts before tariff increases are possible. This renegotiation process is already underway. As the mining industry is consuming 50% of the available electricity, it is clear that a cost covering industrial tariff level is imperative. The ERB has also implemented a list of performance benchmarks for ZESCO, including mainly efficiency targets which are monitored and published on a quarterly basis.[106]

The REA was established for promoting and facilitating access to electricity by the rural population. The authority is administering the Rural Electrification Fund (REF) which is financed by a 3% levy on non-mining electricity tariffs currently worth about USD 2.5 million per year. The REA has additionally received Capacity Building Support from the Swedish International Development Cooperation Agency (SIDA). JICA has funded the development of the Rural Electrification Master Plan (REMP) which outlines the strategy of the government with respect to increasing access to electricity in rural areas. Further support for rural electrification is coming from the EU Energy Facility. The World Bank is contributing to sector development through its "Increased Access to Electricity Services (IAES)" project, among others.

4.3   The performance of the power sector

The national electrification rate in Zambia is about 23% with 43% of the population in urban and less than 3% of the rural population having access to electricity (see Table 27, data 2006).[107] Compared to other resource-rich countries in which rural electrification is at 28% on average (AICD, 2010), this electrification rate is exceptionally low. Furthermore, it can be seen that progress in electrification has been slow over the last 10 years. The government aims at increasing the national rate to 66% by 2030 with 90% in urban and 50% in rural areas, respectively (Vision 2030, REMP). As Zambia is a sparsely populated country, connecting each household to the grid would not be economically sensible. Instead, solar photovoltaic systems are increasingly used as a least-cost alternative, especially in rural areas. However, it should be clear that even those systems will be unaffordable to a large percentage of the rural and even (peri-)urban households and thus their provision will require contributions from the government or donor side. The Ministries of Health and Education use these systems as well for providing electricity to schools and health centres in rural areas. However, nearly 800 health facilities and about 5,800 schools still remain without electricity (World Bank, 2008).[108]

Table 27: Proportion of households with access to electricity

Coverage	Proportion (1998)	Proportion (2006)
All Zambia	21.26%	23.26%
Urban	41.39%	43.00%
Rural	1.75%	2.65%

Source: Own calculations based on LCMS 1998 and 2006.

In order to assess the performance of the power sector and ZESCO in particular, two indicators have been specified in the PAF. The indicators relate to the increase in domestic connections to the grid

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[104] See the MoF's 2010-2012 MTEF (2009).

[105] The "Cost of Services Study" (ERB, 2007) which aimed at determining the full costs of providing electricity and which was supported by the World Bank and SIDA even recommended a tariff increase of 45% on average in 2007-09 and additional increases of about 6% a year thereafter.

[106] See the ERB website at http://www.erb.org.zm/ for more information.

[107] Access to electricity is defined as using electricity for cooking.

[108] See the World Bank PAD for the "Increased Access to Electricity Services Project" (2008).

and the number of customers who are unmetered, an indicator for the efficiency of ZESCO. As can be seen in Table 28, the targets have mostly been met since 2007 which, however, does not change the fact that access to electricity has remained more or less constant due to population growth.

The indicator on the number of ZESCO customers who are unmetered has been included only recently due to pressure from the donor community and through the PRBS dialogue. The government refused, however, to include any indicator on tariff increases, an issue which is now pushed bilaterally. Instead, it wanted to keep the indicator on the number of households connected to the ZESCO grid, an indicator which aims at measuring access to electricity. Yet, due to the fact that connecting each household to the grid will not be economically sensible as discussed above, this indicator appears too one-sided and should at least be generalised to overall access to electricity independent of the source (e.g. grid, solar systems etc.). Furthermore, indicators aiming at measuring the more indirect impact channel of electricity via macroeconomic development and growth are not included in the PAF.

Table 28: Power Indicators for Performance Assessment Framework (PAF)

Indicator			2006	2007	2008	2009
Number of new domestic connections/proportional increase in the number of households connected to the ZESCO grid	Target		269,396 (approx. baseline)	5%	7%	20 - 30,000
	Actual			4.9%	7.6% (23,473)	25,004*
Number of ZESCO customers who are unmetered	Target		n.a.	126,718 (approx. baseline)	n.a.	85,000
	Actual				127,624	62,244*

Source: Annual Progress Reports on FNDP Implementation, Performance Assessment Frameworks, and ERB Reports.
* Figures for end of third quarter 2009.

4.4   The impact of the power sector

Figure 21 clearly shows that the power network mirrors economic geography with high voltage transmission lines in the north-south corridor and more limited and smaller transmission lines in the east-west area. Furthermore, it shows quite clearly that the poor rural areas in Zambia are not connected to the electricity grid, something which is also apparent from Table 28.

Figure 21: The power network and poverty in Zambia
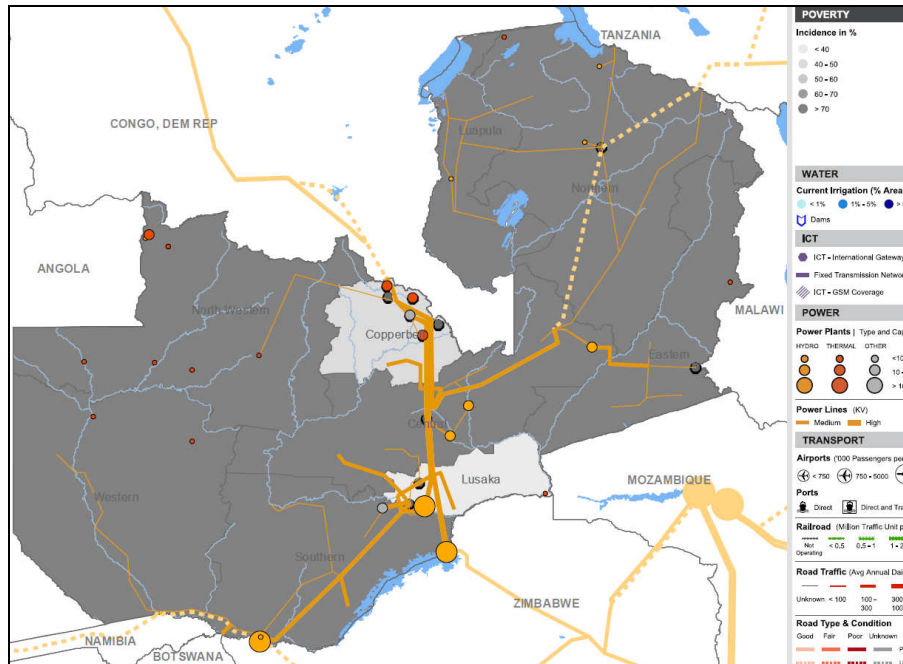
Source: AICD (2010).

Electrification can have positive effects on both, macroeconomic development with indirect effects on poverty reduction and directly on the living conditions of the population. While access to reliable electricity sources is an important contributor to business development and macroeconomic growth (e.g. Wolde-Rufael, 2006), access on the household and small business level is addressing the direct poverty reduction channel of power. For instance, it is assumed that through improved lighting, more hours of the day can be used not only for household chores but also for reading and studying which in turn may have an effect on educational outcomes and subsequently on income levels etc. Living conditions may further improve through the possibility to use refrigerators, electric stoves, and other household amenities while electronic devices such as television and radio can improve access to information which may also have an effect on education. On the small business level, electrification may lead to higher productivity as enterprises can use electric tools, operate more hours etc. Finally, if health centres and schools are equipped with electricity they cannot only use, for instance, refrigerators for medication, but access to electricity especially in rural areas may also facilitate the recruitment of qualified personnel. With respect to the evidence, recent empirical studies find significant and positive effects of access to electricity on livelihoods, especially in rural areas (World Bank, 2008a; Khandker et al., 2009a, 2009b, among others). Effects vary from higher income to positive effects on educational outcomes such as increased study time and higher school completion rates. Thus, electrification seems to have a significant positive impact on the socio-economic welfare of low-income households.

Considering the empirical evidence, it becomes clear that the low electrification rates in Zambia, especially in rural areas, undermine the pace of rural development and economic advancement as a whole. The AICD (2010) estimated that the poor development of the power sector reduced the per capita growth rate by more than 0.1 percentage points over the past decade while the current power cut-offs will also be taking their toll on macroeconomic development. Furthermore, according to enterprise surveys carried out for the AICD, power is the infrastructure handicap that weighs most heavily on them and considerably affects their productivity. Table 29 adds to this perception. It can clearly be seen that poverty rates for households with access to electricity are considerably lower compared to those without such access. The correlation between access to electricity and poverty is for both definitions and both years negative and highly significant at the 1% level suggesting that households in rural areas are considerably less likely to be poor if they have access to electricity. However, the results have to be interpreted with caution as firstly, the number of electrified

households is very low and secondly, correlations do not imply causality (it could of course also be the case – and that is actually highly probable – that richer households are more likely to receive electricity).

Table 29: Access to electricity and poverty in rural areas

	Households with electricity	Households without electricity
2006 Poor (%)	7.44%	72.18%
Extremely poor (%)	1.24%	45.21%
1998 Poor (%)	35.42%	77.87%
Extremely poor (%)	22.22%	65.86%
Number of households in sample 2006	242	8,890
1998	144	8,189

Source: Own calculations based on LCMS 1998 and 2006.

In addition to those findings, it has to be taken into account that access to electricity is limited to more affluent households. More specifically, 84% of the households with access to electricity belong to the top quintile of the income distribution (AICD, 2010). Relating this to the fact that tariffs are such that full cost coverage is not possible, it implies that the richer households are even subsidised meaning that the current tariff structure is highly regressive. This, of course, is another reason why tariffs have to increase. For those households, cost covering tariffs would definitely be affordable (AICD, 2010). Of course, in the long run, when considering connecting poorer households to the grid, the affordability of tariffs has to be taken into account which can, however, be guaranteed with a variation of the block tariff structure already in place. All in all, the evidence suggests that electricity is a bottleneck in Zambia and that expanding access would increase household welfare considerably. Even though the development over the last years suggests that the situation has not worsened and maybe even slightly improved, progress could have been better and it is clear that there is still a long way to go.

5   Conclusions and Answers to the Evaluation Questions

At first sight, the roads and the WSS sector seem quite different, especially when focusing on potential influences of GBS/SBS on sector performance and impact. At second sight, however, a number of similarities emerge.

- Modes of aid delivery: The shares of different modes of aid delivery in both sectors are different. However, in both sectors a mixture of modes can be found. Beside the Road Fund, the roads sector is predominantly financed by general budget flows and SBS, but project aid is still existent. Beside water fees, the water sector is predominantly financed by project aid, but, if not SBS, at least some pooled funding can be found in the form of the DTF to which the GRZ is contributing as well via the general budget. This amount is still small, but increasing; and on-budget sub sector baskets are in preparation. For both sectors, each modality seems to have certain advantages (level of dialogue, amount of funds, oversight, role of consultants, implementation capacity...).

- In both sectors, GRZ policy influenced via the policy dialogue of GBS/SBS is valued by stakeholders for its contribution to the development of the sectors, especially through the creation of institutions and the formulation of policies and sector frameworks (milestones). Undoubtedly, the roads sector gained extra weight by the high amount of general budget

and SBS funds. However, even in the water sector, the PAF dialogue is perceived as very conducive to sector development, last not least thanks to providing a high level discussion forum. GBS/SBS can be thought of as "buying a seat at the table" where the corner stones of national sector policies are discussed and major decisions are prepared.

- In both sectors, the institutional setup is to be classified as good or even best practice on paper. However, more or less severe shortcomings are revealed in the actual functioning of the institutional system. Lack of coordination, inefficiencies, and sometimes overlapping responsibilities are reported in the roads and in the WSS sector. Lack of capacity and resources is especially prominent on the local level. The shortcomings and deficiencies in the roads sector have been made explicit in the audit report. Most certainly, this report would not have been commissioned and problems would have not been analysed in such depth without BS. For the future development of GBS/SBS in the roads sector as well as for sector development as such, the implementation of the report's recommendations through GRZ will be crucial.

- In both sectors, improvements on the outcome level can be recorded which have the potential of positive impact. However, indicators specified in ROADSIP, the PAF and/or in National Development Plans have only partly been reached in the last years, for varying reasons, and sector development has been rather slow. The problem of very high unit costs seems to be most prominent in the government financed roads sector, while in the water sector unit costs show high variations.

- Despite the fact that the attainment of sector-specific indicators has been moderate in both sectors, positive impacts of road projects and access to safe WSS on poverty reduction, health and education could be demonstrated, especially in rural areas. This, however, also means that the effects observed could have been even more widespread and also stronger if resources had been used more efficiently and the quality of works had been higher.

With respect to the power sector, BS had only a small effect on sector performance as the sector receives close to nothing out of the general budget and the PAF dialogue is also considerably less intensive as, for instance, in WSS. The findings for the sector, however, certainly fit into the picture. First of all, considerable inefficiencies remain (e.g. tariffs); second, the development of sector-specific indicators has been moderate while third, positive effects of access to electricity on macro- and microeconomic development are highly likely.

All in all, the general assessment of the development of the sectors is therefore cautiously positive, but more would have been possible in recent years, and more is still needed to overcome all constraints that the roads, the WSS, and the power sector still present for the further development of Zambia. When drawing these conclusions it should be always kept in mind, however, that the main impacts of structural changes in Zambia which have been supported via GBS/SBS most likely will be of a long term nature. Obviously, it is impossible to capture these long term effects at this point in time.

As, in the end, this evaluation/background paper aims at contributing to answering the key evaluation questions outlined in the GBS/SBS evaluation methodology and the respective model ToRs (in particular, questions 4 and 5), the tables in Annex 9 summarise the findings for the roads and the WSS sector once more structured along the specific evaluation questions.

Annex

Annex 1: Roads sector photo documentation

Picture 1: ROADSIP investments on trunk road network

Trunk Road Kafue – Chirundu: Good road condition on regional corridor to Zimbabwe with slow lane for trucks in hilly areas. Trunk Road Kafue – Choma: Good road condition on major connection between Lusaka and Livingstone.

Picture 2: Micro-level impact study comparing badly maintained to well maintained rural roads
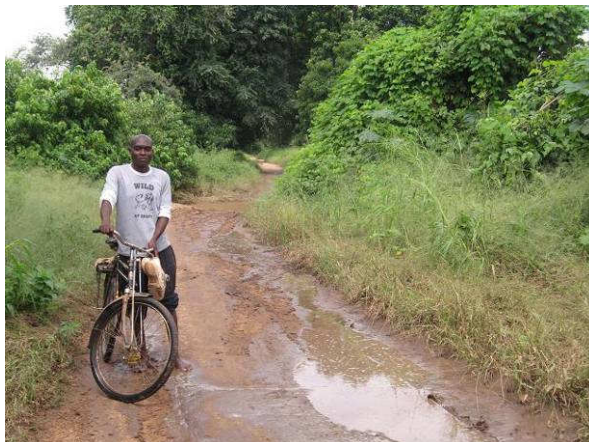
Siavonga District – Bad road condition due to lack of maintenance
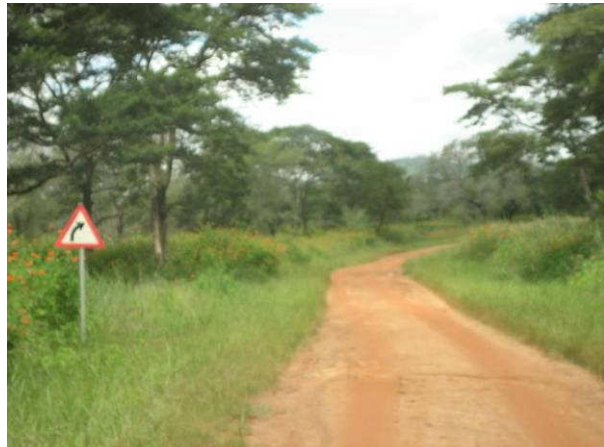
Choma District – Good road condition, recent maintenance activity

Annex 2: Water sector photo documentation

Picture 1: Peri-urban district Kanyama (Lusaka) during rain season

Water supply

Public unmetered stand post

DTF sponsored water kiosk

Sanitation

Improved pit latrine

EcoSan latrine

Picture 2: Rural Districts in Chipata District (Eastern Province)

Water supply

Scoop hole

Protected borehole

Sanitation

Traditional pit latrine

Annex 3: WSS sector overview
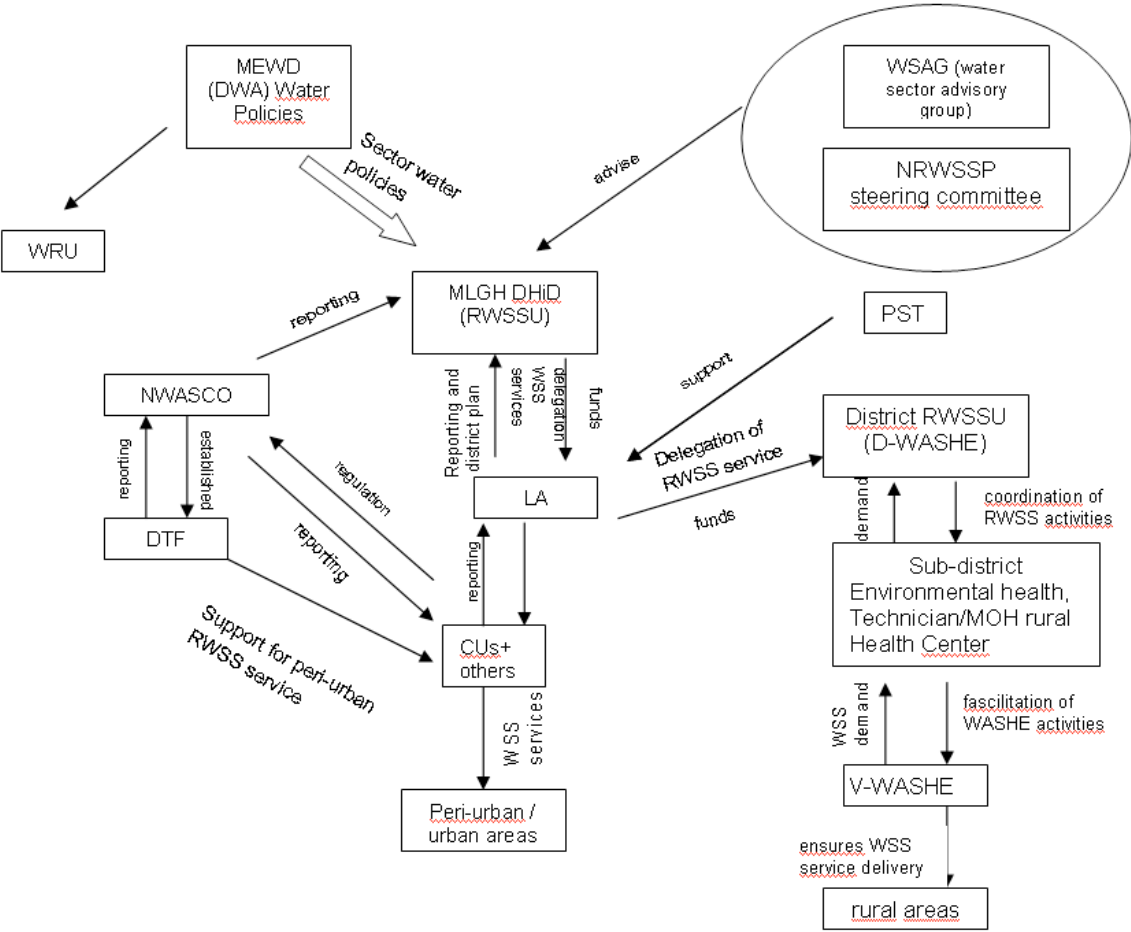
Annex 4: Panel regression results (LCMS) roads

Table 1: building of new road (tarred or gravel) occurred

	(1) Prim. s.	(2) Prim. s. m.	(3) Prim. s. f.	(4) Sec. s.	(5) Sec. s. m.	(6) Sec. s. f.	(7) Extr. poor	(8) Mod. poor	(9) Non-poor	(10) Dist. p. tr.	(11) Exp. tr. s.	(12) Exp. tr. w.	(13) Exp. p. c.	(14) Exp. a. e.	(15) Cons.	(16) C. vis. n.h.	(17) C. vis. h.	(18) Vis. heal.
Share of hh building of new road (tarred or gravel) occurre	0.29* [2.05]	0.26 [1.61]	0.23 [1.34]	0.53*** [4.57]	0.47** [3.07]	0.46** [2.82]	-0.15 [-0.91]	0.12 [1.11]	0.03 [0.25]	-0.08 [-0.65]	0.32 [2.04]	-0.04 [-0.85]	0.01* [2.35]	0.01* [2.25]	0.46* [2.13]	0.52* [2.36]	-0.02 [-0.59]	-0.02 [-0.28]
Share of hh cooking with charcoal or coal	0.43 [0.42]	-0.60 [-0.51]	-0.39 [-0.31]	-0.60 [-0.70]	-1.35 [-1.19]	0.00 [0.00]	2.04 [1.70]	-1.44 [-1.85]	-0.60 [-0.66]	-0.39 [-0.44]	0.79 [1.71]	0.01 [0.04]	-0.04 [-0.81]	-0.04 [-0.85]	-2.02 [-1.20]	-1.87 [-1.10]	0.06 [0.30]	0.82 [1.34]
Share of hh cooking with electricity	0.55 [0.50]	-0.64 [-0.51]	-0.16 [-0.12]	-0.25 [-0.27]	-1.31 [-1.08]	0.54 [0.49]	2.20 [1.71]	-1.32 [-1.59]	-0.88 [-0.90]	-0.28 [-0.29]	0.81 [1.76]	0.12 [0.32]	-0.03 [-0.71]	-0.04 [-0.76]	-1.85 [-1.03]	-1.76 [-0.97]	0.02 [0.08]	0.57 [0.87]
Share of hh cooking with firewood	0.22 [0.22]	-0.79 [-0.67]	-0.61 [-0.48]	-0.71 [-0.82]	-1.56 [-1.37]	-0.14 [-0.14]	2.73* [2.27]	-1.66* [-2.13]	-1.07 [-1.18]	-0.11 [-0.13]	0.70 [1.55]	-0.03 [-0.10]	-0.06 [-1.40]	-0.07 [-1.45]	-2.52 [-1.50]	-2.40 [-1.40]	0.02 [0.11]	0.74 [1.19]
Share of hh heads with lower primary education	0.23 [1.53]	0.25 [1.43]	0.18 [0.97]	-0.10 [-0.81]	-0.09 [-0.54]	-0.01 [-0.08]	-0.13 [-0.74]	0.13 [1.16]	-0.00 [-0.02]	0.08 [0.59]	0.03 [0.46]	0.13 [2.64]	0.01 [1.33]	0.01 [1.18]	0.17 [0.71]	0.24 [0.96]	-0.06* [-2.09]	-0.27** [-3.10]
Share of hh heads with upper secondary education	0.42** [3.09]	0.36* [2.35]	0.58*** [3.54]	0.25* [2.23]	0.35* [2.32]	0.23 [1.70]	-0.49** [-3.11]	0.35*** [3.42]	0.14 [1.18]	-0.06 [-0.54]	0.11* [2.10]	-0.31* [-7.50]	0.02** [2.83]	0.02** [2.84]	0.78*** [3.61]	0.90*** [4.09]	-0.06* [-2.25]	-0.23** [-2.91]
Share of hh heads with lower secondary education	0.81*** [5.07]	0.71*** [3.95]	0.85*** [4.40]	0.65*** [4.88]	0.59*** [3.38]	0.69*** [4.31]	-0.61** [-3.30]	0.49*** [4.10]	0.12 [0.85]	-0.19 [-1.41]	0.16** [2.82]	-0.09 [-1.57]	0.03*** [3.79]	0.03*** [3.68]	0.96*** [3.84]	1.02*** [3.98]	-0.05 [-1.71]	-0.20* [-2.22]
Share of hh with upper secondary education or more	0.53** [3.05]	0.64** [3.24]	0.58** [2.76]	0.42** [2.88]	0.42* [2.21]	0.41* [2.30]	-0.51* [-2.50]	0.11 [0.85]	0.40 * [2.59]	0.03 [0.20]	0.03 [0.58]	-0.58* [-7.34]	0.01 [0.95]	0.01 [0.79]	-0.19 [-0.69]	-0.10 [-0.36]	-0.06 [-1.86]	-0.15 [-1.57]
Average age of household head	0.13 [0.33]	0.09 [0.20]	0.35 [0.76]	0.53 [1.64]	0.63 [1.50]	0.38 [0.97]	0.11 [0.25]	-0.27 [-0.95]	0.16 [0.49]	-0.20 [-0.61]	-0.11 [-0.82]	1.91* [8.26]	-0.01 [-0.71]	-0.01 [-0.86]	0.11 [0.18]	0.08 [0.13]	-0.05 [-0.60]	0.20 [0.94]
Share of male household heads	-0.18 [-0.95]	0.02 [0.11]	-0.41 [-1.78]	-0.00 [-0.02]	-0.06 [-0.30]	-0.15 [-0.77]	-0.40 [-1.83]	0.14 [1.01]	0.26 [1.55]	0.04 [0.25]	-0.06 [-0.64]	0.26 [3.70]	0.01 [1.32]	0.01 [1.37]	-0.04 [-0.14]	-0.10 [-0.34]	0.01 [0.19]	-0.12 [-1.07]
Share of married household heads	-0.12 [-0.46]	-0.02 [-0.07]	-0.09 [-0.29]	-0.46* [-2.17]	-0.79** [-2.80]	-0.05 [-0.18]	0.34 [1.15]	-0.16 [-0.83]	-0.18 [-0.81]	-0.17 [-0.77]	-0.05 [-0.54]	0.46* [5.19]	-0.02 [-1.51]	-0.02 [-1.46]	-0.40 [-1.00]	-0.37 [-0.89]	0.02 [0.47]	-0.04 [-0.26]
Share of separated household heads	0.21 [0.52]	0.51 [1.14]	0.04 [0.09]	0.21 [0.63]	0.19 [0.44]	0.16 [0.41]	-0.27 [-0.60]	-0.18 [-0.60]	0.45 [1.30]	-0.30 [-0.91]	-0.38 [-1.71]	2.11** [10.08]	0.00 [0.05]	0.00 [0.06]	0.24 [0.39]	0.43 [0.67]	-0.11 [-1.34]	-0.53* [-2.25]
Share of divorced household heads	-0.08 [-0.24]	0.03 [0.09]	-0.22 [-0.56]	-0.12 [-0.44]	-0.66 [-1.85]	0.44 [1.34]	0.73 [1.95]	-0.41 [-1.68]	-0.33 [-1.14]	-0.34 [-1.23]	-0.17 [-1.32]	-0.69* [-6.40]	-0.04* [-2.52]	-0.04* [-2.48]	-1.05* [-2.04]	-1.10* [-2.10]	0.01 [0.09]	-0.08 [-0.41]
Share of widowed household heads	0.05 [0.16]	0.53 [1.41]	-0.39 [-0.96]	-0.21 [-0.76]	-0.63 [-1.71]	0.05 [0.15]	-0.10 [-0.25]	-0.05 [-0.20]	0.15 [0.50]	0.09 [0.33]	-0.11 [-0.83]	1.87* [8.58]	-0.00 [-0.19]	-0.00 [-0.16]	-0.22 [-0.42]	-0.20 [-0.38]	0.02 [0.29]	-0.31 [-1.57]
Share of hh with children <= 60 months	8.50 [1.74]	1.10 [0.20]	9.90 [1.68]	-7.52 [-1.85]	-7.76 [-1.45]	-5.83 [-1.17]	1.96 [0.35]	-2.05 [-0.56]	0.09 [0.02]	-2.25 [-0.55]	-1.15 [-1.07]	-16.18* [-7.73]	-0.22 [-1.06]	-0.15 [-0.72]	-8.12 [-1.07]	-9.27 [-1.19]	1.08 [1.13]	1.62 [0.58]
Observations	478	476	478	478	478	477	478	478	478	468	190	142	478	478	468	468	468	443

t statistics in brackets
* p<0.05, ** p<0.01, *** p<0.001

Table 2: grading of gravel road occurred

	(1) Prim. s.	(2) Prim. s. m.	(3) Prim. s. f.	(4) Sec. s.	(5) Sec. s. m.	(6) Sec. s. f.	(7) Extr. poor	(8) Mod. poor	(9) Non-poor	(10) Dist. p. tr.	(11) Exp. tr. s.	(12) Exp. tr. w.	(13) Exp. p. c.	(14) Exp. a. e.	(15) Cons.	(16) C. vis. n.h.	(17) C. vis. h.	(18) Vis. heal.
Share of hh grading of gravel road occurred	0.07 [1.22]	0.06 [0.95]	0.03 [0.49]	0.09 [1.73]	0.12 [1.96]	0.09 [1.53]	-0.18** [-2.86]	0.08* [2.02]	0.10* [2.02]	-0.01 [-0.13]	0.01 [0.43]	-0.14** [-13.91]	0.01** [3.16]	0.01** [3.14]	0.21* [2.43]	0.22* [2.50]	-0.00 [-0.35]	-0.01 [-0.27]
Share of hh cooking with charcoal or coal	0.22 [0.21]	-0.79 [-0.66]	-0.51 [-0.40]	-0.90 [-0.99]	-1.71 [-1.48]	-0.22 [-0.21]	2.46* [2.08]	-1.65* [-2.12]	-0.81 [-0.90]	-0.37 [-0.41]	0.90 [1.77]	0.34* [7.15]	-0.06 [-1.25]	-0.06 [-1.29]	-2.58 [-1.54]	-2.48 [-1.45]	0.08 [0.36]	0.85 [1.37]
Share of hh cooking with electricity	0.36 [0.33]	-0.81 [-0.64]	-0.27 [-0.20]	-0.53 [-0.55]	-1.63 [-1.32]	0.37 [0.32]	2.54* [2.01]	-1.49 [-1.80]	-1.05 [-1.09]	-0.25 [-0.26]	0.92 [1.79]	0.62** [10.31]	-0.05 [-1.06]	-0.05 [-1.10]	-2.32 [-1.30]	-2.27 [-1.25]	0.03 [0.13]	0.59 [0.90]
Share of hh cooking with firewood	0.04 [0.03]	-0.96 [-0.81]	-0.72 [-0.57]	-0.98 [-1.08]	-1.88 [-1.62]	-0.34 [-0.32]	3.07* [2.60]	-1.83* [-2.36]	-1.24 [-1.38]	-0.09 [-0.10]	0.82 [1.65]	0.37* [7.19]	-0.08 [-1.78]	-0.08 [-1.82]	-3.00 [-1.79]	-2.92 [-1.70]	0.03 [0.16]	0.76 [1.22]
Share of hh heads with lower primary education	0.25 [1.61]	0.26 [1.50]	0.19 [1.04]	-0.07 [-0.55]	-0.07 [-0.39]	0.02 [0.10]	-0.13 [-0.72]	0.14 [1.18]	-0.01 [-0.07]	0.07 [0.55]	0.04 [0.67]	0.44** [19.42]	0.01 [1.40]	0.01 [1.24]	0.20 [0.81]	0.26 [1.07]	-0.06* [-2.12]	-0.27** [-3.11]
Share of hh heads with upper secondary education	0.44** [3.20]	0.38* [2.45]	0.59*** [3.56]	0.28* [2.35]	0.38* [2.52]	0.24 [1.72]	-0.54*** [-3.49]	0.37*** [3.67]	0.17 [1.42]	-0.06 [-0.56]	0.11 [1.94]	-0.47*** [-34.48]	0.02** [3.23]	0.02** [3.25]	0.85*** [3.91]	0.97*** [4.39]	-0.06* [-2.28]	-0.23** [-2.92]
Share of hh heads with lower secondary education	0.82*** [5.13]	0.73*** [4.01]	0.86*** [4.47]	0.68*** [4.91]	0.61*** [3.46]	0.71*** [4.37]	-0.59** [-3.28]	0.49*** [4.11]	0.10 [0.76]	-0.19 [-1.45]	0.17** [2.79]	0.13* [7.83]	0.03*** [3.85]	0.03*** [3.73]	0.97*** [3.89]	1.03*** [4.04]	-0.05 [-1.74]	-0.20* [-2.22]
Share of hh with upper secondary education or more	0.55** [3.12]	0.66** [3.29]	0.59** [2.76]	0.44** [2.87]	0.46* [2.36]	0.43* [2.39]	-0.58** [-2.91]	0.15 [1.10]	0.44** [2.87]	0.03 [0.20]	0.05 [0.87]	-0.80*** [-38.65]	0.01 [1.34]	0.01 [1.18]	-0.11 [-0.40]	-0.02 [-0.07]	-0.06 [-1.88]	-0.15 [-1.58]
Average age of household head	0.19 [0.48]	0.14 [0.31]	0.37 [0.79]	0.59 [1.71]	0.74 [1.70]	0.53 [1.30]	-0.09 [-0.21]	-0.18 [-0.63]	0.28 [0.82]	-0.19 [-0.58]	-0.04 [-0.28]	1.83*** [80.83]	-0.00 [-0.24]	-0.01 [-0.39]	0.31 [0.52]	0.30 [0.48]	-0.05 [-0.63]	0.19 [0.90]
Share of male household heads	-0.20 [-1.07]	0.00 [0.00]	-0.42 [-1.85]	-0.04 [-0.27]	-0.11 [-0.50]	-0.15 [-0.78]	-0.37 [-1.71]	0.13 [0.89]	0.24 [1.48]	0.05 [0.29]	-0.05 [-0.59]	0.53** [23.01]	0.01 [1.11]	0.01 [1.17]	-0.09 [-0.32]	-0.16 [-0.53]	0.01 [0.23]	-0.12 [-1.05]
Share of married household heads	-0.12 [-0.45]	-0.02 [-0.07]	-0.09 [-0.28]	-0.46* [-2.06]	-0.78** [-2.74]	-0.05 [-0.20]	0.33 [1.14]	-0.16 [-0.81]	-0.18 [-0.79]	-0.17 [-0.77]	-0.10 [-1.03]	0.07 [2.35]	-0.02 [-1.50]	-0.02 [-1.45]	-0.39 [-0.97]	-0.35 [-0.86]	0.02 [0.47]	-0.04 [-0.27]
Share of separated household heads	0.14 [0.34]	0.45 [1.00]	-0.01 [-0.01]	0.09 [0.25]	0.07 [0.17]	0.09 [0.22]	-0.21 [-0.46]	-0.22 [-0.74]	0.43 [1.24]	-0.29 [-0.87]	-0.46 [-1.97]	2.82*** [47.59]	-0.00 [-0.21]	-0.00 [-0.19]	0.13 [0.21]	0.31 [0.48]	-0.10 [-1.30]	-0.52* [-2.24]
Share of divorced household heads	-0.07 [-0.20]	0.04 [0.11]	-0.22 [-0.55]	-0.12 [-0.41]	-0.64 [-1.75]	0.47 [1.41]	0.67 [1.81]	-0.38 [-1.57]	-0.29 [-1.02]	-0.34 [-1.22]	-0.24 [-1.76]	-0.88*** [-46.70]	-0.03* [-2.38]	-0.03* [-2.34]	-0.98 [-1.92]	-1.04* [-1.98]	0.01 [0.08]	-0.08 [-0.43]
Share of widowed household heads	0.02 [0.06]	0.50 [1.32]	-0.41 [-1.01]	-0.27 [-0.92]	-0.68 [-1.84]	-0.02 [-0.05]	-0.05 [-0.14]	-0.07 [-0.29]	0.13 [0.44]	0.10 [0.36]	-0.14 [-0.95]	2.47*** [45.19]	-0.01 [-0.36]	-0.00 [-0.32]	-0.29 [-0.55]	-0.28 [-0.52]	0.02 [0.31]	-0.31 [-1.56]
Share of hh with children <= 60 months	8.11 [1.65]	0.74 [0.13]	9.56 [1.62]	-8.31 [-1.95]	-8.39 [-1.54]	-5.35 [-1.06]	1.95 [0.35]	-2.13 [-0.58]	0.17 [0.04]	-2.09 [-0.51]	-1.30 [-1.13]	-21.00*** [-46.19]	-0.24 [-1.14]	-0.17 [-0.79]	-8.43 [-1.11]	-9.66 [-1.25]	1.10 [1.15]	1.63 [0.59]
Observations	478	476	478	478	478	477	478	478	478	468	190	142	478	478	468	468	468	443

t statistics in brackets
* p<0.05, ** p<0.01, *** p<0.001

	(1) Prim. s.	(2) Prim. s. m.	(3) Prim. s. f.	(4) Sec. s.	(5) Sec. s. m.	(6) Sec. s. f.	(7) Extr. poor	(8) Mod. poor	(9) Non-poor	(10) Dist. p. tr.	(11) Exp. tr. s.	(12) Exp. tr. w.	(13) Exp. p. c.	(14) Exp. a. e.	(15) Cons.	(16) C. vis. n.h.	(17) C. vis. h.	(18) Vis. heal.
Share of hh tarring of gravel road occurred	0.05 [0.50]	0.01 [0.05]	0.01 [0.06]	0.20* [2.11]	0.20 [1.69]	-0.10 [-0.77]	0.07 [0.55]	0.09 [1.11]	-0.16 [-1.69]	-0.18* [-2.03]	0.01 [0.21]	-0.09 [-0.93]	-0.00 [-1.01]	-0.00 [-0.98]	0.32 [1.90]	0.31 [1.82]	0.01 [0.51]	0.08 [1.41]
Share of hh cooking with charcoal or coal	0.32 [0.31]	-0.66 [-0.56]	-0.44 [-0.35]	-0.89 [-0.98]	-1.62 [-1.40]	0.06 [0.06]	2.01 [1.67]	-1.54* [-1.97]	-0.47 [-0.52]	-0.22 [-0.25]	0.97 [2.01]	-0.14 [-0.46]	-0.04 [-0.78]	-0.04 [-0.83]	-2.43 [-1.45]	-2.30 [-1.34]	0.06 [0.28]	0.75 [1.21]
Share of hh cooking with electricity	0.45 [0.40]	-0.71 [-0.56]	-0.22 [-0.17]	-0.50 [-0.52]	-1.54 [-1.25]	0.59 [0.51]	2.20 [1.71]	-1.40 [-1.68]	-0.80 [-0.83]	-0.15 [-0.16]	1.00* [2.05]	-0.02 [-0.06]	-0.04 [-0.72]	-0.04 [-0.77]	-2.20 [-1.22]	-2.13 [-1.16]	0.02 [0.08]	0.52 [0.79]
Share of hh cooking with firewood	0.10 [0.10]	-0.86 [-0.73]	-0.67 [-0.53]	-1.01 [-1.11]	-1.85 [-1.59]	-0.10 [-0.09]	2.71* [2.24]	-1.77* [-2.26]	-0.95 [-1.05]	0.07 [0.07]	0.89 [1.88]	-0.17 [-0.55]	-0.06 [-1.37]	-0.07 [-1.42]	-2.95 [-1.75]	-2.85 [-1.65]	0.02 [0.09]	0.66 [1.06]
Share of hh heads with lower primary education	0.26 [1.69]	0.27 [1.53]	0.20 [1.06]	-0.04 [-0.27]	-0.03 [-0.15]	0.01 [0.06]	-0.13 [-0.73]	0.16 [1.35]	-0.02 [-0.19]	0.04 [0.34]	0.04 [0.67]	0.15 [2.91]	0.01 [1.35]	0.01 [1.20]	0.26 [1.06]	0.33 [1.31]	-0.06* [-2.05]	-0.25** [-2.97]
Share of hh heads with upper secondary education	0.42** [3.09]	0.36* [2.35]	0.58*** [3.53]	0.27* [2.24]	0.36* [2.36]	0.21 [1.47]	-0.49** [-3.09]	0.36*** [3.47]	0.13 [1.13]	-0.07 [-0.62]	0.10 [1.91]	-0.33* [-5.87]	0.02** [2.77]	0.02** [2.79]	0.80*** [3.72]	0.92*** [4.17]	-0.06* [-2.22]	-0.22** [-2.87]
Share of hh heads with lower secondary education	0.83*** [5.16]	0.74*** [4.06]	0.87*** [4.49]	0.68*** [4.91]	0.62*** [3.47]	0.73*** [4.48]	-0.63*** [-3.40]	0.49*** [4.13]	0.13 [0.97]	-0.18 [-1.36]	0.17* [2.73]	-0.11 [-1.71]	0.03*** [3.99]	0.03*** [3.88]	0.99*** [3.93]	1.05*** [4.08]	-0.06 [-1.79]	-0.20* [-2.33]
Share of hh with upper secondary education or more	0.52** [2.94]	0.63** [3.17]	0.57** [2.71]	0.39* [2.55]	0.39* [2.02]	0.40* [2.22]	-0.51* [-2.51]	0.10 [0.76]	0.41 [2.69]	** 0.05 [0.33]	0.04 [0.73]	-0.61* [-6.12]	0.01 [0.94]	0.01 [0.78]	-0.22 [-0.83]	-0.14 [-0.51]	-0.06 [-1.87]	-0.16 [-1.65]
Average age of household head	0.08 [0.20]	0.06 [0.14]	0.33 [0.70]	0.39 [1.14]	0.50 [1.14]	0.49 [1.19]	0.09 [0.20]	-0.33 [-1.12]	0.24 [0.71]	-0.09 [-0.29]	-0.03 [-0.25]	1.92* [8.46]	-0.01 [-0.62]	-0.01 [-0.77]	-0.09 [-0.14]	-0.11 [-0.18]	-0.05 [-0.65]	0.16 [0.76]
Share of male household heads	-0.19 [-1.00]	0.01 [0.04]	-0.42 [-1.83]	-0.02 [-0.11]	-0.07 [-0.35]	-0.14 [-0.71]	-0.39 [-1.77]	0.14 [1.01]	0.24 [1.48]	0.03 [0.20]	-0.06 [-0.63]	0.28 [3.35]	0.01 [1.17]	0.01 [1.22]	-0.05 [-0.16]	-0.11 [-0.37]	0.01 [0.23]	-0.11 [-0.99]
Share of married household heads	-0.12 [-0.45]	-0.02 [-0.08]	-0.09 [-0.29]	-0.45* [-2.03]	-0.78** [-2.71]	-0.07 [-0.25]	0.35 [1.16]	-0.15 [-0.80]	-0.19 [-0.86]	-0.18 [-0.82]	-0.10 [-1.01]	0.43* [4.94]	-0.02 [-1.53]	-0.02 [-1.48]	-0.39 [-0.96]	-0.35 [-0.85]	0.03 [0.50]	-0.03 [-0.23]
Share of separated household heads	0.16 [0.41]	0.47 [1.03]	0.00 [0.00]	0.15 [0.43]	0.15 [0.33]	0.09 [0.23]	-0.23 [-0.50]	-0.18 [-0.61]	0.41 [1.19]	-0.33 [-1.00]	-0.48 [-2.02]	2.24* [8.20]	-0.00 [-0.17]	-0.00 [-0.16]	0.23 [0.36]	0.40 [0.62]	-0.10 [-1.26]	-0.50* [-2.16]
Share of divorced household heads	-0.10 [-0.30]	0.02 [0.05]	-0.23 [-0.59]	-0.17 [-0.59]	-0.70 [-1.93]	0.45 [1.34]	0.74 [1.95]	-0.42 [-1.73]	-0.31 [-1.11]	-0.32 [-1.17]	-0.25 [-1.71]	-0.74* [-6.09]	-0.04* [-2.52]	-0.04* [-2.48]	-1.11* [-2.16]	-1.17* [-2.22]	0.01 [0.09]	-0.09 [-0.45]
Share of widowed household heads	0.05 [0.14]	0.52 [1.35]	-0.40 [-0.99]	-0.19 [-0.66]	-0.60 [-1.60]	-0.04 [-0.11]	-0.06 [-0.16]	-0.03 [-0.12]	0.10 [0.33]	0.05 [0.17]	-0.14 [-0.96]	1.94* [7.63]	-0.01 [-0.36]	-0.00 [-0.32]	-0.16 [-0.31]	-0.15 [-0.28]	0.02 [0.36]	-0.28 [-1.41]
Share of hh with children <= 60 months	8.16 [1.65]	0.68 [0.12]	9.53 [1.61]	-7.89 [-1.85]	-8.01 [-1.47]	-5.46 [-1.08]	2.40 [0.42]	-2.00 [-0.54]	-0.40 [-0.09]	-2.60 [-0.64]	-1.33 [-1.15]	-16.38* [-7.77]	-0.26 [-1.22]	-0.19 [-0.88]	-8.10 [-1.06]	-9.39 [-1.20]	1.14 [1.19]	1.89 [0.68]
Observations	476	474	476	476	476	475	476	476	476	466	190	142	476	476	466	466	466	442

t statistics in brackets
* p<0.05, ** p<0.01, *** p<0.001

Table 4: any road project occurred

	(1) Prim. s.	(2) Prim. s. m.	(3) Prim. s. f.	(4) Sec. s.	(5) Sec. s. m.	(6) Sec. s. f.	(7) Extr. poor	(8) Mod. poor	(9) Non-poor	(10) Dist. p. tr.	(11) Exp. tr. s.	(12) Exp. tr. w.	(13) Exp. p. c.	(14) Exp. a. e.	(15) Cons.	(16) C. vis. n.h.	(17) C. vis. h.	(18) Vis. heal.
Share of hh any road project occurred	0.08 [1.58]	0.06 [1.06]	0.04 [0.68]	0.11* [2.59]	0.14* [2.59]	0.06 [1.13]	-0.14* [-2.48]	0.09* [2.38]	0.05 [1.23]	-0.04 [-0.98]	0.01 [0.33]	-0.05 [-3.51]	0.01** [2.68]	0.01** [2.68]	0.22** [3.00]	0.23** [3.06]	-0.00 [-0.12]	0.01 [0.46]
Share of hh cooking with charcoal or coal	0.18 [0.17]	-0.80 [-0.68]	-0.53 [-0.42]	-0.98 [-1.09]	-1.79 [-1.55]	-0.18 [-0.17]	2.40* [2.02]	-1.67* [-2.16]	-0.73 [-0.80]	-0.27 [-0.31]	0.92 [1.81]	0.22 [1.35]	-0.05 [-1.18]	-0.06 [-1.22]	-2.68 [-1.62]	-2.58 [-1.52]	0.07 [0.33]	0.80 [1.29]
Share of hh cooking with electricity	0.35 [0.31]	-0.81 [-0.64]	-0.29 [-0.21]	-0.57 [-0.59]	-1.66 [-1.36]	0.40 [0.35]	2.47 [1.94]	-1.50 [-1.82]	-0.97 [-1.00]	-0.18 [-0.19]	0.94 [1.86]	0.39 [2.11]	-0.05 [-0.98]	-0.05 [-1.03]	-2.35 [-1.33]	-2.30 [-1.27]	0.03 [0.11]	0.56 [0.85]
Share of hh cooking with firewood	0.00 [0.00]	-0.97 [-0.82]	-0.74 [-0.59]	-1.05 [-1.17]	-1.95 [-1.69]	-0.32 [-0.30]	3.04* [2.55]	-1.86* [-2.40]	-1.18 [-1.30]	-0.01 [-0.01]	0.84 [1.69]	0.19 [1.16]	-0.08 [-1.73]	-0.08 [-1.77]	-3.09 [-1.86]	-3.01 [-1.78]	0.03 [0.14]	0.72 [1.15]
Share of hh heads with lower primary education	0.26 [1.67]	0.27 [1.54]	0.20 [1.06]	-0.06 [-0.48]	-0.05 [-0.31]	0.02 [0.15]	-0.14 [-0.83]	0.14 [1.27]	0.00 [0.00]	0.07 [0.55]	0.04 [0.65]	0.25* [6.32]	0.01 [1.51]	0.01 [1.35]	0.22 [0.94]	0.29 [1.21]	-0.06* [-2.13]	-0.27** [-3.10]
Share of hh heads with upper secondary education	0.45** [3.26]	0.38* [2.46]	0.60*** [3.59]	0.29* [2.47]	0.40** [2.61]	0.24 [1.70]	-0.54*** [-3.43]	0.38*** [3.73]	0.16 [1.32]	-0.08 [-0.67]	0.10 [1.92]	-0.39** [-12.24]	0.02** [3.16]	0.02** [3.18]	0.86*** [4.04]	0.99*** [4.52]	-0.06* [-2.25]	-0.22** [-2.83]
Share of hh heads with lower secondary education	0.82*** [5.11]	0.72*** [4.00]	0.86*** [4.45]	0.67*** [4.89]	0.60*** [3.43]	0.72*** [4.37]	-0.59** [-3.26]	0.48*** [4.09]	0.11 [0.79]	-0.18 [-1.39]	0.17** [2.77]	-0.01 [-0.34]	0.03*** [3.82]	0.03*** [3.71]	0.96*** [3.88]	1.02*** [4.04]	-0.06 [-1.76]	-0.20* [-2.29]
Share of hh with upper secondary education or more	0.55** [3.13]	0.65** [3.28]	0.59** [2.77]	0.44** [2.92]	0.46* [2.37]	0.41* [2.29]	-0.55** [-2.76]	0.14 [1.06]	0.41 [2.70]	0.02** [0.13]	0.04 [0.81]	-0.70** [-12.96]	0.01 [1.17]	0.01 [1.01]	-0.12 [-0.44]	-0.03 [-0.12]	-0.06 [-1.85]	-0.14 [-1.52]
Average age of household head	0.17 [0.43]	0.11 [0.26]	0.37 [0.78]	0.57 [1.71]	0.71 [1.65]	0.45 [1.14]	0.01 [0.03]	-0.22 [-0.75]	0.20 [0.60]	-0.21 [-0.66]	-0.03 [-0.25]	1.93** [21.15]	-0.01 [-0.50]	-0.01 [-0.65]	0.24 [0.41]	0.22 [0.37]	-0.04 [-0.59]	0.21 [0.98]
Share of male household heads	-0.20 [-1.05]	0.00 [0.02]	-0.42 [-1.84]	-0.04 [-0.24]	-0.10 [-0.47]	-0.15 [-0.76]	-0.38 [-1.78]	0.13 [0.94]	0.25 [1.53]	0.05 [0.31]	-0.06 [-0.63]	0.40* [7.10]	0.01 [1.19]	0.01 [1.24]	-0.08 [-0.27]	-0.14 [-0.48]	0.01 [0.21]	-0.12 [-1.05]
Share of married household heads	-0.12 [-0.46]	-0.02 [-0.08]	-0.09 [-0.29]	-0.47* [-2.10]	-0.79** [-2.78]	-0.05 [-0.21]	0.34 [1.16]	-0.16 [-0.84]	-0.18 [-0.81]	-0.17 [-0.77]	-0.10 [-1.03]	0.30* [5.18]	-0.02 [-1.52]	-0.02 [-1.47]	-0.40 [-1.00]	-0.36 [-0.89]	0.02 [0.48]	-0.04 [-0.25]
Share of separated household heads	0.14 [0.36]	0.46 [1.02]	-0.00 [-0.01]	0.09 [0.28]	0.09 [0.20]	0.10 [0.24]	-0.23 [-0.52]	-0.21 [-0.71]	0.44 [1.28]	-0.28 [-0.86]	-0.47 [-2.02]	2.41** [18.32]	-0.00 [-0.14]	-0.00 [-0.13]	0.16 [0.27]	0.34 [0.54]	-0.10 [-1.30]	-0.51* [-2.21]
Share of divorced household heads	-0.09 [-0.27]	0.02 [0.06]	-0.23 [-0.58]	-0.14 [-0.51]	-0.68 [-1.88]	0.44 [1.30]	0.73* [1.98]	-0.41 [-1.70]	-0.32 [-1.14]	-0.33 [-1.22]	-0.24 [-1.78]	-0.77** [-14.56]	-0.04* [-2.56]	-0.04* [-2.52]	-1.06* [-2.09]	-1.11* [-2.15]	0.01 [0.10]	-0.07 [-0.39]
Share of widowed household heads	0.03 [0.09]	0.51 [1.35]	-0.41 [-1.00]	-0.25 [-0.88]	-0.66 [-1.80]	-0.00 [-0.00]	-0.08 [-0.22]	-0.06 [-0.24]	0.14 [0.49]	0.10 [0.36]	-0.14 [-0.98]	2.15** [15.97]	-0.00 [-0.27]	-0.00 [-0.24]	-0.25 [-0.49]	-0.24 [-0.45]	0.02 [0.31]	-0.31 [-1.55]
Share of hh with children <= 60 months	8.14 [1.66]	0.76 [0.14]	9.58 [1.62]	-8.24 [-1.95]	-8.32 [-1.54]	-5.56 [-1.10]	1.97 [0.35]	-2.10 [-0.58]	0.13 [0.03]	-2.14 [-0.52]	-1.33 [-1.15]	-18.31** [-15.78]	-0.24 [-1.13]	-0.17 [-0.79]	-8.31 [-1.11]	-9.54 [-1.25]	1.11 [1.16]	1.68 [0.61]
Observations	478	476	478	478	478	477	478	478	478	468	190	142	478	478	468	468	468	443

t statistics in brackets
* p<0.05, ** p<0.01, *** p<0.001

Table 5: transport service provided/improved occurred

	(1) Prim. s.	(2) Prim. s. m.	(3) Prim. s. f.	(4) Sec. s.	(5) Sec. s. m.	(6) Sec. s. f.	(7) Extr. poor	(8) Mod. poor	(9) Non-poor	(10) Dist. p. tr.	(11) Exp. tr. s.	(12) Exp. tr. w.	(13) Exp. p. c.	(14) Exp. a. e.	(15) Cons.	(16) C. vis. n.h.	(17) C. vis. h.	(18) Vis. heal.
Share of hh transport service provided/improved occurred	0.06 [1.03]	-0.01 [-0.18]	0.10 [1.32]	0.16** [3.00]	0.10 [1.50]	0.11 [1.73]	-0.16* [-2.30]	0.15*** [3.39]	0.01 [0.18]	-0.05 [-1.00]	0.05** [3.00]	-0.04 [-2.43]	0.01** [3.15]	0.01** [3.29]	0.28** [2.97]	0.28** [2.96]	0.00 [0.01]	-0.01 [-0.28]
Share of hh cooking with charcoal or coal	0.36 [0.35]	-0.66 [-0.56]	-0.45 [-0.36]	-0.73 [-0.82]	-1.46 [-1.26]	-0.06 [-0.06]	2.08 [1.76]	-1.48 [-1.96]	-0.61 [-0.67]	-0.37 [-0.41]	0.64 [1.46]	-0.31 [-1.61]	-0.04 [-0.91]	-0.04 [-0.95]	-2.29 [-1.39]	-2.17 [-1.28]	0.07 [0.32]	0.83 [1.36]
Share of hh cooking with electricity	0.46 [0.41]	-0.70 [-0.56]	-0.25 [-0.19]	-0.44 [-0.47]	-1.47 [-1.18]	0.45 [0.40]	2.29 [1.81]	-1.40 [-1.74]	-0.89 [-0.92]	-0.23 [-0.25]	0.66 [1.50]	-0.21 [-0.97]	-0.04 [-0.85]	-0.04 [-0.91]	-2.21 [-1.25]	-2.15 [-1.19]	0.02 [0.11]	0.59 [0.89]
Share of hh cooking with firewood	0.16 [0.16]	-0.86 [-0.73]	-0.65 [-0.52]	-0.81 [-0.91]	-1.66 [-1.43]	-0.19 [-0.18]	2.74* [2.31]	-1.66* [-2.19]	-1.08 [-1.19]	-0.10 [-0.11]	0.58 [1.37]	-0.39 [-1.85]	-0.07 [-1.47]	-0.07 [-1.51]	-2.74 [-1.65]	-2.64 [-1.56]	0.03 [0.13]	0.75 [1.20]
Share of hh heads with lower primary education	0.25 [1.62]	0.27 [1.53]	0.19 [1.02]	-0.08 [-0.59]	-0.06 [-0.37]	0.01 [0.09]	-0.13 [-0.74]	0.13 [1.17]	-0.00 [-0.01]	0.07 [0.58]	-0.01 [-0.23]	0.20* [5.08]	0.01 [1.41]	0.01 [1.25]	0.20 [0.83]	0.27 [1.09]	-0.06* [-2.13]	-0.27** [-3.09]
Share of hh heads with upper secondary education	0.40** [2.90]	0.37* [2.35]	0.55** [3.32]	0.21 [1.75]	0.32* [2.06]	0.19 [1.33]	-0.44** [-2.80]	0.30** [3.02]	0.14 [1.14]	-0.05 [-0.40]	0.10* [2.17]	-0.36** [-10.37]	0.01* [2.41]	0.01* [2.41]	0.70** [3.27]	0.82*** [3.74]	-0.06* [-2.24]	-0.22** [-2.80]
Share of hh heads with lower secondary education	0.78*** [4.62]	0.75*** [3.92]	0.78*** [3.89]	0.56*** [3.91]	0.55** [2.92]	0.63*** [3.70]	-0.49* [-2.54]	0.37** [3.05]	0.11 [0.77]	-0.15 [-1.06]	0.18** [3.39]	-0.00 [-0.07]	0.02** [2.86]	0.02** [2.71]	0.77** [2.97]	0.83*** [3.12]	-0.06 [-1.69]	-0.19* [-2.07]
Share of hh with upper secondary education or more	0.50** [2.81]	0.64** [3.17]	0.54* [2.52]	0.34* [2.26]	0.37 [1.88]	0.35 [1.93]	-0.44* [-2.18]	0.05 [0.37]	0.39 [2.54]	* 0.05 [0.36]	-0.02 [-0.36]	-0.60** [-14.02]	0.00 [0.47]	0.00 [0.29]	-0.31 [-1.14]	-0.22 [-0.81]	-0.06 [-1.83]	-0.14 [-1.50]
Average age of household head	0.10 [0.26]	0.07 [0.15]	0.33 [0.70]	0.47 [1.42]	0.59 [1.36]	0.39 [0.98]	0.14 [0.31]	-0.30 [-1.05]	0.16 [0.48]	-0.18 [-0.56]	0.10 [0.78]	2.01** [14.13]	-0.01 [-0.83]	-0.02 [-0.98]	0.03 [0.06]	0.01 [0.01]	-0.04 [-0.58]	0.20 [0.95]
Share of male household heads	-0.18 [-0.97]	0.01 [0.03]	-0.40 [-1.77]	-0.01 [-0.04]	-0.07 [-0.34]	-0.13 [-0.67]	-0.42 [-1.93]	0.16 [1.17]	0.26 [1.55]	0.04 [0.23]	-0.15 [-1.76]	0.35* [5.73]	0.01 [1.41]	0.01 [1.47]	-0.01 [-0.05]	-0.08 [-0.26]	0.01 [0.21]	-0.12 [-1.07]
Share of married household heads	-0.15 [-0.56]	-0.02 [-0.06]	-0.13 [-0.42]	-0.53* [-2.40]	-0.83** [-2.89]	-0.10 [-0.38]	0.41 [1.38]	-0.22 [-1.18]	-0.19 [-0.82]	-0.14 [-0.66]	-0.20* [-2.21]	0.35* [5.26]	-0.02 [-1.84]	-0.02 [-1.80]	-0.53 [-1.33]	-0.50 [-1.22]	0.02 [0.48]	-0.03 [-0.22]
Share of separated household heads	0.14 [0.36]	0.47 [1.03]	-0.01 [-0.03]	0.08 [0.24]	0.09 [0.20]	0.08 [0.20]	-0.22 [-0.49]	-0.22 [-0.77]	0.45 [1.29]	-0.28 [-0.84]	-0.57* [-2.75]	2.32** [14.69]	-0.00 [-0.18]	-0.00 [-0.17]	0.12 [0.20]	0.30 [0.47]	-0.10 [-1.30]	-0.52* [-2.22]
Share of divorced household heads	-0.10 [-0.32]	0.02 [0.05]	-0.25 [-0.63]	-0.18 [-0.63]	-0.70 [-1.93]	0.41 [1.24]	0.77* [2.07]	-0.44 [-1.85]	-0.33 [-1.16]	-0.32 [-1.18]	-0.41** [-3.13]	-0.70** [-10.99]	-0.04** [-2.70]	-0.04** [-2.67]	-1.14* [-2.24]	-1.19* [-2.30]	0.01 [0.11]	-0.07 [-0.37]
Share of widowed household heads	0.01 [0.04]	0.52 [1.36]	-0.43 [-1.08]	-0.30 [-1.05]	-0.70 [-1.86]	-0.03 [-0.10]	-0.04 [-0.09]	-0.11 [-0.43]	0.14 [0.48]	0.12 [0.42]	-0.35* [-2.42]	2.03** [13.33]	-0.01 [-0.45]	-0.01 [-0.42]	-0.36 [-0.69]	-0.35 [-0.66]	0.02 [0.31]	-0.31 [-1.53]
Share of hh with children <= 60 months	8.16 [1.66]	0.63 [0.11]	9.74 [1.65]	-8.05 [-1.92]	-8.32 [-1.52]	-5.50 [-1.09]	1.82 [0.33]	-1.88 [-0.53]	0.06 [0.01]	-2.21 [-0.54]	-0.06 [-0.06]	-16.67** [-13.45]	-0.23 [-1.09]	-0.16 [-0.75]	-8.24 [-1.10]	-9.49 [-1.24]	1.11 [1.16]	1.61 [0.58]
Observations	478	476	478	478	478	477	478	478	478	468	190	142	478	478	468	468	468	443

t statistics in brackets
* p<0.05, ** p<0.01, *** p<0.001

Annex 5: Propensity score matching results (LCMS) roads

Extremely poor

	2006						**1998**			

1. treatment: building of new road (tarred or gravel) occurred

	Treated	Controls	ATT	T-stat			Treated	Controls	ATT	T-stat
Primary school attendance rate	0.68	0.66	0.02	0.5		Primary school attendance rate	0.6	0.57	0.03	0.54
Prim school attend rate male	0.62	0.66	-0.04	-0.62		Prim school attend rate male	0.52	0.59	-0.07	-0.78
Prim school attend rate female	0.77	0.67	0.09	1.59		Prim school attend rate female	0.63	0.56	0.07	0.87
Secondary school attendance rate	0.13	0.17	-0.04	-0.93		Secondary school attendance rate	0.19	0.13	0.06	0.78
Second school attend rate male	0.15	0.2	-0.04	-0.69		Second school attend rate male	0.13	0.15	-0.02	-0.17
Second school attend rate female	0.14	0.16	-0.02	-0.38		Second school attend rate female	0.23	0.1	0.12	1.28
Distance to public transport	4.48	8.86	-4.38	-2.54		Distance to public transport	2.58	8.9	-6.31	-5.81
Expenditures transport school	5660.38	1772.64	3887.74	0.9		Expenditures transport school	2213.11	225.81	1987.3	0.93
Expenditures transport work	9386.79	2263.07	7123.72	1.13		Expenditures transport work	327.87	95.79	232.08	0.71
Expenditures per capita	32840.91	32553.13	287.79	0.24		Expenditures per capita	14523.32	13888.98	634.34	0.62
Expenditures per adult equiv	38411.41	38162.92	248.49	0.18		Expenditures per adult equiv	16342.59	15827.74	514.85	0.45
Share consulted	0.67	0.6	0.07	0.89		Share consulted	0.47	0.32	0.14	1.55
Share cons and visited nonhealer	0.67	0.59	0.07	1.01		Share cons and visited nonhealer	0.43	0.29	0.14	1.6
Share cons and visited healer	0	0.01	-0.01	-1.57		Share cons and visited healer	0.03	0	0.03	0.86
Share healer	0	0.02	-0.02	-2.09		Share healer	0	0.01	-0.01	-0.47
						Revenue from food crops	98006.25	106069	-8062.73	-0.19

2. treatment: grading of gravel road occurred

	Treated	Controls	ATT	T-stat			Treated	Controls	ATT	T-stat
Primary school attendance rate	0.66	0.65	0.01	0.36		Primary school attendance rate	0.58	0.58	0	-0.16
Prim school attend rate male	0.67	0.65	0.02	0.67		Prim school attend rate male	0.56	0.59	-0.03	-1.06
Prim school attend rate female	0.65	0.66	-0.01	-0.36		Prim school attend rate female	0.6	0.58	0.03	0.85
Secondary school attendance rate	0.17	0.18	-0.01	-0.56		Secondary school attendance rate	0.14	0.14	0	-0.03
Second school attend rate male	0.16	0.21	-0.05	-1.73		Second school attend rate male	0.17	0.16	0.01	0.2
Second school attend rate female	0.18	0.15	0.03	0.95		Second school attend rate female	0.1	0.13	-0.03	-1.15
Distance to public transport	4.8	8.88	-4.08	-6.98		Distance to public transport	3.29	9.09	-5.81	-12.46
Expenditures transport school	1826.22	1657.94	168.27	0.16		Expenditures transport school	318.62	286.8	31.82	0.24
Expenditures transport work	4646.58	2063.42	2583.16	1.69		Expenditures transport work	90.21	98.22	-8.01	-0.16
Expenditures per capita	32844.29	33187.39	-343.1	-0.64		Expenditures per capita	14698.82	13893.42	805.4	2.22
Expenditures per adult equiv	38538.89	38776.6	-237.71	-0.39		Expenditures per adult equiv	16949.74	15945.04	1004.7	2.48
Share consulted	0.6	0.58	0.02	0.57		Share consulted	0.33	0.33	0	0.01
Share cons and visited nonhealer	0.6	0.57	0.03	0.94		Share cons and visited nonhealer	0.31	0.3	0.01	0.29
Share cons and visited healer	0	0.01	-0.01	-2.77		Share cons and visited healer	0.01	0.01	0.01	0.98
Share healer	0	0.02	-0.02	-2.34		Share healer	0.03	0.02	0.02	0.85
						Revenue from food crops	146454.3	107394	39060.3	1.48

3. treatment: tarring of gravel road occurred

	Treated	Controls	ATT	T-stat			Treated	Controls	ATT	T-stat
Primary school attendance rate	0.65	0.66	-0.01	-0.18		Primary school attendance rate	0.61	0.59	0.03	0.52
Prim school attend rate male	0.68	0.67	0.02	0.21		Prim school attend rate male	0.58	0.59	-0.01	-0.17
Prim school attend rate female	0.68	0.66	0.02	0.33		Prim school attend rate female	0.59	0.61	-0.02	-0.33
Secondary school attendance rate	0.26	0.18	0.08	1.08		Secondary school attendance rate	0.18	0.14	0.04	0.82
Second school attend rate male	0.28	0.19	0.1	1.06		Second school attend rate male	0.21	0.17	0.05	0.7
Second school attend rate female	0.21	0.18	0.03	0.29		Second school attend rate female	0.09	0.15	-0.06	-1.09
Distance to public transport	3.22	8.81	-5.59	-5.25		Distance to public transport	0.73	10.01	-9.28	-24.22
Expenditures transport school	1515.15	2234.74	-719.59	-0.45		Expenditures transport school	202.25	331.23	-128.98	-0.9
Expenditures transport work	0	2376.87	-2376.87	-5.13		Expenditures transport work	0	64.49	-64.49	-4
Expenditures per capita	32357.42	32577.36	-219.95	-0.13		Expenditures per capita	12912.57	13436.17	-523.6	-0.65
Expenditures per adult equiv	37956.16	38136.58	-180.42	-0.1		Expenditures per adult equiv	14485.83	15364.41	-878.58	-0.99
Share consulted	0.51	0.61	-0.1	-1.08		Share consulted	0.24	0.35	-0.11	-1.47
Share cons and visited nonhealer	0.51	0.61	-0.1	-1		Share cons and visited nonhealer	0.23	0.32	-0.09	-1.27
Share cons and visited healer	0	0.01	-0.01	-2.41		Share cons and visited healer	0.01	0.01	0.01	0.45
Share healer	0	0.01	-0.01	-1.87		Share healer	0.1	0.01	0.09	0.87
						Revenue from food crops	92301.51	107163.6	-14862.12	-0.5

4. treatment: any road project occurred

	Treated	Controls	ATT	T-stat			Treated	Controls	ATT	T-stat
Primary school attendance rate	0.66	0.65	0.01	0.43		Primary school attendance rate	0.58	0.59	-0.01	-0.36
Prim school attend rate male	0.67	0.65	0.02	0.72		Prim school attend rate male	0.56	0.59	-0.03	-1.15
Prim school attend rate female	0.67	0.66	0	0.13		Prim school attend rate female	0.59	0.58	0.01	0.29
Secondary school attendance rate	0.17	0.18	-0.02	-0.78		Secondary school attendance rate	0.15	0.14	0.01	0.29
Second school attend rate male	0.16	0.22	-0.06	-2		Second school attend rate male	0.18	0.16	0.01	0.48
Second school attend rate female	0.18	0.16	0.03	0.89		Second school attend rate female	0.1	0.14	-0.03	-1.51
Distance to public transport	4.8	9	-4.2	-7.15		Distance to public transport	3	9.42	-6.42	-14.69
Expenditures transport school	1851.37	4417.23	-2565.86	-2.38		Expenditures transport school	504.75	256.62	248.13	1.05
Expenditures transport work	5019.6	1865.97	3153.62	2.02		Expenditures transport work	106.01	88.19	17.82	0.33
Expenditures per capita	32951.44	33187.28	-235.84	-0.46		Expenditures per capita	14451.56	13785.56	666	2.01
Expenditures per adult equiv	38656.86	38741.82	-84.96	-0.15		Expenditures per adult equiv	16629.53	15803.76	825.77	2.22
Share consulted	0.61	0.59	0.02	0.46		Share consulted	0.33	0.33	0	-0.06
Share cons and visited nonhealer	0.61	0.58	0.03	0.86		Share cons and visited nonhealer	0.31	0.3	0.01	0.32
Share cons and visited healer	0	0.01	-0.01	-2.62		Share cons and visited healer	0.01	0.01	0.01	1.05
Share healer	0	0.02	-0.02	-3.15		Share healer	0.04	0.01	0.02	1.15
						Revenue from food crops	131664.2	108266.2	23397.95	1.03

5. treatment: transport service provided/improved occurred

	Treated	Controls	ATT	T-stat			Treated	Controls	ATT	T-stat
Primary school attendance rate	0.63	0.64	-0.01	-0.44		Primary school attendance rate	0.67	0.6	0.07	2.36
Prim school attend rate male	0.64	0.64	0	0.13		Prim school attend rate male	0.6	0.63	-0.03	-0.8
Prim school attend rate female	0.63	0.65	-0.03	-0.83		Prim school attend rate female	0.71	0.59	0.11	3.27
Secondary school attendance rate	0.16	0.17	-0.01	-0.31		Secondary school attendance rate	0.19	0.13	0.06	2.23
Second school attend rate male	0.18	0.18	0	0.07		Second school attend rate male	0.22	0.17	0.05	1.34
Second school attend rate female	0.15	0.15	-0.01	-0.23		Second school attend rate female	0.16	0.11	0.04	1.26
Distance to public transport	3.75	8.23	-4.48	-8.23		Distance to public transport	1.4	8.3	-6.89	-16.44
Expenditures transport school	2150.38	1677.7	472.67	0.42		Expenditures transport school	89.64	247.36	-157.72	-1.89
Expenditures transport work	778.99	2564.75	-1785.75	-2.35		Expenditures transport work	212.89	60.56	152.32	1.45
Expenditures per capita	33886.14	32593.45	1292.69	2.43		Expenditures per capita	15078.4	14021.53	1056.87	2.5
Expenditures per adult equiv	40318.1	38730.21	1587.89	2.64		Expenditures per adult equiv	17221.89	16149.13	1072.76	2.32
Share consulted	0.61	0.57	0.04	1.25		Share consulted	0.47	0.35	0.12	2.84
Share cons and visited nonhealer	0.6	0.55	0.05	1.66		Share cons and visited nonhealer	0.44	0.32	0.13	3
Share cons and visited healer	0	0.02	-0.02	-3.12		Share cons and visited healer	0.01	0	0	0.25
Share healer	0.01	0.03	-0.02	-1.99		Share healer	0.01	0.02	0	-0.24
						Revenue from food crops	55570.74	109909.2	-54338.49	-3.07

Moderately Poor

<table>
<tr><th colspan="5">2006</th><th colspan="5">1998</th></tr>
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1. treatment: building of new road (tarred or gravel) occurred

	Treated	Controls	ATT	T-stat		Treated	Controls	ATT	T-stat
Primary school attendance rate	0.73	0.73	0	-0.01	Primary school attendance rate	0.5	0.81	-0.31	-1.41
Prim school attend rate male	0.74	0.72	0.02	0.24	Prim school attend rate male	0.5	0.74	-0.24	-1.1
Prim school attend rate female	0.73	0.75	-0.02	-0.32	Prim school attend rate male	0.67	0.78	-0.11	-0.32
Secondary school attendance rate	0.31	0.26	0.05	0.51	Secondary school attendance rate	0.1	0.19	-0.09	-0.85
Second school attend rate male	0.29	0.28	0.02	0.16	Second school attend rate male	0.5	0.22	0.28	.
Second school attend rate female	0.25	0.24	0.01	0.09	Second school attend rate female	0	0.1	-0.1	-0.78
Distance to public transport	4.66	7.1	-2.44	-2.11	Distance to public transport	2.69	9.04	-6.35	-4.23
Expenditures transport school	2432.43	9778.57	-7346.13	-2.22	Expenditures transport school	0	868.14	-868.14	-2.14
Expenditures transport work	5000	11976.65	-6976.65	-1.39	Expenditures transport work	3307.69	228.68	3079.02	1.26
Expenditures per capita	69351.84	69497.62	-145.78	-0.1	Expenditures per capita	34389.1	34046.41	342.69	0.2
Expenditures per adult equiv	81011.47	81477.6	-466.13	-0.3	Expenditures per adult equiv	40587.53	39504.68	1082.85	0.91
Share consulted	0.52	0.6	-0.08	-0.87	Share consulted	0.5	0.48	0.02	0.1
Share cons and visited nonhealer	0.48	0.59	-0.11	-1.13	Share cons and visited nonhealer	0.5	0.44	0.06	0.31
Share cons and visited healer	0.04	0.01	0.02	0.65	Share cons and visited healer	0	0	0	.
Share healer	0.07	0.02	0.05	0.68	Share healer	0	0	0	.
					Revenue from food crops	158125	94844.53	63280.47	0.47

2. treatment: grading of gravel road occurred

	Treated	Controls	ATT	T-stat		Treated	Controls	ATT	T-stat
Primary school attendance rate	0.73	0.73	0	-0.05	Primary school attendance rate	0.66	0.69	-0.03	-0.59
Prim school attend rate male	0.71	0.73	-0.02	-0.46	Prim school attend rate male	0.63	0.7	-0.08	-1.1
Prim school attend rate female	0.77	0.73	0.03	0.98	Prim school attend rate female	0.75	0.64	0.12	1.49
Secondary school attendance rate	0.27	0.27	-0.01	-0.16	Secondary school attendance rate	0.13	0.15	-0.03	-0.62
Second school attend rate male	0.29	0.31	-0.03	-0.58	Second school attend rate male	0.18	0.17	0.01	0.16
Second school attend rate female	0.27	0.26	0.02	0.42	Second school attend rate female	0.14	0.13	0.01	0.08
Distance to public transport	5.15	6.97	-1.81	-2.7	Distance to public transport	5.09	8.76	-3.67	-3.08
Expenditures transport school	4321.76	9007.34	-4685.59	-1.34	Expenditures transport school	314.05	1667.52	-1353.47	-2.56
Expenditures transport work	9611.11	11212.78	-1601.67	-0.31	Expenditures transport work	363.64	407.91	-44.27	-0.14
Expenditures per capita	70482.89	70666.21	-183.32	-0.24	Expenditures per capita	33179.04	34111.97	-932.93	-1.63
Expenditures per adult equiv	81652.44	81877.69	-225.25	-0.33	Expenditures per adult equiv	38926.48	39593.49	-667.01	-1.6
Share consulted	0.63	0.6	0.03	0.7	Share consulted	0.31	0.41	-0.1	-1.56
Share cons and visited nonhealer	0.62	0.59	0.03	0.71	Share cons and visited nonhealer	0.28	0.39	-0.11	-1.74
Share cons and visited healer	0.02	0.02	0	0.13	Share cons and visited healer	0.01	0.01	0.01	0.35
Share healer	0.02	0.03	-0.01	-0.9	Share healer	0.05	0.01	0.04	0.84
					Revenue from food crops	172770.4	166876.8	5893.53	0.1

3. treatment: tarring of gravel road occurred

	Treated	Controls	ATT	T-stat		Treated	Controls	ATT	T-stat
Primary school attendance rate	0.7	0.73	-0.03	-0.39	Primary school attendance rate	0.89	0.63	0.26	2.17
Prim school attend rate male	0.76	0.71	0.05	0.57	Prim school attend rate male	0.83	0.68	0.15	0.86
Prim school attend rate female	0.69	0.76	-0.07	-0.85	Prim school attend rate female	1	0.72	0.28	5.5
Secondary school attendance rate	0.34	0.28	0.06	0.65	Secondary school attendance rate	0.21	0.19	0.03	0.16
Second school attend rate male	0.49	0.28	0.21	1.57	Second school attend rate male	.	.	.	.
Second school attend rate female	0.37	0.25	0.12	0.74	Second school attend rate female	.	.	.	.
Distance to public transport	3.89	7.21	-3.33	-3.57	Distance to public transport	2.14	10.63	-8.48	-4.32
Expenditures transport school	0	11101.72	-11101.72	-4.79	Expenditures transport school	275	1385.87	-1110.87	-1.78
Expenditures transport work	9241.38	11078.24	-1836.86	-0.32	Expenditures transport work	1500	316.94	1183.06	0.78
Expenditures per capita	69182.42	70150.61	-968.19	-0.62	Expenditures per capita	34441.72	34102.94	338.78	0.24
Expenditures per adult equiv	80945.53	81666.35	-720.82	-0.41	Expenditures per adult equiv	39796.17	39406.35	389.82	0.39
Share consulted	0.59	0.6	-0.01	-0.08	Share consulted	0.38	0.39	-0.01	-0.07
Share cons and visited nonhealer	0.59	0.59	0.00	0	Share cons and visited nonhealer	0.38	0.37	0	0.02
Share cons and visited healer	0	0.01	-0.01	-1.54	Share cons and visited healer	0	0	0	-0.48
Share healer	0	0.03	-0.03	-2.48	Share healer	0	0.01	-0.01	-0.52
					Revenue from food crops	87721.05	168724.3	-81003.19	-1.08

4. treatment: any road project occurred

	Treated	Controls	ATT	T-stat		Treated	Controls	ATT	T-stat
Primary school attendance rate	0.71	0.73	-0.02	-0.92	Primary school attendance rate	0.67	0.68	-0.01	-0.22
Prim school attend rate male	0.7	0.72	-0.03	-0.8	Prim school attend rate male	0.63	0.7	-0.06	-0.99
Prim school attend rate female	0.74	0.74	0	0	Prim school attend rate female	0.77	0.65	0.11	1.57
Secondary school attendance rate	0.26	0.28	-0.02	-0.55	Secondary school attendance rate	0.13	0.19	-0.06	-1.3
Second school attend rate male	0.29	0.32	-0.03	-0.56	Second school attend rate male	0.19	0.2	-0.02	-0.23
Second school attend rate female	0.28	0.26	0.02	0.35	Second school attend rate female	0.11	0.15	-0.04	-0.57
Distance to public transport	4.94	7.3	-2.36	-3.81	Distance to public transport	4.51	9.08	-4.57	-4.18
Expenditures transport school	4118.71	9340.64	-5221.93	-1.54	Expenditures transport school	295.92	1567.92	-1272	-2.5
Expenditures transport work	9050.3	11637.88	-2587.58	-0.54	Expenditures transport work	387.76	364.1	23.65	0.09
Expenditures per capita	70290.55	70592.48	-301.93	-0.42	Expenditures per capita	33312.77	34025.11	-712.34	-1.33
Expenditures per adult equiv	81569.1	81848.85	-279.75	-0.43	Expenditures per adult equiv	39157.68	39555.6	-397.92	-1.02
Share consulted	0.62	0.6	0.02	0.45	Share consulted	0.34	0.38	-0.05	-0.84
Share cons and visited nonhealer	0.61	0.59	0.02	0.49	Share cons and visited nonhealer	0.31	0.37	-0.06	-0.98
Share cons and visited healer	0.02	0.02	0	-0.09	Share cons and visited healer	0.01	0.01	0	0.31
Share healer	0.02	0.04	-0.02	-1.39	Share healer	0.03	0.01	0.03	0.72
					Revenue from food crops	157373.1	173904.6	-16531.51	-0.31

5. treatment: transport service provided/improved occurred

	Treated	Controls	ATT	T-stat		Treated	Controls	ATT	T-stat
Primary school attendance rate	0.72	0.72	0	-0.13	Primary school attendance rate	0.68	0.69	-0.01	-0.14
Prim school attend rate male	0.71	0.71	-0.01	-0.15	Prim school attend rate male	0.7	0.74	-0.04	-0.42
Prim school attend rate female	0.75	0.75	0	-0.01	Prim school attend rate female	0.7	0.69	0.01	0.1
Secondary school attendance rate	0.3	0.27	0.03	0.92	Secondary school attendance rate	0.22	0.11	0.11	1.41
Second school attend rate male	0.33	0.29	0.04	0.87	Second school attend rate male	0.2	0.18	0.02	0.22
Second school attend rate female	0.29	0.28	0.01	0.21	Second school attend rate female	0.3	0.12	0.18	1.44
Distance to public transport	3.1	6.7	-3.61	-6.76	Distance to public transport	1.86	7.01	-5.15	-4.67
Expenditures transport school	23138.46	7819.9	15318.56	1.77	Expenditures transport school	2917.65	756.01	2161.64	0.76
Expenditures transport work	6098.9	12793.78	-6694.88	-1.41	Expenditures transport work	1011.76	289.49	722.27	1.37
Expenditures per capita	68168.48	69271.21	-1102.73	-1.54	Expenditures per capita	34386.69	33971.09	415.6	0.57
Expenditures per adult equiv	81027.08	82100.96	-1073.89	-1.57	Expenditures per adult equiv	39852.67	39467.54	385.13	0.77
Share consulted	0.64	0.59	0.05	1.37	Share consulted	0.6	0.41	0.19	2.08
Share cons and visited nonhealer	0.63	0.57	0.06	1.49	Share cons and visited nonhealer	0.54	0.4	0.14	1.53
Share cons and visited healer	0.01	0.02	-0.01	-0.64	Share cons and visited healer	0.02	0	0.02	0.83
Share healer	0.02	0.04	-0.02	-1.26	Share healer	0.05	0	0.05	0.85
					Revenue from food crops	67171.88	155772.3	-88600.44	-1.82

Non Poor

2006   **1998**

1. treatment: building of new road (tarred or gravel) occurred

2006

	Treated	Controls	ATT	T-stat
Primary school attendance rate	0.8	0.76	0.05	0.73
Prim school attend rate male	0.73	0.8	-0.08	-0.78
Prim school attend rate female	0.83	0.72	0.12	1.57
Secondary school attendance rate	0.39	0.39	0	-0.06
Second school attend rate male	0.39	0.42	-0.03	-0.2
Second school attend rate female	0.39	0.38	0.01	0.1
Distance to public transport	6.19	5.43	0.76	0.45
Expenditures transport school	51919.19	68376.73	-16457.54	-0.57
Expenditures transport work	412525.3	45827.69	366697.6	1.01
Expenditures per capita	217272.7	231908.9	-14636.18	-0.58
Expenditures per adult equiv	234502.1	254316.4	-19814.32	-0.82
Share consulted	0.68	0.61	0.07	0.76
Share cons and visited nonhealer	0.64	0.59	0.06	0.61
Share cons and visited healer	0.04	0.02	0.01	0.32
Share healer	0.05	0.05	-0.01	-0.13

1998

	Treated	Controls	ATT	T-stat
Primary school attendance rate	0.63	0.69	-0.06	-0.54
Prim school attend rate male	0.57	0.74	-0.17	-1.05
Prim school attend rate female	0.71	0.72	0	-0.02
Secondary school attendance rate	0.17	0.27	-0.11	-1.07
Second school attend rate male	0.11	0.22	-0.11	-0.95
Second school attend rate female	0.33	0.25	0.09	0.4
Distance to public transport	1.56	8.23	-6.68	-7.09
Expenditures transport school	2083.33	1449.29	634.04	0.28
Expenditures transport work	8222.22	974.83	7247.39	1.27
Expenditures per capita	117063.1	120054.8	-2991.67	-0.11
Expenditures per adult equiv	126782.2	135086.4	-8304.18	-0.3
Share consulted	0.61	0.47	0.15	1.18
Share cons and visited nonhealer	0.6	0.44	0.17	1.31
Share cons and visited healer	0	0	0	-0.56
Share healer	0	0.01	-0.01	-0.46
Revenue from food crops	405568.2	305888.2	99679.99	0.41

2. treatment: grading of gravel road occurred

2006

	Treated	Controls	ATT	T-stat
Primary school attendance rate	0.8	0.79	0.01	0.42
Prim school attend rate male	0.85	0.8	0.05	1.59
Prim school attend rate female	0.76	0.78	-0.02	-0.6
Secondary school attendance rate	0.44	0.42	0.03	0.77
Second school attend rate male	0.49	0.43	0.06	1.15
Second school attend rate female	0.43	0.42	0.01	0.18
Distance to public transport	4.58	5.92	-1.34	-2.29
Expenditures transport school	112627.8	54735.22	57892.58	0.99
Expenditures transport work	111218.9	55299.42	55919.43	0.93
Expenditures per capita	206938.4	231072.3	-24133.87	-2.38
Expenditures per adult equiv	230927.4	254128.3	-23200.86	-2.22
Share consulted	0.66	0.63	0.03	0.96
Share cons and visited nonhealer	0.66	0.61	0.05	1.42
Share cons and visited healer	0	0.02	-0.02	-3.35
Share healer	0	0.03	-0.03	-3.21

1998

	Treated	Controls	ATT	T-stat
Primary school attendance rate	0.77	0.73	0.04	1
Prim school attend rate male	0.74	0.73	0	0.07
Prim school attend rate female	0.8	0.73	0.07	1.35
Secondary school attendance rate	0.21	0.27	-0.05	-1.15
Second school attend rate male	0.22	0.37	-0.15	-2.25
Second school attend rate female	0.25	0.22	0.03	0.55
Distance to public transport	3.02	7.4	-4.38	-6.65
Expenditures transport school	846.15	2207.87	-1361.71	-1.92
Expenditures transport work	1273.08	1306.6	-33.53	-0.05
Expenditures per capita	126669.2	115313.2	11355.96	0.66
Expenditures per adult equiv	139904	128277.4	11626.6	0.66
Share consulted	0.46	0.41	0.04	0.86
Share cons and visited nonhealer	0.42	0.39	0.03	0.61
Share cons and visited healer	0.01	0.01	0	0.15
Share healer	0.02	0.02	0	0.1
Revenue from food crops	716919.5	514239.8	202679.7	0.77

3. treatment: tarring of gravel road occurred

2006

	Treated	Controls	ATT	T-stat
Primary school attendance rate	0.71	0.81	-0.09	-1.26
Prim school attend rate male	0.7	0.83	-0.13	-1.43
Prim school attend rate female	0.69	0.78	-0.08	-0.73
Secondary school attendance rate	0.39	0.39	0	-0.02
Second school attend rate male	0.28	0.42	-0.13	-1.17
Second school attend rate female	0.53	0.4	0.13	1.04
Distance to public transport	2.56	6.14	-3.58	-6.24
Expenditures transport school	38205.13	69274.7	-31069.58	-1.08
Expenditures transport work	30769.23	68033.63	-37264.4	-1.46
Expenditures per capita	289257.9	218074.6	71183.36	1.11
Expenditures per adult equiv	323948.9	242709.9	81239.06	1.09
Share consulted	0.72	0.62	0.1	1.04
Share cons and visited nonhealer	0.72	0.61	0.11	1.19
Share cons and visited healer	0	0.02	-0.02	-3.2
Share healer	0	0.03	-0.03	-3.08

1998

	Treated	Controls	ATT	T-stat
Primary school attendance rate	0.76	0.73	0.04	0.43
Prim school attend rate male	0.77	0.72	0.05	0.42
Prim school attend rate female	0.77	0.81	-0.04	-0.32
Secondary school attendance rate	0.26	0.23	0.03	0.3
Second school attend rate male	0.39	0.24	0.15	0.97
Second school attend rate female	0.15	0.29	-0.14	-1.52
Distance to public transport	1	6.83	-5.83	-9.39
Expenditures transport school	2512.2	1351.48	1160.71	0.59
Expenditures transport work	3902.44	1107.34	2795.1	1.51
Expenditures per capita	81580.28	104858	-23277.72	-2.93
Expenditures per adult equiv	94066.89	117957.5	-23890.61	-2.54
Share consulted	0.49	0.47	0.02	0.12
Share cons and visited nonhealer	0.49	0.42	0.07	0.54
Share cons and visited healer	0	0.01	-0.01	-0.96
Share healer	0	0.01	-0.01	-0.38
Revenue from food crops	329079.3	287787.9	41291.44	0.34

4. treatment: any road project occurred

2006

	Treated	Controls	ATT	T-stat
Primary school attendance rate	0.79	0.79	-0.01	-0.23
Prim school attend rate male	0.81	0.81	0	-0.06
Prim school attend rate female	0.76	0.77	-0.02	-0.44
Secondary school attendance rate	0.43	0.41	0.02	0.58
Second school attend rate male	0.47	0.41	0.06	1.35
Second school attend rate female	0.41	0.41	0	0.01
Distance to public transport	4.45	6.01	-1.57	-2.74
Expenditures transport school	104551.2	51758.4	52792.8	1.01
Expenditures transport work	100396.9	53515.26	46881.66	0.89
Expenditures per capita	212375.9	227177.7	-14801.8	-1.26
Expenditures per adult equiv	237277.6	249510.5	-12232.87	-0.98
Share consulted	0.66	0.62	0.04	1.13
Share cons and visited nonhealer	0.66	0.6	0.05	1.56
Share cons and visited healer	0	0.02	-0.02	-2.55
Share healer	0.01	0.04	-0.03	-2.38

1998

	Treated	Controls	ATT	T-stat
Primary school attendance rate	0.75	0.74	0.02	0.44
Prim school attend rate male	0.71	0.73	-0.02	-0.39
Prim school attend rate female	0.8	0.75	0.05	0.93
Secondary school attendance rate	0.21	0.27	-0.06	-1.36
Second school attend rate male	0.23	0.36	-0.13	-2.18
Second school attend rate female	0.24	0.24	-0.01	-0.12
Distance to public transport	2.67	7.46	-4.79	-7.55
Expenditures transport school	789.81	2055.66	-1265.85	-1.8
Expenditures transport work	2028.66	1040.66	988	1.1
Expenditures per capita	118698.7	114031.9	4666.77	0.31
Expenditures per adult equiv	131795.5	127132.4	4663.07	0.31
Share consulted	0.46	0.41	0.05	1.01
Share cons and visited nonhealer	0.43	0.38	0.04	0.87
Share cons and visited healer	0.01	0.01	0	0.05
Share healer	0.02	0.02	0	0.04
Revenue from food crops	688456.7	497322.2	191134.5	0.84

5. treatment: transport service provided/improved occurred

2006

	Treated	Controls	ATT	T-stat
Primary school attendance rate	0.83	0.78	0.05	2.15
Prim school attend rate male	0.86	0.82	0.04	1.29
Prim school attend rate female	0.81	0.75	0.06	1.72
Secondary school attendance rate	0.43	0.39	0.03	1.02
Second school attend rate male	0.48	0.41	0.07	1.46
Second school attend rate female	0.39	0.36	0.03	0.69
Distance to public transport	2.48	6.45	-3.96	-8.77
Expenditures transport school	66640.13	99143.79	-32503.66	-1.23
Expenditures transport work	121576.4	46163.9	75412.54	1.26
Expenditures per capita	292451.1	206624.3	85826.81	1.59
Expenditures per adult equiv	315333.1	232959.4	82373.7	1.61
Share consulted	0.67	0.63	0.05	1.33
Share cons and visited nonhealer	0.66	0.61	0.05	1.31
Share cons and visited healer	0.01	0.01	0	0.02
Share healer	0.02	0.02	0	-0.28

1998

	Treated	Controls	ATT	T-stat
Primary school attendance rate	0.76	0.75	0.01	0.26
Prim school attend rate male	0.75	0.75	0	0.02
Prim school attend rate female	0.79	0.76	0.03	0.44
Secondary school attendance rate	0.24	0.26	-0.02	-0.45
Second school attend rate male	0.23	0.31	-0.08	-1.17
Second school attend rate female	0.29	0.25	0.04	0.52
Distance to public transport	1.35	6.26	-4.92	-7.65
Expenditures transport school	1472.53	1559.68	-87.15	-0.09
Expenditures transport work	1741.21	1364.95	376.25	0.54
Expenditures per capita	100445	107007.5	-6562.48	-0.41
Expenditures per adult equiv	109988.5	121381.5	-11393.07	-0.71
Share consulted	0.52	0.44	0.08	1.22
Share cons and visited nonhealer	0.53	0.39	0.14	2.15
Share cons and visited healer	0	0.01	-0.01	-1.5
Share healer	0	0.02	-0.02	-0.79
Revenue from food crops	661075.2	417009	244066.2	1.02

All rural households

1. treatment: building of new road (tarred or gravel) occurred

	2006 Treated	Controls	ATT	T-stat	1998 Treated	Controls	ATT	T-stat
Primary school attendance rate	0.73	0.7	0.02	0.8	0.61	0.61	0	0.02
Prim school attend rate male	0.68	0.7	-0.02	-0.56	0.54	0.61	-0.07	-1.03
Prim school attend rate female	0.77	0.71	0.06	1.65	0.66	0.61	0.05	0.74
Secondary school attendance rate	0.26	0.25	0.01	0.27	0.16	0.15	0.01	0.18
Second school attend rate male	0.26	0.27	-0.01	-0.23	0.12	0.18	-0.06	-1.06
Second school attend rate female	0.25	0.24	0.01	0.2	0.19	0.14	0.05	0.68
Share extremely poor	0.38	0.45	-0.06	-2.16	0.54	0.63	-0.08	-1.72
Share moderately poor	0.26	0.26	0	0.04	0.12	0.12	-0.01	-0.26
Share non-poor	0.35	0.29	0.06	2.17	0.34	0.25	0.09	1.99
Distance to public transport	5.17	7.19	-2.01	-2.2	2.22	8.49	-6.28	-9.43
Expenditures transport school	21142.86	22755.1	-1612.24	-0.17	1875	607.12	1267.88	0.94
Expenditures transport work	150732.1	17486.14	133246	1.03	3473.21	349.1	3124.12	1.65
Expenditures per capita	107773.8	98082.48	9691.34	1.01	53742.1	40034.18	13707.92	1.34
Expenditures per adult equiv	119046.2	110702.9	8343.23	0.89	59027.06	45152.28	13874.79	1.34
Share consulted	0.62	0.6	0.02	0.42	0.52	0.37	0.15	2.2
Share cons and visited nonhealer	0.6	0.58	0.02	0.32	0.5	0.35	0.15	2.33
Share cons and visited healer	0.02	0.02	0	0.3	0.02	0.01	0.01	0.7
Share healer	0.03	0.03	0	0.1	0.03	0.01	0.02	0.65
Revenue from food crops					200435	203896.9	-3461.92	-0.05

2. treatment: grading of gravel road occurred

	2006 Treated	Controls	ATT	T-stat	1998 Treated	Controls	ATT	T-stat
Primary school attendance rate	0.72	0.7	0.02	1.15	0.63	0.62	0.01	0.58
Prim school attend rate male	0.73	0.7	0.03	1.51	0.6	0.63	-0.03	-0.97
Prim school attend rate female	0.71	0.71	0	0.17	0.66	0.62	0.05	1.8
Secondary school attendance rate	0.27	0.26	0.01	0.63	0.15	0.17	-0.02	-0.95
Second school attend rate male	0.29	0.29	-0.01	-0.31	0.18	0.2	-0.02	-0.9
Second school attend rate female	0.29	0.25	0.03	1.53	0.14	0.15	-0.02	-0.7
Share extremely poor	0.39	0.43	-0.04	-2.63	0.58	0.63	-0.06	-3.32
Share moderately poor	0.25	0.27	-0.02	-1.71	0.14	0.12	0.02	1.39
Share non-poor	0.36	0.3	0.06	4.3	0.29	0.25	0.04	2.58
Distance to public transport	4.8	7.33	-2.53	-7.22	3.48	8.66	-5.17	-14.42
Expenditures transport school	42354.43	19179.04	23175.39	1.1	467.99	834.25	-366.26	-1.93
Expenditures transport work	44436.15	20615.56	23820.59	1.11	465.78	445.8	19.98	0.1
Expenditures per capita	105046.1	104726.3	319.79	0.08	49387.25	41123.97	8263.27	1.62
Expenditures per adult equiv	118677.9	116730.8	1947.13	0.47	55276.98	46263.88	9013.1	1.71
Share consulted	0.63	0.6	0.03	1.6	0.36	0.37	-0.01	-0.28
Share cons and visited nonhealer	0.63	0.58	0.05	2.19	0.33	0.34	-0.01	-0.27
Share cons and visited healer	0	0.02	-0.01	-3.33	0.01	0.01	0.01	1.08
Share healer	0.01	0.03	-0.03	-3.99	0.03	0.01	0.02	1.18
Revenue from food crops					302231.6	202903.8	99327.79	1.37

3. treatment: tarring of gravel road occurred

	2006 Treated	Controls	ATT	T-stat	1998 Treated	Controls	ATT	T-stat
Primary school attendance rate	0.69	0.71	-0.02	-0.48	0.68	0.62	0.06	1.42
Prim school attend rate male	0.71	0.71	0	-0.03	0.66	0.62	0.03	0.52
Prim school attend rate female	0.69	0.71	-0.02	-0.37	0.67	0.65	0.02	0.33
Secondary school attendance rate	0.32	0.25	0.07	1.43	0.19	0.16	0.03	0.73
Second school attend rate male	0.33	0.28	0.05	0.84	0.25	0.18	0.07	1.19
Second school attend rate female	0.37	0.25	0.12	1.73	0.1	0.17	-0.08	-1.91
Share extremely poor	0.33	0.44	-0.12	-3.46	0.58	0.66	-0.07	-1.79
Share moderately poor	0.29	0.26	0.02	0.7	0.14	0.12	0.03	0.91
Share non-poor	0.39	0.29	0.09	2.69	0.27	0.23	0.05	1.27
Distance to public transport	3.13	7.17	-4.03	-8.38	0.99	9.07	-8.08	-23.19
Expenditures transport school	15247.52	23876.19	-8628.67	-0.9	821.43	698.51	122.92	0.23
Expenditures transport work	14534.65	22549.63	-8014.98	-0.95	1512.99	352.93	1160.06	2.02
Expenditures per capita	142130.1	97734.53	44395.59	1.73	36326.15	35856.04	470.11	0.13
Expenditures per adult equiv	160732.5	110342.4	50390.06	1.69	41258.33	40675.56	582.77	0.14
Share consulted	0.62	0.61	0	0.04	0.34	0.36	-0.02	-0.29
Share cons and visited nonhealer	0.62	0.6	0.02	0.27	0.33	0.33	0	0.07
Share cons and visited healer	0	0.01	-0.01	-6.15	0.01	0.01	0	-0.24
Share healer	0	0.02	-0.02	-6.24	0.04	0.02	0.02	0.53
Revenue from food crops					146107.3	152866.9	-6759.65	-0.2

4. treatment: any road project occurred

	2006 Treated	Controls	ATT	T-stat	1998 Treated	Controls	ATT	T-stat
Primary school attendance rate	0.71	0.7	0.01	0.58	0.63	0.62	0.01	0.33
Prim school attend rate male	0.71	0.7	0.01	0.6	0.6	0.63	-0.03	-1.26
Prim school attend rate female	0.71	0.71	0	0.24	0.65	0.62	0.03	1.34
Secondary school attendance rate	0.27	0.27	0	0.26	0.16	0.17	-0.01	-0.94
Second school attend rate male	0.28	0.3	-0.01	-0.49	0.19	0.19	-0.01	-0.31
Second school attend rate female	0.28	0.25	0.03	1.46	0.13	0.16	-0.02	-1.22
Share extremely poor	0.39	0.43	-0.04	-3.3	0.58	0.64	-0.07	-4.03
Share moderately poor	0.25	0.27	-0.02	-1.54	0.14	0.12	0.02	1.8
Share non-poor	0.36	0.3	0.06	4.85	0.29	0.24	0.04	3.06
Distance to public transport	4.7	7.53	-2.83	-8.26	3.14	8.79	-5.66	-16.62
Expenditures transport school	39439.84	18956.18	20483.66	1.1	556.01	750.71	-194.7	-0.91
Expenditures transport work	40410.03	20272.92	20137.11	1.06	693.08	376.09	316.99	1.24
Expenditures per capita	107015.7	103703	3312.72	0.76	46879.39	41688.48	5190.92	1.2
Expenditures per adult equiv	121043.1	115536.6	5506.48	1.15	52690.28	46799.72	5890.56	1.32
Share consulted	0.63	0.59	0.04	1.8	0.36	0.36	0	-0.04
Share cons and visited nonhealer	0.62	0.58	0.05	2.42	0.34	0.33	0	0.16
Share cons and visited healer	0.01	0.02	-0.01	-3.3	0.01	0.01	0	1.02
Share healer	0.01	0.04	-0.03	-4.04	0.03	0.01	0.02	1.29
Revenue from food crops					279665.2	204553.4	75111.72	1.23

5. treatment: transport service provided/improved occurred

	2006 Treated	Controls	ATT	T-stat	1998 Treated	Controls	ATT	T-stat
Primary school attendance rate	0.71	0.7	0.01	0.66	0.69	0.65	0.04	1.66
Prim school attend rate male	0.72	0.7	0.01	0.7	0.64	0.66	-0.02	-0.71
Prim school attend rate female	0.71	0.71	0.01	0.31	0.73	0.64	0.08	2.93
Secondary school attendance rate	0.28	0.26	0.02	1.32	0.21	0.16	0.04	1.95
Second school attend rate male	0.3	0.28	0.03	1.16	0.22	0.19	0.02	0.71
Second school attend rate female	0.26	0.25	0.01	0.59	0.2	0.15	0.05	1.74
Share extremely poor	0.38	0.42	-0.04	-2.66	0.57	0.62	-0.04	-2.03
Share moderately poor	0.26	0.26	0	-0.27	0.14	0.12	0.01	0.96
Share non-poor	0.36	0.32	0.04	3.01	0.29	0.25	0.03	1.49
Distance to public transport	3.1	7.15	-4.05	-13.72	1.43	7.61	-6.18	-18.1
Expenditures transport school	30712.33	36271.27	-5558.94	-0.69	878.57	706.67	171.9	0.37
Expenditures transport work	45458.35	19145.39	26312.96	1.23	820.48	396.33	424.15	1.98
Expenditures per capita	135466	98046.52	37419.47	1.92	42900.59	40096.21	2804.37	0.6
Expenditures per adult equiv	149468.9	112304.9	37163.99	2.01	47639.55	45766.18	1873.37	0.4
Share consulted	0.64	0.59	0.05	2.6	0.5	0.36	0.14	4.28
Share cons and visited nonhealer	0.63	0.57	0.06	2.86	0.48	0.33	0.15	4.58
Share cons and visited healer	0.01	0.02	-0.01	-1.48	0.01	0.01	0	0.28
Share healer	0.01	0.03	-0.02	-2.13	0.01	0.02	0	-0.1
Revenue from food crops					212357.1	178676	33681.04	0.54

Annex 6: Panel regression results (LCMS) WSS

Table 1: access to boreholes

	(1) D	(2) D	(3) D 12	(4) D 12	(5) D 60	(6) D 60	(7) D b	(8) D b	(9) D b 12	(10) D b 12	(11) D b 60	(12) D b 60	(13) Prim	(14) Prim	(15) Prim mal	(16) Prim mal	(17) Prim fem	(18) Prim fem	(19) Sec	(20) Sec	(21) Sec mal	(22) Sec mal	(23) Sec fem	(24) Sec fem	(25) Exp pc	(26) Exp pc	(27) Exp pae	(28) Exp pae	(29) Treat w	(30) Treat w	(31) poorex	(32) poormod	(33) poor
Share of hh with water supply from borehole	-0.01 [-1.75]	-0.01 [-1.25]	0.02 [0.43]	0.04 [0.62]	-0.01 [-0.58]	-0.01 [-0.31]	0.00 [0.09]	0.00 [0.28]	-0.01 [-0.79]	-0.02 [-1.41]	-0.01 [-1.20]	-0.01 [-1.28]	0.20** [3.23]	0.17* [2.60]	0.26*** [3.68]	0.23** [3.13]	0.17* [2.23]	0.13 [1.69]	0.12* [2.11]	0.08 [1.41]	0.10 [1.43]	0.06 [0.89]	0.09 [1.34]	0.04 [0.66]	1.27*** [5.77]	0.68*** [4.61]	1.33*** [6.04]	0.74*** [4.99]	0.02 [0.33]	-0.07 [-1.27]	-0.23*** [-3.51]	0.16*** [3.42]	0.07 [1.37
Share of hh treating drinking water	-0.00 [-0.74]	-0.00 [-0.18]	0.02 [0.29]	0.04 [0.44]	0.01 [0.37]	0.02 [0.76]	0.00 [0.41]	0.00 [0.72]	0.04 [1.87]	0.03 [1.40]	0.01 [0.63]	0.01 [0.67]	0.22* [2.58]	0.18 [1.95]	0.21* [2.22]	0.16 [1.54]	0.25* [2.46]	0.18 [1.61]	0.20** [2.64]	0.11 [1.32]	0.29** [3.07]	0.21* [1.97]	0.12 [1.33]	0.04 [0.46]	2.72*** [9.21]	1.26*** [5.92]	2.74*** [9.30]	1.29*** [6.08]		-0.59*** [-6.68]		0.20** [3.20]	0.39 [5.53
Share of hh cooking with charcoal or coal	0.04 [0.66]		-0.13 [-0.14]		0.13 [0.41]		0.02 [1.02]		0.05 [0.21]		-0.01 [-0.10]		0.46 [0.46]		-0.47 [-0.42]		-0.43 [-0.35]		-0.74 [-0.82]		-1.59 [-1.39]		-0.02 [-0.02]		-4.68 [-1.32]		-4.82 [-1.36]		0.99 [1.09]	2.29* [2.17]		-1.42 [-1.91]	-0.87 [-1.0
Share of hh cooking with electricity	0.06 [0.94]		0.08 [0.08]		0.19 [0.59]		0.02 [0.80]		0.04 [0.15]		-0.04 [-0.31]		0.51 [0.48]		-0.61 [-0.51]		-0.24 [-0.19]		-0.42 [-0.44]		-1.54 [-1.27]		0.51 [0.45]		-4.50 [-1.19]		-4.72 [-1.26]		0.71 [0.73]	2.43* [2.17]		-1.34 [-1.70]	-1.09 [-1.2
Share of hh cooking with firewood	0.04 [0.67]		-0.09 [-0.09]		0.14 [0.45]		0.02 [1.05]		0.09 [0.37]		-0.00 [-0.04]		0.35 [0.35]		-0.55 [-0.49]		-0.54 [-0.44]		-0.77 [-0.86]		-1.70 [-1.49]		-0.12 [-0.12]		-6.29 [-1.78]		-6.45 [-1.82]		0.69 [0.75]	2.76** [2.62]		-1.55* [-2.08]	-1.21 [-1.4
Share of hh heads with lower primary education	-0.01 [-0.57]	-0.01 [-0.55]	0.07 [0.48]	0.07 [0.50]	-0.06 [-1.26]	-0.06 [-1.27]	0.00 [1.09]	0.00 [1.22]	0.02 [0.67]	0.02 [0.48]	0.01 [0.43]	0.01 [0.46]	0.27 [1.80]	0.22 [1.52]	0.29 [1.75]	0.27 [1.62]	0.20 [1.09]	0.15 [0.86]	-0.07 [-0.54]	-0.11 [-0.81]	-0.08 [-0.48]	-0.11 [-0.67]	0.02 [0.15]	-0.04 [-0.27]	0.82 [1.56]	0.48 [1.42]	0.73 [1.39]	0.39 [1.14]	0.17 [1.25]	0.10 [0.84]	-0.09 [-0.60]	0.14 [1.31]	-0.05 [-0.4
Share of hh heads with upper secondary education	0.00 [0.00]	0.00 [0.35]	0.12 [1.02]	0.13 [1.09]	-0.01 [-0.14]	0.00 [0.05]	0.00 [1.38]	0.01 [1.71]	0.02 [0.55]	0.00 [0.10]	0.03 [1.91]	0.03 [1.83]	0.40** [3.07]	0.33* [2.47]	0.35* [2.36]	0.28 [1.85]	0.56*** [3.50]	0.46** [2.85]	0.24* [2.04]	0.14 [1.21]	0.32* [2.16]	0.22 [1.45]	0.21 [1.48]	0.09 [0.63]	1.45** [3.13]	0.27 [0.87]	1.46** [3.18]	0.28 [0.91]	0.72 [0.72]	-0.06 [-0.52]	-0.44** [-3.21]	0.33*** [3.44]	0.11 [0.98
Share of hh heads with lower secondary education	-0.02 [-1.74]	-0.01 [-1.46]	-0.14 [-1.01]	-0.13 [-0.88]	-0.09 [-1.85]	-0.08 [-1.74]	-0.00 [-1.08]	-0.00 [-0.78]	0.04 [0.97]	0.00 [0.13]	0.01 [0.29]	0.00 [0.19]	0.69*** [4.39]	0.61*** [3.88]	0.57*** [3.26]	0.51** [2.89]	0.72*** [3.78]	0.64** [3.29]	0.59*** [4.18]	0.49*** [3.50]	0.50** [2.77]	0.42* [2.31]	0.65*** [3.91]	0.53** [3.15]	1.36* [2.46]	0.47 [1.27]	1.27* [2.30]	0.36 [0.99]	0.32* [2.29]	0.18 [1.35]	-0.34* [-2.05]	0.37** [3.22]	-0.04 [-0.2
Share of hh with upper secondary education or more	-0.02 [-1.62]	-0.01 [-1.28]	-0.12 [-0.80]	-0.10 [-0.67]	-0.11* [-2.08]	-0.09 [-1.86]	0.00 [1.08]	0.00 [1.03]	0.05 [1.28]	0.03 [0.90]	0.04 [1.78]	0.03 [1.64]	0.51** [3.04]	0.52** [3.19]	0.63** [3.32]	0.60** [3.29]	0.55** [2.69]	0.55** [2.78]	0.39* [2.58]	0.35* [2.46]	0.38 [1.96]	0.36 [1.96]	0.38* [2.14]	0.41* [2.37]	0.41 [0.69]	-0.48 [-1.26]	0.30 [0.50]	-0.58 [-1.54]	0.16 [1.04]	-0.03 [-0.22]	-0.44* [-2.49]	0.10 [0.77]	0.34 [2.43
Average age of household head	-0.00 [-0.76]	-0.00 [-0.86]	0.00 [0.76]	0.00 [0.73]	-0.00 [-0.67]	-0.00 [-0.71]	0.00 [1.25]	0.00 [1.10]	0.00 [0.49]	0.00 [0.77]	0.00 [0.70]	0.00 [0.73]	0.00 [0.53]	0.00 [0.58]	0.00 [0.51]	0.00 [0.62]	0.00 [0.84]	0.00 [0.97]	0.01 [1.56]	0.01 [1.77]	0.01 [1.38]	0.01 [1.62]	0.00 [1.13]	0.01 [1.31]	-0.01 [-0.75]	-0.01 [-0.88]	-0.01 [-0.92]	-0.01 [-1.12]	0.00 [0.86]	0.00 [0.61]	0.00 [0.23]	-0.00 [-0.76]	0.00 [0.38
Share of male household heads	0.00 [0.22]	0.01 [0.43]	0.10 [0.58]	0.10 [0.61]	0.03 [0.45]	0.03 [0.62]	-0.00 [-0.43]	-0.00 [-0.22]	0.05 [1.04]	0.05 [1.06]	-0.02 [-1.14]	-0.02 [-1.07]	-0.11 [-0.61]	-0.15 [-0.85]	0.11 [0.54]	0.06 [0.29]	-0.35 [-1.56]	-0.42 [-1.89]	0.01 [0.07]	-0.06 [-0.39]	-0.05 [-0.26]	-0.14 [-0.69]	-0.11 [-0.54]	-0.18 [-0.93]	1.40* [2.17]	0.20 [0.47]	1.47* [2.29]	0.27 [0.65]	0.06 [0.37]	-0.10 [-0.64]	-0.46* [-2.39]	0.19 [1.44]	0.26 [1.72
Share of married household heads	-0.01 [-0.75]	-0.01 [-0.95]	-0.16 [-0.69]	-0.19 [-0.83]	-0.01 [-0.14]	-0.02 [-0.28]	0.01 [1.35]	0.01 [1.40]	-0.02 [-0.29]	-0.00 [-0.04]	0.00 [0.05]	0.00 [0.13]	-0.06 [-0.26]	-0.04 [-0.18]	0.05 [0.19]	0.08 [0.31]	-0.05 [-0.16]	-0.03 [-0.11]	-0.44 [-1.97]	-0.42 [-1.95]	-0.77** [-2.73]	-0.75** [-2.70]	-0.03 [-0.12]	-0.03 [-0.13]	-1.37 [-1.56]	-0.72 [-1.27]	-1.30 [-1.49]	-0.65 [-1.15]	0.05 [0.24]	0.17 [0.82]	0.29 [1.10]	-0.11 [-0.62]	-0.17 [-0.8
Share of separated household heads	-0.03 [-1.06]	-0.03 [-1.17]	-0.38 [-1.08]	-0.38 [-1.10]	-0.07 [-0.62]	-0.07 [-0.62]	0.01 [1.37]	0.01 [1.35]	-0.06 [-0.62]	-0.04 [-0.45]	-0.05 [-1.11]	-0.04 [-0.97]	0.24 [0.62]	0.25 [0.65]	0.58 [1.35]	0.61 [1.43]	0.06 [0.13]	0.05 [0.12]	0.14 [0.40]	0.11 [0.33]	0.11 [0.24]	0.12 [0.27]	0.14 [0.34]	0.12 [0.29]	0.00 [0.00]	-0.69 [-0.79]	0.06 [0.04]	-0.61 [-0.69]	0.23 [0.65]	0.05 [0.17]	-0.26 [-0.65]	-0.15 [-0.52]	0.41 [1.27
Share of divorced household heads	0.00 [0.22]	0.00 [0.02]	0.06 [0.20]	0.01 [0.05]	0.01 [0.08]	-0.00 [-0.05]	0.00 [0.38]	0.00 [0.30]	0.05 [0.64]	0.06 [0.78]	-0.00 [-0.06]	-0.00 [-0.05]	0.04 [0.13]	0.13 [0.41]	0.17 [0.47]	0.25 [0.71]	-0.10 [-0.25]	-0.00 [-0.01]	-0.05 [-0.19]	0.01 [0.05]	-0.57 [-1.59]	-0.47 [-1.34]	0.50 [1.50]	0.59 [1.82]	-2.49* [-2.25]	-1.09 [-1.51]	-2.43* [-2.20]	-1.02 [-1.42]	-0.25 [-0.90]	-0.00 [-0.01]	0.51 [1.56]	-0.31 [-1.34]	-0.20 [-0.7
Share of widowed household heads	-0.01 [-0.66]	-0.01 [-0.72]	-0.20 [-0.67]	-0.23 [-0.76]	0.00 [0.01]	0.00 [0.01]	0.01 [1.31]	0.01 [1.40]	0.01 [0.14]	0.03 [0.38]	-0.02 [-0.45]	-0.01 [-0.37]	-0.00 [-0.00]	0.02 [0.08]	0.47 [1.30]	0.48 [1.35]	-0.43 [-1.11]	-0.44 [-1.15]	-0.27 [-0.94]	-0.29 [-1.03]	-0.68 [-1.85]	-0.71 [-1.97]	-0.01 [-0.04]	-0.02 [-0.06]	-0.59 [-0.52]	-0.74 [-1.01]	-0.54 [-0.48]	-0.69 [-0.94]	0.01 [0.05]	0.02 [0.10]	-0.05 [-0.15]	-0.08 [-0.34]	0.13 [0.48
Share of hh with children <= 60 months	0.00 [1.24]	0.00 [1.01]	0.01 [0.24]	0.01 [0.20]	0.02 [1.31]	0.02 [1.20]	-0.00 [-0.05]	-0.00 [-0.16]	0.00 [0.39]	0.01 [0.52]	-0.01 [-1.34]	-0.01 [-1.22]	0.08 [1.64]	0.08 [1.65]	0.00 [0.06]	0.01 [0.19]	0.09 [1.59]	0.09 [1.67]	-0.09* [-2.05]	-0.08* [-2.05]	-0.09 [-1.48]	-0.08 [-1.12]	-0.06 [-1.25]	-0.06 [-1.62]	-0.27 [-2.12]	-0.22* [-2.12]	-0.20 [-1.19]	-0.15 [-1.44]	0.15 [0.15]	0.00 [0.12]	0.03 [0.52]	-0.02 [-0.69]	-0.00 [-0.0
Share of hh in extreme poverty		0.00 [0.47]		0.03 [0.33]		0.02 [0.78]		0.00 [0.04]		0.02 [1.15]		0.01 [0.61]		-0.02 [-0.21]		-0.04 [-0.40]		-0.07 [-0.63]		-0.09 [-1.18]		-0.08 [-0.85]		-0.04 [-0.46]		-2.50*** [-12.39]		-2.46*** [-12.26]		-0.40*** [-6.22]			
Share of hh in moderate poverty		-0.01 [-0.64]		-0.01 [-0.11]		0.00 [0.11]		-0.00 [-1.05]		0.07* [2.28]		0.01 [0.55]		0.21 [1.67]		0.16 [1.09]		0.20 [1.31]		0.16 [1.37]		0.19 [1.31]		0.30* [2.25]		0.32 [1.07]		0.40 [1.37]		-0.12 [-1.17]			
Observations	479	479	458	458	478	478	479	479	458	458	478	478	479	479	477	477	479	479	479	479	479	479	478	478	479	479	479	479	479	479	479	479	479

t statistics in brackets
* p<0.05, ** p<0.01, *** p<0.001

Table 4: access to safe water sources

	(1) D	(2) D	(3) D 12	(4) D 12	(5) D 60	(6) D 60	(7) D b	(8) D b	(9) D b 12	(10) D b 12	(11) D b 60	(12) D b 60	(13) Prim	(14) Prim	(15) Prim mal	(16) Prim mal	(17) Prim fem	(18) Prim fem	(19) Sec	(20) Sec	(21) Sec mal	(22) Sec mal	(23) Sec fem	(24) Sec fem	(25) Exp pc	(26) Exp pc	(27) Exp pae	(28) Exp pae	(29) Treat w	(30) Treat w	(31) poorex	(32) poormod	(33) poornon
Share of hh with safe water supply	0.00 [0.61]	0.00 [0.85]	0.18 [3.30]	0.18*** [3.39]	0.02 [1.21]	0.03 [1.41]	0.00 [2.27]	0.00* [2.19]	-0.01 [-0.50]	-0.01 [-0.66]	0.01 [1.08]	0.01 [1.02]	0.17** [2.88]	0.17** [2.93]	0.25*** [3.70]	0.24*** [3.66]	0.09 [1.27]	0.09 [1.28]	0.06 [1.03]	0.05 [0.93]	0.02 [0.29]	0.02 [0.26]	-0.04 [-0.60]	-0.03 [-0.53]	0.36 [1.56]	0.11 [0.77]	0.35 [1.54]	0.11 [0.77]	-0.02 [-0.35]	-0.06 [-1.26]	-0.11 [-1.73]	0.01 [0.29]	0.10 [1.97]
Share of hh treating drinking water	-0.00 [-0.76]	0.00 [0.02]	0.03 [0.44]	0.05 [0.68]	0.01 [0.39]	0.03 [0.92]	0.00 [0.48]	0.00 [0.91]	0.04 [1.84]	0.03 [1.50]	0.01 [0.63]	0.01 [0.89]	0.23** [2.72]	0.18* [1.98]	0.23* [2.41]	0.16 [1.60]	0.26* [2.52]	0.18 [1.56]	0.20** [2.70]	0.10 [1.27]	0.30** [3.09]	0.20 [1.91]	0.12 [1.36]	0.04 [0.36]	2.78*** [8.66]	1.19*** [5.25]	2.80*** [8.68]	1.21*** [5.32]		-0.60*** [-6.64]		0.20** [3.19]	0.39*** [5.65]
Share of hh cooking with charcoal or coal	0.05 [0.85]		-0.04 [-0.04]		0.16 [0.54]		0.03 [1.15]		0.07 [0.27]		0.01 [0.08]		0.29 [0.29]		-0.66 [-0.59]		-0.62 [-0.50]		-0.87 [-0.97]		-1.73 [-1.51]		-0.19 [-0.17]		-6.36 [-1.66]		-6.59 [-1.71]		0.95 [1.05]	2.55* [2.37]		-1.66* [-2.16]	-0.90 [-1.08]
Share of hh cooking with electricity	0.07 [1.04]		0.08 [0.08]		0.21 [0.65]		0.02 [0.84]		0.05 [0.19]		-0.03 [-0.22]		0.37 [0.34]		-0.79 [-0.66]		-0.38 [-0.29]		-0.52 [-0.54]		-1.64 [-1.34]		0.42 [0.37]		-5.62 [-1.38]		-5.89 [-1.44]		0.69 [0.71]	2.62* [2.28]		-1.49 [-1.83]	-1.13 [-1.27]
Share of hh cooking with firewood	0.06 [0.90]		0.05 [0.05]		0.18 [0.59]		0.03 [1.21]		0.11 [0.43]		0.02 [0.17]		0.19 [0.19]		-0.73 [-0.65]		-0.74 [-0.60]		-0.92 [-1.02]		-1.86 [-1.62]		-0.32 [-0.30]		-8.13* [-2.12]		-8.38* [-2.18]		0.63 [0.70]	3.04** [2.82]		-1.81* [-2.37]	-1.23 [-1.48]
Share of hh heads with lower primary education	-0.00 [-0.37]	-0.00 [-0.33]	0.09 [0.70]	0.09 [0.70]	-0.05 [-1.12]	-0.05 [-1.13]	0.00 [1.27]	0.00 [1.38]	0.02 [0.68]	0.02 [0.55]	0.01 [0.62]	0.01 [0.70]	0.26 [1.71]	0.21 [1.47]	0.28 [1.70]	0.26 [1.57]	0.18 [0.97]	0.14 [0.77]	-0.09 [-0.65]	-0.12 [-0.89]	-0.10 [-0.58]	-0.13 [-0.76]	-0.00 [-0.02]	-0.06 [-0.40]	0.61 [1.07]	0.32 [0.90]	0.51 [0.88]	0.21 [0.59]	0.16 [1.20]	0.11 [0.89]	-0.06 [-0.40]	0.11 [0.99]	-0.05 [-0.39]
Share of hh heads with upper secondary education	0.00 [0.04]	0.00 [0.52]	0.14 [1.25]	0.16 [1.36]	-0.00 [-0.07]	0.01 [0.19]	0.00 [1.53]	0.01 [1.88]	0.02 [0.50]	0.01 [0.16]	0.03 [1.97]	0.03* [2.01]	0.42** [3.21]	0.33* [2.50]	0.38* [2.56]	0.28 [1.90]	0.57*** [3.53]	0.46** [2.80]	0.25* [2.08]	0.14 [1.16]	0.32* [2.16]	0.21 [1.39]	0.20 [1.42]	0.07 [0.52]	1.49** [2.97]	0.17 [0.52]	1.51** [2.99]	0.17 [0.52]	0.08 [0.69]	-0.06 [-0.52]	-0.45** [-3.22]	0.34** [3.34]	0.12 [1.10]
Share of hh heads with lower secondary education	-0.02* [-2.02]	-0.02 [-1.56]	-0.13 [-0.98]	-0.13 [-0.92]	-0.09* [-1.98]	-0.09 [-1.78]	-0.00 [-1.11]	-0.00 [-0.77]	0.03 [0.86]	0.00 [0.04]	0.00 [0.10]	0.00 [0.08]	0.76*** [4.90]	0.64*** [4.12]	0.67*** [3.86]	0.56*** [3.18]	0.79*** [4.12]	0.66*** [3.43]	0.63*** [4.51]	0.51*** [3.62]	0.53** [3.01]	0.43* [2.38]	0.69*** [4.13]	0.53* [3.21]	1.85** [3.11]	0.61 [1.57]	1.78** [2.98]	0.51 [1.32]	0.33* [2.37]	0.16 [1.25]	-0.43* [-2.55]	0.44*** [3.67]	-0.07 [-0.07]
Share of hh with upper secondary education or more	-0.02 [-1.53]	-0.01 [-1.22]	-0.12 [-0.80]	-0.11 [-0.75]	-0.10* [-2.06]	-0.09 [-1.87]	0.00 [1.09]	0.00 [1.00]	0.05 [1.32]	0.04 [0.99]	0.04 [1.83]	0.03 [1.70]	0.49** [2.87]	0.49** [3.02]	0.60** [3.14]	0.56** [3.09]	0.53* [2.56]	0.53** [2.65]	0.37* [2.46]	0.34* [2.36]	0.36 [1.89]	0.35 [1.90]	0.37* [2.07]	0.40* [2.35]	0.25 [0.38]	-0.58 [-1.46]	0.13 [0.19]	-0.69 [-1.73]	0.16 [1.03]	-0.02 [-0.13]	-0.41* [-2.26]	0.08 [0.59]	0.33* [2.38]
Average age of household head	-0.00 [-0.38]	-0.00 [-0.53]	0.00 [1.27]	0.00 [1.27]	-0.00 [-0.35]	-0.00 [-0.39]	0.00 [1.70]	0.00 [1.49]	0.00 [0.50]	0.00 [0.78]	0.00 [1.07]	0.00 [1.07]	0.00 [0.63]	0.00 [0.83]	0.00 [0.71]	0.00 [0.95]	0.00 [0.76]	0.00 [1.00]	0.01 [1.43]	0.01 [1.76]	0.01 [1.21]	0.01 [1.54]	0.00 [0.83]	0.00 [1.13]	-0.02 [-1.14]	-0.01 [-1.19]	-0.02 [-1.32]	-0.01 [-1.45]	0.00 [0.74]	0.00 [0.51]	0.00 [0.37]	-0.00 [-1.14]	0.00 [0.57]
Share of male household heads	0.01 [0.49]	0.01 [0.74]	0.10 [0.60]	0.11 [0.68]	0.03 [0.59]	0.04 [0.80]	-0.00 [-0.35]	-0.00 [-0.12]	0.05 [1.12]	0.05 [1.24]	-0.02 [-0.93]	-0.02 [-0.76]	-0.17 [-0.94]	-0.20 [-1.14]	0.04 [0.19]	-0.00 [-0.02]	-0.40 [-1.81]	-0.47* [-2.13]	-0.03 [-0.18]	-0.09 [-0.59]	-0.09 [-0.45]	-0.17 [-0.85]	-0.14 [-0.73]	-0.21 [-1.10]	0.92 [1.33]	-0.14 [-0.32]	0.97 [1.40]	-0.10 [-0.22]	0.05 [0.31]	-0.07 [-0.50]	-0.38 [-1.93]	0.13 [0.95]	0.25 [1.63]
Share of married household heads	-0.01 [-0.46]	-0.01 [-0.67]	-0.03 [-0.15]	-0.06 [-0.26]	0.01 [0.13]	0.00 [0.02]	0.01 [1.76]	0.01 [1.79]	-0.02 [-0.32]	-0.00 [-0.07]	0.01 [0.36]	0.01 [0.43]	-0.01 [-0.03]	0.04 [0.16]	0.15 [0.52]	0.20 [0.73]	-0.04 [-0.13]	-0.00 [-0.01]	-0.44 [-1.93]	-0.41 [-1.85]	-0.79** [-2.76]	-0.76** [-2.68]	-0.10 [-0.36]	-0.07 [-0.29]	-1.56 [-1.63]	-0.85 [-1.40]	-1.52 [-1.57]	-0.80 [-1.31]	0.03 [0.15]	0.14 [0.68]	0.29 [1.06]	-0.16 [-0.85]	-0.12 [-0.59]
Share of separated household heads	-0.02 [-0.91]	-0.03 [-1.06]	-0.48 [-1.44]	-0.47 [-1.41]	-0.07 [-0.62]	-0.07 [-0.63]	0.01 [1.27]	0.01 [1.29]	-0.05 [-0.50]	-0.02 [-0.27]	-0.05 [-1.05]	-0.04 [-0.86]	0.06 [0.15]	0.11 [0.30]	0.35 [0.80]	0.42 [1.01]	-0.07 [-0.15]	-0.05 [-0.10]	0.05 [0.14]	0.05 [0.16]	0.04 [0.09]	0.07 [0.17]	0.10 [0.25]	0.10 [0.24]	-0.89 [-0.60]	-1.15 [-1.24]	-0.86 [-0.59]	-1.10 [-1.18]	0.22 [0.64]	0.11 [0.34]	-0.08 [-0.21]	-0.25 [-0.84]	0.33 [1.04]
Share of divorced household heads	0.01 [0.40]	0.00 [0.14]	0.17 [0.62]	0.12 [0.43]	0.02 [0.25]	0.01 [0.09]	0.00 [0.62]	0.00 [0.50]	0.05 [0.63]	0.05 [0.73]	0.00 [0.13]	0.00 [0.09]	0.07 [0.21]	0.18 [0.60]	0.22 [0.61]	0.33 [0.94]	-0.10 [-0.26]	0.02 [0.05]	-0.06 [-0.22]	0.03 [0.09]	-0.59 [-1.64]	-0.48 [-1.34]	0.45 [1.35]	0.57 [1.75]	-2.71* [-2.25]	-1.14 [-1.50]	-2.67* [-2.21]	-1.08 [-1.41]	-0.27 [-0.95]	-0.02 [-0.09]	0.53 [1.56]	-0.35 [-1.47]	-0.17 [-0.66]
Share of widowed household heads	-0.01 [-0.70]	-0.01 [-0.72]	-0.19 [-0.65]	-0.20 [-0.70]	-0.00 [-0.01]	0.00 [0.02]	0.01 [1.31]	0.01 [1.44]	0.01 [0.12]	0.03 [0.35]	-0.02 [-0.49]	-0.01 [-0.37]	0.01 [0.04]	0.04 [0.13]	0.49 [1.35]	0.50 [1.43]	-0.42 [-1.06]	-0.43 [-1.11]	-0.26 [-0.89]	-0.28 [-1.01]	-0.67 [-1.81]	-0.70 [-1.95]	-0.00 [-0.01]	-0.02 [-0.07]	-0.46 [-0.37]	-0.70 [-0.90]	-0.41 [-0.33]	-0.64 [-0.82]	0.02 [0.06]	0.02 [0.07]	-0.07 [-0.20]	-0.06 [-0.25]	0.13 [0.49]
Share of hh with children <= 60 months	0.00 [1.21]	0.00 [0.98]	0.00 [0.04]	0.00 [0.07]	0.02 [1.27]	0.02 [1.16]	-0.00 [-0.15]	-0.00 [-0.23]	0.00 [0.42]	0.01 [0.56]	-0.01 [-1.38]	-0.01 [-1.25]	0.07 [1.50]	0.07 [1.57]	-0.01 [-0.11]	0.00 [0.09]	0.09 [1.52]	0.09 [1.63]	-0.09* [-2.08]	-0.08* [-2.07]	-0.09 [-1.65]	-0.08 [-1.48]	-0.05 [-1.06]	-0.06 [-1.21]	-0.28 [-1.56]	-0.23* [-2.02]	-0.21 [-1.16]	-0.15 [-1.35]	0.01 [0.16]	0.01 [0.16]	0.03 [0.59]	-0.02 [-0.68]	-0.01 [-0.13]
Share of hh in extreme poverty		0.00 [0.82]		0.07 [0.87]		0.03 [1.10]		0.00 [0.41]		0.03 [1.25]		0.01 [0.99]		-0.01 [-0.06]		-0.02 [-0.20]		-0.07 [-0.64]		-0.09 [-1.21]		-0.09 [-0.93]		-0.06 [-0.65]		-2.61*** [-12.17]		-2.59*** [-12.00]		-0.41*** [-6.23]			
Share of hh in moderate poverty		-0.01 [-0.73]		0.03 [0.31]		0.01 [0.18]		-0.00 [-0.86]		0.06* [2.04]		0.01 [0.47]		0.28* [2.24]		0.25 [1.78]		0.25 [1.62]		0.18 [1.62]		0.21 [1.44]		0.31* [2.31]		0.51 [1.62]		0.60 [1.92]		-0.15 [-1.43]			
Observations	479	479	458	458	478	478	479	479	458	458	478	478	479	479	477	477	479	479	479	479	479	479	478	478	479	479	479	479	479	479	479	479	479

t statistics in brackets
* p<0.05, ** p<0.01, *** p<0.001

Table 5: access to safe toilets

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)	(29)	(30) (31)	(32)	(33)
	D	D	D 12	D 12	D 60	D 60	D b	D b	D b 12	D b 12	D b 60	D b 60	Prim	Prim	Prim mal	Prim mal	Prim fem	Prim fem	Sec	Sec	Sec mal	Sec mal	Sec fem	Sec fem	Exp pc	Exp pc	Exp pae	Exp pae	Treat w	Treat w poorex	poormod	poornon
Share of hh with safe toilet	-0.01* [-2.31]	-0.01* [-1.99]	-0.00 [-0.04]	0.01 [0.11]	-0.04 [-1.64]	-0.03 [-1.53]	-0.00 [-0.64]	-0.00 [-0.54]	0.00 [0.25]	-0.00 [-0.15]	0.00 [0.04]	-0.00 [-0.07]	0.23** [3.11]	0.19* [2.60]	0.24** [2.79]	0.20* [2.40]	0.31*** [3.44]	0.28** [3.11]	0.21** [3.28]	0.19** [3.02]	0.20** [2.39]	0.17* [2.09]	0.27*** [3.48]	0.23** [3.07]	0.59* [2.07]	0.27 [1.50]	0.62* [2.16]	0.29 [1.59]	0.17* [2.55]	0.10 -0.10 [1.72][-1.28]	0.14* [2.59]	-0.04 [-0.66]
Share of hh treating drinking water*	-0.00 [-0.33]	0.00 [0.20]	0.02 [0.29]	0.03 [0.35]	0.02 [0.67]	0.03 [0.98]	0.00 [0.53]	0.00 [0.76]	0.04 [1.77]	0.03 [1.57]	0.01 [0.58]	0.01 [0.80]	0.17* [2.01]	0.12 [1.36]	0.17 [1.70]	0.10 [0.91]	0.19 [1.86]	0.12 [1.06]	0.15* [2.06]	0.07 [0.81]	0.25** [2.62]	0.17 [1.63]	0.07 [0.74]	0.00 [0.03]	2.64*** [8.11]	1.13*** [4.99]	2.65*** [8.12]	1.14*** [5.05]		-0.57*** [-6.20]	0.17** [2.69]	0.40*** [5.57]
Share of hh cooking with charcoal or coal	0.04 [0.60]		-0.18 [-0.19]		0.09 [0.31]		0.02 [0.95]		0.08 [0.33]		0.00 [0.03]		0.45 [0.45]		-0.56 [-0.49]		-0.29 [-0.24]		-0.63 [-0.72]		-1.48 [-1.31]		0.21 [0.20]		-5.88 [-1.54]		-6.07 [-1.58]		1.15 [1.29]	2.51* [2.31]	-1.47* [-1.96]	-1.04 [-1.23]
Share of hh cooking with electricity	0.06 [0.94]		0.05 [0.05]		0.18 [0.56]		0.02 [0.77]		0.06 [0.22]		-0.03 [-0.24]		0.46 [0.43]		-0.71 [-0.58]		-0.21 [-0.16]		-0.40 [-0.43]		-1.51 [-1.26]		0.60 [0.55]		-5.35 [-1.32]		-5.60 [-1.37]		0.77 [0.81]	2.59* [2.24]	-1.40 [-1.75]	-1.18 [-1.32]
Share of hh cooking with firewood	0.04 [0.65]		-0.15 [-0.15]		0.11 [0.36]		0.02 [0.98]		0.13 [0.50]		0.01 [0.10]		0.29 [0.29]		-0.70 [-0.61]		-0.45 [-0.37]		-0.70 [-0.80]		-1.63 [-1.44]		0.07 [0.07]		-7.77* [-2.03]		-7.99* [-2.08]		0.85 [0.95]	3.03** [2.80]	-1.64* [-2.18]	-1.39 [-1.65]
Share of hh heads with lower primary education	-0.01 [-0.55]	-0.01 [-0.56]	0.06 [0.45]	0.06 [0.46]	-0.06 [-1.31]	-0.06 [-1.36]	0.00 [1.05]	0.00 [1.15]	0.03 [0.73]	0.02 [0.59]	0.01 [0.54]	0.01 [0.61]	0.25 [1.68]	0.21 [1.42]	0.26 [1.56]	0.24 [1.43]	0.20 [1.10]	0.16 [0.91]	-0.07 [-0.56]	-0.10 [-0.77]	-0.08 [-0.48]	-0.10 [-0.63]	0.03 [0.23]	-0.02 [-0.13]	0.61 [1.08]	0.34 [0.96]	0.51 [0.90]	0.23 [0.65]	0.18 [1.34]	0.13 -0.06 [1.12][-0.35]	0.13 [1.13]	-0.07 [-0.57]
Share of hh heads with upper secondary education	0.00 [0.19]	0.00 [0.51]	0.12 [1.02]	0.13 [1.04]	-0.00 [-0.01]	0.00 [0.12]	0.00 [1.43]	0.01 [1.70]	0.02 [0.52]	0.01 [0.22]	0.03 [1.89]	0.03 [1.93]	0.37** [2.81]	0.29* [2.20]	0.31* [2.09]	0.23 [1.52]	0.52** [3.28]	0.43** [2.70]	0.21 [1.81]	0.12 [1.05]	0.29* [1.99]	0.20 [1.35]	0.17 [1.22]	0.07 [0.51]	1.36** [2.73]	0.14 [0.43]	1.38** [2.75]	0.14 [0.43]	0.06 [0.50]	-0.05 -0.43** [-0.45][-3.01]	0.31** [3.18]	0.11 [1.02]
Share of hh heads with lower secondary education	-0.02 [-1.83]	-0.02 [-1.52]	-0.14 [-0.96]	-0.12 [-0.84]	-0.09 [-1.82]	-0.08 [-1.74]	-0.00 [-1.02]	-0.00 [-0.74]	0.03 [0.85]	0.00 [0.03]	0.00 [0.10]	0.00 [0.09]	0.72*** [4.63]	0.63*** [4.04]	0.63*** [3.54]	0.55** [3.06]	0.73*** [3.92]	0.65*** [3.43]	0.59*** [4.33]	0.50*** [3.62]	0.50** [2.83]	0.42** [2.36]	0.64*** [3.94]	0.52** [3.21]	1.74** [2.93]	0.59 [1.54]	1.67** [2.80]	0.50 [1.29]	0.29* [2.08]	0.15 -0.41* [1.20][-2.42]	0.41*** [3.49]	-0.00 [-0.01]
Share of hh with upper secondary education or more	-0.01 [-1.35]	-0.01 [-1.02]	-0.12 [-0.82]	-0.11 [-0.72]	-0.10 [-1.92]	-0.08 [-1.70]	0.00 [1.13]	0.00 [1.06]	0.05 [1.31]	0.04 [0.99]	0.04 [1.82]	0.03 [1.71]	0.44** [2.61]	0.45** [2.78]	0.55** [2.86]	0.53** [2.84]	0.47* [2.34]	0.47* [2.42]	0.33* [2.25]	0.30* [2.13]	0.33 [1.71]	0.32 [1.72]	0.32 [1.84]	0.35* [2.10]	0.14 [0.21]	-0.63 [-1.59]	0.09 [0.02]	-0.75 [-1.87]	0.12 [0.80]	-0.04 -0.39* [-0.31][-2.14]	0.05 [0.39]	0.34* [2.41]
Average age of household head	-0.00 [-0.64]	-0.00 [-0.77]	0.00 [0.71]	0.00 [0.67]	-0.00 [-0.69]	-0.00 [-0.72]	0.00 [1.22]	0.00 [1.06]	0.00 [0.60]	0.00 [0.91]	0.00 [0.88]	0.00 [0.88]	0.00 [0.23]	0.00 [0.34]	0.00 [0.13]	0.00 [0.30]	0.00 [0.72]	0.00 [0.87]	0.00 [1.47]	0.00 [1.73]	0.01 [1.33]	0.01 [1.60]	0.01 [1.19]	0.00 [1.37]	0.01 [-1.37]	-0.02 [-1.33]	-0.01 [-1.55]	-0.02 [-1.59]	-0.01 [0.94]	0.00 0.00 [0.82][0.65]	-0.00 [-1.10]	0.00 [0.14]
Share of male household heads	0.01 [0.63]	0.01 [0.78]	0.09 [0.54]	0.09 [0.52]	0.04 [0.65]	0.04 [0.77]	-0.00 [-0.40]	-0.00 [-0.25]	0.05 [1.11]	0.06 [1.27]	-0.02 [-0.98]	-0.02 [-0.83]	-0.23 [-1.27]	-0.27 [-1.49]	-0.03 [-0.16]	-0.09 [-0.42]	-0.47* [-2.15]	-0.52* [-2.44]	-0.07 [-0.45]	-0.13 [-0.83]	-0.13 [-0.62]	-0.20 [-0.98]	-0.18 [-0.96]	-0.23 [-1.23]	0.78 [1.13]	-0.20 [-0.46]	0.83 [1.19]	-0.16 [-0.36]	0.02 [0.15]	-0.07 -0.35 [-0.49][-1.76]	0.11 [0.78]	0.24 [1.57]
Share of married household heads	-0.01 [-0.82]	-0.02 [-1.06]	-0.16 [-0.72]	-0.20 [-0.87]	-0.02 [-0.25]	-0.03 [-0.42]	0.01 [1.28]	0.01 [1.32]	-0.01 [-0.22]	0.00 [0.05]	0.00 [0.16]	0.01 [0.23]	-0.06 [-0.26]	-0.03 [-0.12]	0.03 [0.12]	0.08 [0.30]	-0.01 [-0.04]	0.02 [0.07]	-0.41 [-1.88]	-0.38 [-1.79]	-0.74** [-2.65]	-0.71* [-2.58]	0.02 [0.09]	0.03 [0.13]	-1.65 [-1.75]	-0.84 [-1.42]	-1.59 [-1.68]	-0.79 [-1.31]	0.10 [0.46]	0.22 0.34 [1.11][1.26]	-0.12 [-0.67]	-0.21 [-1.02]
Share of separated household heads	-0.02 [-0.77]	-0.02 [-0.92]	-0.39 [-1.12]	-0.40 [-1.17]	-0.05 [-0.48]	-0.06 [-0.51]	0.01 [1.40]	0.01 [1.36]	-0.05 [-0.57]	-0.03 [-0.29]	-0.04 [-0.99]	-0.04 [-0.83]	0.05 [0.13]	0.08 [0.22]	0.36 [0.83]	0.40 [0.94]	-0.13 [-0.27]	-0.11 [-0.25]	0.01 [0.02]	0.00 [0.01]	-0.01 [-0.02]	0.02 [0.05]	0.02 [0.04]	0.02 [0.05]	-0.93 [-0.64]	-1.21 [-1.31]	-0.92 [-0.63]	-1.16 [-1.26]	0.16 [0.47]	0.06 -0.09 [0.21][-0.22]	-0.28 [-0.98]	0.37 [1.17]
Share of divorced household heads	0.00 [0.02]	-0.00 [-0.20]	0.05 [0.16]	0.01 [0.04]	-0.01 [-0.11]	-0.02 [-0.25]	0.00 [0.28]	0.00 [0.22]	0.05 [0.73]	0.06 [0.79]	0.00 [0.02]	-0.00 [-0.01]	0.11 [0.35]	0.21 [0.67]	0.22 [0.61]	0.32 [0.91]	0.03 [0.07]	0.13 [0.34]	0.03 [0.12]	0.11 [0.41]	-0.48 [-1.36]	-0.39 [-1.10]	0.63 [1.93]	0.72* [2.24]	-2.56* [-2.13]	-1.05 [-1.37]	-2.50* [-2.07]	-0.97 [-1.27]	-0.15 [-0.54]	0.07 0.53 [0.26][1.55]	-0.28 [-1.17]	-0.25 [-0.94]
Share of widowed household heads	-0.01 [-0.66]	-0.01 [-0.71]	-0.20 [-0.66]	-0.23 [-0.76]	0.00 [0.03]	0.00 [0.02]	0.01 [1.33]	0.01 [1.41]	0.01 [0.12]	0.03 [0.37]	-0.02 [-0.48]	-0.01 [-0.38]	0.00 [0.01]	0.02 [0.08]	0.48 [1.31]	0.48 [1.35]	-0.44 [-1.14]	-0.45 [-1.18]	-0.27 [-0.97]	-0.29 [-1.07]	-0.68 [-1.88]	-0.71* [-2.00]	-0.03 [-0.09]	-0.03 [-0.10]	-0.49 [-0.40]	-0.71 [-0.93]	-0.44 [-0.36]	-0.66 [-0.85]	0.00 [0.01]	0.02 -0.07 [0.06][-0.20]	-0.07 [-0.30]	0.14 [0.52]
Share of hh with children <= 60 months	0.00 [1.09]	0.00 [0.88]	0.01 [0.24]	0.01 [0.20]	0.02 [1.21]	0.02 [1.10]	-0.00 [-0.10]	-0.00 [-0.19]	0.00 [0.41]	0.01 [0.52]	-0.01 [-1.32]	-0.01 [-1.22]	0.09 [1.83]	0.08 [1.82]	0.01 [0.24]	0.02 [0.35]	0.10 [1.85]	0.10 [1.90]	-0.08 [-1.87]	-0.07 [-1.89]	-0.08 [-1.50]	-0.07 [-1.36]	-0.04 [-0.88]	-0.05 [-1.06]	-0.24 [-1.36]	-0.21 [-1.42]	-0.17 [-1.90]	-0.14 [-1.23]	0.01 [0.31]	0.01 0.02 [0.23][0.42]	-0.02 [-0.51]	-0.00 [-0.09]
Share of hh in extreme poverty		0.00 [0.75]		0.02 [0.23]		0.02 [0.90]		0.00 [0.02]		0.03 [1.39]		0.01 [0.82]		-0.06 [-0.72]		-0.10 [-0.98]		-0.11 [-1.03]		-0.12 [-1.56]		-0.11 [-1.09]		-0.06 [-0.69]		-2.66*** [-12.65]		-2.63*** [-12.48]		-0.39*** [-6.09]		
Share of hh in moderate poverty		-0.00 [-0.43]		-0.01 [-0.05]		0.01 [0.35]		-0.00 [-0.91]		0.06* [2.12]		0.01 [0.40]		0.19 [1.50]		0.15 [1.00]		0.15 [0.96]		0.11 [1.01]		0.15 [1.03]		0.24 [1.82]		0.40 [1.27]		0.49 [1.55]		-0.17 [-1.62]		
Observations	479	479	458	458	478	478	479	479	458	458	478	478	479	479	477	477	479	479	479	479	479	479	478	478	479	479	479	479	479	479 479	479	479

t statistics in brackets
* p<0.05, ** p<0.01, *** p<0.001

Table 3: access to boreholes and safe toilets

	(1) D	(2) D	(3) D 12	(4) D 12	(5) D 60	(6) D 60	(7) D b	(8) D b	(9) D b 12	(10) D b 12	(11) D b 60	(12) D b 60	(13) Prim	(14) Prim	(15) Prim mal	(16) Prim mal	(17) Prim fem	(18) Prim fem	(19) Sec	(20) Sec	(21) Sec mal	(22) Sec mal	(23) Sec fem	(24) Sec fem	(25) Exp pc	(26) Exp pc	(27) Exp pae	(28) Exp pae	(29) Treat w	(30) Treat w	(31) poorex	(32) poormod	(33) poor
Share of hh with water supply from borehole and sa	-0.01 [-1.44]	-0.01 [-0.90]	0.04 [0.59]	0.06 [0.78]	-0.01 [-0.50]	-0.01 [-0.23]	-0.00 [-0.22]	-0.00 [-0.01]	-0.02 [-1.12]	-0.04 [-1.84]	-0.02 [-1.71]	-0.02 [-1.87]	0.23** [2.64]	0.18* [2.04]	0.26** [2.61]	0.20* [2.04]	0.27* [2.57]	0.22* [2.07]	0.11 [1.40]	0.05 [0.69]	0.13 [1.34]	0.08 [0.79]	0.13 [1.48]	0.08 [0.85]	1.41*** [4.53]	0.68** [3.29]	1.47*** [4.74]	0.74** [3.57]	0.04 [0.47]	-0.06 [-0.83]	-0.28** [-3.13]	0.22*** [3.54]	0.06 [0.81]
Share of hh treating drinking water	-0.00 [-0.73]	-0.00 [-0.12]	0.02 [0.28]	0.04 [0.43]	0.01 [0.38]	0.02 [0.77]	0.00 [0.42]	0.00 [0.70]	0.04 [1.89]	0.03 [1.42]	0.01 [0.66]	0.01 [0.69]	0.21* [2.54]	0.17 [1.82]	0.21* [2.17]	0.14 [1.35]	0.25* [2.43]	0.18 [1.58]	0.20** [2.62]	0.10 [1.22]	0.29** [3.05]	0.20 [1.94]	0.12 [1.33]	0.04 [0.46]	2.72*** [8.89]	1.21*** [5.55]	2.74*** [8.95]	1.24** [5.66]		-0.58*** [-6.60]	0.20** [3.17]	0.39 [5.51]	
Share of hh cooking with charcoal or coal	0.05 [0.75]		-0.14 [-0.15]		0.13 [0.44]		0.02 [1.00]		0.06 [0.23]		-0.01 [-0.07]		0.29 [0.28]		-0.71 [-0.62]		-0.53 [-0.43]		-0.85 [-0.95]		-1.66 [-1.46]		-0.07 [-0.06]		-5.78 [-1.58]		-5.97 [-1.64]		0.99 [1.09]	2.47* [2.34]	-1.53* [-2.07]	-0.94 [-1.1]	
Share of hh cooking with electricity	0.07 [1.01]		0.06 [0.06]		0.20 [0.62]		0.02 [0.79]		0.05 [0.19]		-0.03 [-0.27]		0.36 [0.33]		-0.82 [-0.67]		-0.36 [-0.28]		-0.52 [-0.54]		-1.62 [-1.33]		0.45 [0.40]		-5.48 [-1.41]		-5.74 [-1.48]		0.70 [0.72]	2.60* [2.31]	-1.46 [-1.85]	-1.14 [-1.2]	
Share of hh cooking with firewood	0.05 [0.77]		-0.10 [-0.10]		0.14 [0.48]		0.02 [1.03]		0.10 [0.38]		-0.00 [-0.03]		0.18 [0.18]		-0.79 [-0.69]		-0.62 [-0.51]		-0.89 [-0.99]		-1.78 [-1.56]		-0.16 [-0.15]		-7.37* [-2.02]		-7.57* [-2.07]		0.69 [0.75]	2.93** [2.78]	-1.64* [-2.22]	-1.29 [-1.5]	
Share of hh heads with lower primary education	-0.00 [-0.51]	-0.00 [-0.49]	0.07 [0.49]	0.07 [0.52]	-0.06 [-1.24]	-0.06 [-1.26]	0.00 [1.07]	0.00 [1.18]	0.02 [0.64]	0.02 [0.44]	0.01 [0.43]	0.01 [0.43]	0.25 [1.67]	0.21 [1.41]	0.27 [1.57]	0.24 [1.44]	0.19 [1.07]	0.16 [0.87]	-0.08 [-0.63]	-0.12 [-0.90]	-0.09 [-0.52]	-0.12 [-0.70]	0.02 [0.13]	-0.04 [-0.27]	0.71 [1.31]	0.42 [1.19]	0.61 [1.13]	0.31 [0.90]	0.17 [1.25]	0.11 [0.91]	-0.08 [-0.49]	0.14 [1.24]	-0.06 [-0.4]
Share of hh heads with upper secondary education	0.00 [0.06]	0.00 [0.42]	0.12 [0.99]	0.13 [1.07]	-0.00 [-0.12]	0.00 [0.07]	0.00 [1.39]	0.01 [1.69]	0.02 [0.59]	0.00 [0.15]	0.03 [1.98]	0.03 [1.87]	0.39** [2.94]	0.31* [2.33]	0.33* [2.21]	0.25 [1.65]	0.54*** [3.41]	0.46** [2.81]	0.23* [1.97]	0.13 [1.11]	0.31* [2.11]	0.21 [1.41]	0.20 [1.41]	0.09 [0.61]	1.36** [2.86]	0.19 [0.61]	1.38** [2.89]	0.20 [0.62]	0.08 [0.70]	-0.05 [-0.45]	-0.42** [-3.07]	0.32** [3.32]	0.10 [0.94]
Share of hh heads with lower secondary education	-0.02 [-1.81]	-0.02 [-1.50]	-0.15 [-1.03]	-0.13 [-0.89]	-0.09 [-1.88]	-0.08 [-1.75]	-0.00 [-1.04]	-0.00 [-0.76]	0.04 [1.00]	0.01 [0.14]	0.01 [0.34]	0.00 [0.22]	0.71*** [4.48]	0.62*** [3.92]	0.61*** [3.40]	0.53** [2.96]	0.72*** [3.79]	0.63** [3.30]	0.60*** [4.29]	0.50*** [3.56]	0.50** [2.81]	0.42* [2.33]	0.65*** [3.91]	0.52** [3.15]	1.50** [2.62]	0.52 [1.38]	1.41* [2.47]	0.42 [1.12]	0.32* [2.28]	0.17 [1.31]	-0.36* [-2.15]	0.38** [3.28]	-0.02 [-0.1]
Share of hh with upper secondary education or more	-0.02 [-1.50]	-0.01 [-1.18]	-0.12 [-0.82]	-0.11 [-0.72]	-0.10* [-2.04]	-0.09 [-1.83]	0.00 [1.08]	0.00 [1.01]	0.05 [1.33]	0.04 [1.02]	0.04 [1.87]	0.03 [1.79]	0.48** [2.81]	0.48** [2.95]	0.59** [3.04]	0.56** [3.00]	0.52* [2.55]	0.52** [2.63]	0.37* [2.44]	0.34* [2.35]	0.36 [1.87]	0.35 [1.88]	0.37* [2.05]	0.40* [2.31]	0.20 [0.32]	-0.62 [-1.59]	0.07 [0.12]	-0.73 [-1.89]	0.16 [1.02]	-0.02 [-0.12]	-0.40* [-2.25]	0.07 [0.55]	0.33 [2.35]
Average age of household head	-0.00 [-0.62]	-0.00 [-0.75]	0.00 [0.75]	0.00 [0.71]	-0.00 [-0.63]	-0.00 [-0.69]	0.00 [1.24]	0.00 [1.07]	0.00 [0.51]	0.00 [0.82]	0.00 [0.76]	0.00 [0.80]	0.00 [0.25]	0.00 [0.37]	0.00 [0.17]	0.00 [0.34]	0.00 [0.71]	0.00 [0.88]	0.00 [1.35]	0.01 [1.64]	0.01 [1.28]	0.01 [1.56]	0.00 [1.07]	0.01 [1.29]	-0.02 [-1.22]	-0.01 [-1.24]	-0.02 [-1.40]	-0.01 [-1.50]	0.00 [0.85]	0.00 [0.73]	0.00 [0.51]	-0.00 [-1.00]	0.00 [0.24]
Share of male household heads	0.00 [0.36]	0.01 [0.57]	0.10 [0.58]	0.10 [0.61]	0.03 [0.50]	0.04 [0.66]	-0.00 [-0.46]	-0.00 [-0.28]	0.05 [1.04]	0.05 [1.07]	-0.02 [-1.11]	-0.02 [-1.06]	-0.16 [-0.87]	-0.20 [-1.11]	0.04 [0.21]	-0.01 [-0.06]	-0.38 [-1.71]	-0.44* [-2.00]	-0.02 [-0.12]	-0.09 [-0.58]	-0.07 [-0.36]	-0.16 [-0.77]	-0.12 [-0.61]	-0.18 [-0.96]	1.09 [1.65]	-0.01 [-0.02]	1.15 [1.75]	0.05 [0.12]	0.06 [0.36]	-0.07 [-0.50]	-0.41* [-2.12]	0.16 [1.22]	0.24 [1.59]
Share of married household heads	-0.01 [-0.65]	-0.01 [-0.88]	-0.16 [-0.70]	-0.19 [-0.85]	-0.01 [-0.11]	-0.02 [-0.26]	0.01 [1.34]	0.01 [1.38]	-0.02 [-0.28]	0.00 [0.00]	0.00 [0.09]	0.00 [0.17]	-0.11 [-0.44]	-0.08 [-0.32]	-0.01 [-0.04]	0.03 [0.12]	-0.08 [-0.26]	-0.05 [-0.18]	-0.46* [-2.10]	-0.44* [-2.04]	-0.79** [-2.81]	-0.76** [-2.76]	-0.05 [-0.18]	-0.04 [-0.16]	-1.66 [-1.84]	-0.86 [-1.49]	-1.60 [-1.78]	-0.81 [-1.39]	0.05 [0.23]	0.18 [0.90]	0.33 [1.28]	-0.14 [-0.79]	-0.19 [-0.9]
Share of separated household heads	-0.02 [-0.90]	-0.03 [-1.04]	-0.38 [-1.11]	-0.39 [-1.14]	-0.07 [-0.56]	-0.07 [-0.60]	0.01 [1.37]	0.01 [1.33]	-0.05 [-0.58]	-0.03 [-0.38]	-0.04 [-1.01]	-0.04 [-0.86]	0.12 [0.31]	0.15 [0.40]	0.43 [0.99]	0.47 [1.10]	-0.03 [-0.07]	-0.02 [-0.05]	0.07 [0.20]	0.06 [0.19]	0.05 [0.11]	0.08 [0.18]	0.09 [0.23]	0.09 [0.24]	-0.73 [-0.53]	-1.10 [-1.22]	-0.71 [-0.51]	-1.04 [-1.16]	0.22 [0.62]	0.09 [0.30]	-0.13 [-0.32]	-0.24 [-0.84]	0.36 [1.14]
Share of divorced household heads	0.01 [0.28]	0.00 [0.06]	0.05 [0.20]	0.01 [0.03]	0.01 [0.10]	-0.00 [-0.04]	0.00 [0.37]	0.00 [0.29]	0.05 [0.65]	0.06 [0.82]	-0.00 [-0.05]	-0.00 [-0.01]	0.01 [0.02]	0.10 [0.33]	0.12 [0.32]	0.21 [0.60]	-0.11 [-0.30]	-0.02 [-0.06]	-0.08 [-0.27]	0.00 [0.01]	-0.58 [-1.63]	-0.48 [-1.37]	0.49 [1.48]	0.59 [1.81]	-2.71* [-2.38]	-1.19 [-1.61]	-2.66* [-2.33]	-1.13 [-1.53]	-0.26 [-0.90]	0.01 [0.03]	0.55 [1.66]	-0.33 [-1.43]	-0.22 [-0.8]
Share of widowed household heads	-0.01 [-0.61]	-0.01 [-0.69]	-0.21 [-0.68]	-0.23 [-0.78]	0.00 [0.03]	0.00 [0.02]	0.01 [1.33]	0.01 [1.41]	0.01 [0.16]	0.03 [0.42]	-0.01 [-0.39]	-0.01 [-0.29]	-0.02 [-0.07]	0.00 [0.01]	0.45 [1.22]	0.46 [1.27]	-0.47 [-1.20]	-0.47 [-1.23]	-0.28 [-0.96]	-0.29 [-1.04]	-0.69 [-1.89]	-0.72* [-1.99]	-0.03 [-0.10]	-0.03 [-0.10]	-0.73 [-0.62]	-0.82 [-1.09]	-0.69 [-0.59]	-0.77 [-1.03]	0.01 [0.03]	0.03 [0.12]	-0.02 [-0.05]	-0.11 [-0.45]	0.13 [0.47]
Share of hh with children <= 60 months	0.00 [1.24]	0.00 [1.00]	0.01 [0.23]	0.01 [0.20]	0.02 [1.31]	0.02 [1.20]	-0.00 [-0.05]	-0.00 [-0.16]	0.00 [0.41]	0.01 [0.52]	-0.01 [-1.34]	-0.01 [-1.24]	0.08 [1.62]	0.08 [1.65]	0.00 [0.05]	0.01 [0.21]	0.09 [1.60]	0.09 [1.69]	-0.09* [-2.04]	-0.08* [-2.03]	-0.09 [-1.64]	-0.08 [-1.48]	-0.06 [-1.09]	-0.06 [-1.23]	-0.27 [-1.57]	-0.22* [-2.04]	-0.20 [-1.16]	-0.15 [-1.36]	0.01 [0.15]	0.00 [0.11]	0.03 [0.52]	-0.02 [-0.69]	-0.00 [-0.0]
Share of hh in extreme poverty		0.00 [0.56]		0.03 [0.34]		0.02 [0.81]		-0.00 [-0.00]		0.02 [1.13]		0.01 [0.59]		-0.03 [-0.37]		-0.06 [-0.63]		-0.07 [-0.65]		-0.10 [-1.32]		-0.09 [-0.90]		-0.04 [-0.46]		-2.56*** [-12.41]		-2.53*** [-12.26]		-0.40*** [-6.14]			
Share of hh in moderate poverty		-0.01 [-0.66]		-0.02 [-0.14]		0.00 [0.10]		-0.00 [-1.01]		0.07* [2.36]		0.01 [0.67]		0.21 [1.66]		0.17 [1.14]		0.19 [1.21]		0.16 [1.43]		0.19 [1.29]		0.30* [2.21]		0.34 [1.09]		0.42 [1.37]		-0.13 [-1.20]			
Observations	479	479	458	458	478	478	479	479	458	458	478	478	479	479	477	477	479	479	479	479	479	479	478	478	479	479	479	479	479	479	479	479	479

t statistics in brackets
* p<0.05, ** p<0.01, *** p<0.001

Table 3: water treatment

	(1) D	(2) D	(3) D 12	(4) D 12	(5) D 60	(6) D 60	(7) D b	(8) D b	(9) D b 12	(10) D b 12	(11) D b 60	(12) D b 60	(13) Prim	(14) Prim	(15) Prim mal	(16) Prim mal	(17) Prim fem	(18) Prim fem	(19) Sec	(20) Sec	(21) Sec mal	(22) Sec mal	(23) Sec fem	(24) Sec fem	(25) Exp pc	(26) Exp pc	(27) Exp pae	(28) Exp pae	(29) Treat w	(30) Treat w poorex	(31) poorex	(32) poormod	(33) poor
Share of hh treating drinking water	-0.00 [-0.78]	-0.00 [-0.06]	0.02 [0.29]	0.03 [0.37]	0.01 [0.36]	0.02 [0.79]	0.00 [0.41]	0.00 [0.70]	0.04 [1.87]	0.03 [1.57]	0.01 [0.60]	0.01 [0.80]	0.22* [2.59]	0.16 [1.68]	0.22* [2.23]	0.13 [1.21]	0.26* [2.48]	0.16 [1.44]	0.20** [2.67]	0.10 [1.19]	0.30** [3.10]	0.20 [1.90]	0.12 [1.38]	0.04 [0.41]	2.77*** [8.58]	1.17*** [5.20]	2.79*** [8.61]	1.19*** [5.28]		-0.59*** [-6.55]		0.20** [3.19]	0.39 [5.55]
Share of hh cooking with charcoal or coal	0.05 [0.82]		-0.18 [-0.18]		0.14 [0.47]		0.02 [1.02]		0.07 [0.29]		0.00 [0.02]		0.14 [0.14]		-0.87 [-0.75]		-0.70 [-0.56]		-0.92 [-1.02]		-1.74 [-1.53]		-0.15 [-0.14]		-6.66 [-1.74]		-6.90 [-1.79]		0.97 [1.07]	2.65* [2.45]		-1.67* [-2.19]	-0.98 [-1.1]
Share of hh cooking with electricity	0.07 [1.03]		0.06 [0.06]		0.20 [0.63]		0.02 [0.80]		0.05 [0.20]		-0.03 [-0.24]		0.32 [0.29]		-0.86 [-0.70]		-0.41 [-0.31]		-0.53 [-0.56]		-1.64 [-1.35]		0.43 [0.38]		-5.72 [-1.40]		-5.99 [-1.46]		0.69 [0.72]	2.65* [2.30]		-1.50 [-1.84]	-1.15 [-1.2]
Share of hh cooking with firewood	0.06 [0.87]		-0.14 [-0.15]		0.16 [0.51]		0.02 [1.05]		0.12 [0.47]		0.01 [0.09]		-0.00 [-0.00]		-1.00 [-0.86]		-0.84 [-0.68]		-0.98 [-1.09]		-1.88 [-1.65]		-0.28 [-0.26]		-8.52* [-2.22]		-8.78* [-2.27]		0.66 [0.73]	3.16** [2.93]		-1.83* [-2.40]	-1.34 [-1.6]
Share of hh heads with lower primary education	-0.00 [-0.41]	-0.00 [-0.40]	0.06 [0.45]	0.06 [0.45]	-0.05 [-1.21]	-0.06 [-1.25]	0.00 [1.09]	0.00 [1.19]	0.03 [0.72]	0.02 [0.60]	0.01 [0.54]	0.01 [0.61]	0.22 [1.47]	0.18 [1.20]	0.24 [1.38]	0.21 [1.23]	0.16 [0.88]	0.12 [0.66]	-0.10 [-0.73]	-0.13 [-0.98]	-0.10 [-0.61]	-0.13 [-0.78]	0.00 [0.03]	-0.05 [-0.36]	0.54 [0.95]	0.30 [0.84]	0.44 [0.77]	0.19 [0.53]	0.16 [1.23]	0.12 [1.00]	-0.04 [-0.27]	0.11 [0.97]	-0.07 [-0.5]
Share of hh heads with upper secondary education	0.00 [0.00]	0.00 [0.46]	0.12 [1.02]	0.13 [1.04]	-0.01 [-0.14]	0.00 [0.08]	0.00 [1.39]	0.01 [1.69]	0.02 [0.54]	0.01 [0.22]	0.03 [1.91]	0.03 [1.94]	0.40** [2.99]	0.30* [2.23]	0.35* [2.27]	0.24 [1.56]	0.56*** [3.46]	0.44** [2.70]	0.24* [2.02]	0.13 [1.09]	0.32* [2.15]	0.21 [1.38]	0.21 [1.46]	0.08 [0.58]	1.45** [2.88]	0.15 [0.46]	1.47** [2.90]	0.15 [0.46]	0.09 [0.72]	-0.05 [-0.42]	-0.44** [-3.11]	0.33** [3.34]	0.11 [0.98]
Share of hh heads with lower secondary education	-0.02* [-2.02]	-0.02 [-1.56]	-0.14 [-0.96]	-0.12 [-0.84]	-0.09 [-1.97]	-0.09 [-1.77]	-0.00 [-1.08]	-0.00 [-0.76]	0.03 [0.87]	0.00 [0.03]	0.00 [0.10]	0.00 [0.08]	0.77*** [4.81]	0.65*** [4.04]	0.67*** [3.74]	0.56*** [3.08]	0.79*** [4.12]	0.66*** [3.43]	0.63*** [4.51]	0.51*** [3.62]	0.53** [3.02]	0.43* [2.39]	0.69*** [4.14]	0.53** [3.22]	1.85** [3.10]	0.61 [1.57]	1.78** [2.97]	0.51 [1.33]	0.33* [2.38]	0.16 [1.26]	-0.43* [-2.54]	0.44*** [3.68]	-0.01 [-0.0]
Share of hh with upper secondary education or more	-0.02 [-1.53]	-0.01 [-1.21]	-0.12 [-0.83]	-0.11 [-0.72]	-0.10* [-2.06]	-0.09 [-1.85]	0.00 [1.08]	0.00 [1.02]	0.05 [1.33]	0.04 [0.99]	0.04 [1.83]	0.03 [1.72]	0.49** [2.81]	0.49** [2.99]	0.60** [3.04]	0.57** [3.04]	0.53* [2.55]	0.53** [2.67]	0.37* [2.46]	0.34* [2.37]	0.36 [1.89]	0.35 [1.91]	0.37* [2.07]	0.40* [2.34]	0.25 [0.39]	-0.58 [-1.45]	0.13 [0.20]	-0.69 [-1.72]	0.16 [1.03]	-0.02 [-0.15]	-0.41* [-2.25]	0.08 [0.59]	0.33 [2.37]
Average age of household head	-0.00 [-0.51]	-0.00 [-0.71]	0.00 [0.71]	0.00 [0.67]	-0.00 [-0.60]	-0.00 [-0.68]	0.00 [1.26]	0.00 [1.07]	0.00 [0.59]	0.00 [0.91]	0.00 [0.88]	0.00 [0.89]	0.00 [0.06]	0.00 [0.26]	-0.00 [-0.02]	0.00 [0.23]	0.00 [0.52]	0.00 [0.77]	0.00 [1.25]	0.01 [1.61]	0.00 [1.18]	0.01 [1.52]	0.00 [0.96]	0.00 [1.25]	-0.02 [-1.47]	-0.01 [-1.37]	-0.02 [-1.65]	-0.01 [-1.63]	0.00 [0.82]	0.00 [0.78]	0.00 [0.72]	-0.00 [-1.22]	0.00 [0.18]
Share of male household heads	0.01 [0.47]	0.01 [0.68]	0.09 [0.54]	0.09 [0.53]	0.03 [0.54]	0.04 [0.69]	-0.00 [-0.45]	-0.00 [-0.28]	0.05 [1.13]	0.06 [1.27]	-0.02 [-0.98]	-0.02 [-0.84]	-0.19 [-1.04]	-0.24 [-1.34]	0.01 [0.02]	-0.06 [-0.29]	-0.42 [-1.87]	-0.49* [-2.23]	-0.04 [-0.23]	-0.11 [-0.67]	-0.09 [-0.46]	-0.18 [-0.87]	-0.14 [-0.72]	-0.20 [-1.07]	0.87 [1.26]	-0.17 [-0.39]	0.93 [1.33]	-0.12 [-0.28]	0.05 [0.33]	-0.06 [-0.41]	-0.36 [-1.85]	0.13 [0.94]	0.23 [1.53]
Share of married household heads	-0.01 [-0.58]	-0.01 [-0.85]	-0.16 [-0.72]	-0.20 [-0.88]	-0.01 [-0.09]	-0.02 [-0.25]	0.01 [1.35]	0.01 [1.39]	-0.01 [-0.23]	0.00 [0.06]	0.01 [0.16]	0.01 [0.24]	-0.14 [-0.55]	-0.10 [-0.39]	-0.04 [-0.15]	0.01 [0.04]	-0.11 [-0.37]	-0.08 [-0.26]	-0.48* [-2.16]	-0.44* [-2.07]	-0.81** [-2.86]	-0.77** [-2.79]	-0.07 [-0.25]	-0.05 [-0.19]	-1.84 [-1.94]	-0.94 [-1.58]	-1.79 [-1.88]	-0.89 [-1.48]	0.05 [0.21]	0.19 [0.94]	0.37 [1.39]	-0.17 [-0.92]	-0.20 [-0.9]
Share of separated household heads	-0.02 [-0.89]	-0.03 [-1.04]	-0.39 [-1.13]	-0.40 [-1.17]	-0.06 [-0.56]	-0.07 [-0.60]	0.01 [1.37]	0.01 [1.33]	-0.05 [-0.55]	-0.03 [-0.31]	-0.04 [-0.99]	-0.04 [-0.84]	0.11 [0.29]	0.14 [0.37]	0.43 [0.96]	0.46 [1.07]	-0.04 [-0.09]	-0.03 [-0.07]	0.07 [0.19]	0.06 [0.18]	0.04 [0.10]	0.07 [0.17]	0.09 [0.21]	0.09 [0.23]	-0.77 [-0.52]	-1.13 [-1.22]	-0.75 [-0.51]	-1.08 [-1.16]	0.21 [0.62]	0.10 [0.31]	-0.12 [-0.29]	-0.24 [-0.83]	0.36 [1.13]
Share of divorced household heads	0.01 [0.34]	0.00 [0.06]	0.05 [0.17]	0.01 [0.03]	0.01 [0.12]	-0.00 [-0.04]	0.00 [0.38]	0.00 [0.29]	0.05 [0.70]	0.06 [0.81]	0.00 [0.02]	-0.00 [-0.00]	-0.03 [-0.08]	0.10 [0.32]	0.08 [0.22]	0.21 [0.59]	-0.15 [-0.39]	-0.03 [-0.07]	-0.09 [-0.33]	0.00 [0.01]	-0.60 [-1.68]	-0.48 [-1.38]	0.47 [1.42]	0.59 [1.80]	-2.91* [-2.42]	-1.20 [-1.58]	-2.86* [-2.37]	-1.13 [-1.49]	-0.26 [-0.92]	0.01 [0.03]	0.59 [1.74]	-0.36 [-1.52]	-0.23
Share of widowed household heads	-0.01 [-0.69]	-0.01 [-0.73]	-0.20 [-0.66]	-0.23 [-0.76]	0.00 [0.00]	0.00 [0.01]	0.01 [1.32]	0.01 [1.41]	0.01 [0.13]	0.03 [0.37]	-0.02 [-0.48]	-0.01 [-0.38]	0.02 [0.07]	0.03 [0.11]	0.50 [1.34]	0.49 [1.35]	-0.41 [-1.04]	-0.43 [-1.12]	-0.26 [-0.88]	-0.28 [-1.01]	-0.66 [-1.81]	-0.70 [-1.96]	-0.01 [-0.02]	-0.02 [-0.06]	-0.44 [-0.35]	-0.70 [-0.91]	-0.39 [-0.31]	-0.65 [-0.83]	0.02 [0.06]	0.02 [0.08]	-0.08 [-0.22]	-0.06 [-0.25]	0.14 [0.51]
Share of hh with children <= 60 months	0.00 [1.23]	0.00 [1.00]	0.01 [0.24]	0.01 [0.20]	0.02 [1.32]	0.02 [1.20]	-0.00 [-0.05]	-0.00 [-0.16]	0.00 [0.39]	0.01 [0.53]	-0.01 [-1.33]	-0.01 [-1.22]	0.08 [1.59]	0.08 [1.63]	0.00 [0.05]	0.01 [0.20]	0.09 [1.57]	0.09 [1.67]	-0.09* [-2.03]	-0.08* [-2.04]	-0.09 [-1.64]	-0.08 [-1.48]	-0.06 [-1.10]	-0.06 [-1.24]	-0.27 [-1.49]	-0.22* [-2.00]	-0.20 [-1.09]	-0.15 [-1.33]	0.01 [0.15]	0.00 [0.12]	0.03 [0.51]	-0.02 [-0.67]	-0.00 [-0.0]
Share of hh in extreme poverty		0.00 [0.67]		0.02 [0.23]		0.02 [0.84]		-0.00 [-0.00]		0.03 [1.40]		0.01 [0.82]		-0.05 [-0.61]		-0.09 [-0.88]		-0.09 [-0.90]		-0.11 [-1.42]		-0.10 [-1.00]		-0.05 [-0.57]		-2.64*** [-12.56]		-2.62*** [-12.38]		-0.39*** [-6.09]			
Share of hh in moderate poverty		-0.01 [-0.80]		-0.00 [-0.04]		0.00 [0.07]		-0.00 [-1.03]		0.06* [2.13]		0.01 [0.39]		0.25 [1.97]		0.21 [1.45]		0.24 [1.52]		0.17 [1.55]		0.21 [1.43]		0.32* [2.36]		0.49 [1.56]		0.58 [1.87]		-0.14 [-1.34]			
Observations	479	479	458	458	478	478	479	479	458	458	478	478	479	479	477	477	479	479	479	479	479	479	478	478	479	479	479	479	479	479	479	479	479

t statistics in brackets
* p<0.05, ** p<0.01, *** p<0.001

Annex 7: Propensity score matching results (LCMS) WSS for rural areas

Extremely Poor

2006

1. treatment: borehole

	Treated	Controls	ATT	Tstat	NOB_t	NOB_unt
Treat water	0.09	0.1	0	-0.23	1037	2962
Diarrhea	0.35	0.53	-0.18	-1.41	1037	2961
Diarrhea <=12 months	2.83	4.43	-1.6	-0.97	212	525
Diarrhea <=60 months	1.59	2.42	-0.83	-1.21	565	1452
Diarrhea with blood	0.12	0.13	0	-0.04	1037	2961
Diarrhea with blood <=12 months	0.94	0.03	0.91	1.26	212	525
Diarrhea with blood <=60 months	0.68	0.38	0.29	0.78	565	1452
Primary school attendance rate	65.73	63.76	1.97	0.97	714	2048
Prim school attend rate male	66.77	62.42	4.35	1.65	489	1400
Prim school attend rate female	66.75	67.39	-0.63	-0.24	493	1351
Secondary school attendance rate	19.85	15.97	3.88	1.97	545	1486
Second school attend rate male	21.57	17.78	3.79	1.37	352	886
Second school attend rate female	18.96	14.58	4.38	1.66	323	907
Expenditures per capita	32378.38	32857.16	-478.79	-0.97	1037	2962
Expenditures per adult equiv	38266.77	38899.51	-632.75	-1.14	1037	2962

2. treatment: safe water source

	Treated	Controls	ATT	Tstat	NOB_t	NOB_unt
Treat water	0.12	0.12	0	-0.11	1438	2561
Diarrhea	0.42	0.52	-0.1	-0.82	1438	2560
Diarrhea <=12 months	3.37	4	-0.63	-0.4	297	440
Diarrhea <=60 months	1.97	2.27	-0.3	-0.45	766	1251
Diarrhea with blood	0.14	0.09	0.05	0.8	1438	2560
Diarrhea with blood <=12 months	0.67	0.03	0.64	1.13	297	440
Diarrhea with blood <=60 months	0.63	0.24	0.39	1.19	766	1251
Primary school attendance rate	66.55	64.6	1.95	1.04	1003	1759
Prim school attend rate male	66.86	62.67	4.19	1.7	697	1192
Prim school attend rate female	68.5	67.09	1.41	0.58	671	1173
Secondary school attendance rate	19.58	14.87	4.7	2.58	758	1273
Second school attend rate male	22.45	16.05	6.4	2.44	480	758
Second school attend rate female	18.43	13.86	4.58	1.9	446	784
Expenditures per capita	32939.44	32529.27	410.17	0.89	1438	2561
Expenditures per adult equiv	38776.39	38455.66	320.73	0.62	1438	2561

3. treatment: safe toilet

	Treated	Controls	ATT	Tstat	NOB_t	NOB_unt
Treat water	0.15	0.17	-0.01	-0.78	2527	1470
Diarrhea	0.47	0.55	-0.08	-0.45	2526	1470
Diarrhea <=12 months	3.35	5.43	-2.08	-0.99	445	292
Diarrhea <=60 months	1.83	3.1	-1.27	-1.19	1242	775
Diarrhea with blood	0.08	0.08	0	0.01	2526	1470
Diarrhea with blood <=12 months	0.48	0.03	0.45	0.66	445	292
Diarrhea with blood <=60 months	0.31	0.14	0.17	0.33	1242	775
Primary school attendance rate	66.85	59.14	7.71	2.72	1811	951
Prim school attend rate male	66.27	59.85	6.42	1.76	1241	648
Prim school attend rate female	67.93	59.77	8.16	2.16	1220	624
Secondary school attendance rate	18.78	13.23	5.55	2.25	1365	666
Second school attend rate male	21.13	17.74	3.39	0.87	855	383
Second school attend rate female	17.15	11.37	5.78	1.82	803	427
Expenditures per capita	33655.86	32159.48	1496.38	2.26	2527	1470
Expenditures per adult equiv	39519.85	38093.06	1426.79	1.9	2527	1470

4. treatment: borehole & safe toilet

	Treated	Controls	ATT	Tstat	NOB_t	NOB_unt
Treat water	0.13	0.13	0	-0.21	616	3383
Diarrhea	0.34	0.48	-0.13	-1.03	616	3382
Diarrhea <=12 months	1.67	4.97	-3.3	-2.13	120	617
Diarrhea <=60 months	1.23	2.3	-1.06	-1.61	325	1692
Diarrhea with blood	0.08	0.11	-0.03	-0.56	616	3382
Diarrhea with blood <=12 months	0.83	0.13	0.7	0.79	120	617
Diarrhea with blood <=60 months	0.41	0.38	0.03	0.07	325	1692
Primary school attendance rate	67.81	64.67	3.13	1.41	438	2324
Prim school attend rate male	67.16	63.87	3.29	1.13	304	1585
Prim school attend rate female	69.67	66.71	2.96	1.04	304	1540
Secondary school attendance rate	23.21	16.69	6.52	2.88	364	1667
Second school attend rate male	24.08	19.19	4.89	1.59	240	998
Second school attend rate female	21.81	15.67	6.15	2.03	205	1025
Expenditures per capita	33641.3	32997.17	644.14	1.17	616	3383
Expenditures per adult equiv	39268.35	38862.58	405.76	0.66	616	3383

5. treatment: water treatment

	Treated	Controls	ATT	Tstat	NOB_t	NOB_unt
Treat water	1	0	1	.	521	3475
Diarrhea	0.28	0.55	-0.27	-2.06	520	3475
Diarrhea <=12 months	0.97	4.16	-3.19	-2.38	104	633
Diarrhea <=60 months	0.95	2.23	-1.29	-2	284	1733
Diarrhea with blood	0.12	0.11	0.01	0.14	520	3475
Diarrhea with blood <=12 months	1.94	0.07	1.87	1.35	104	633
Diarrhea with blood <=60 months	0.47	0.39	0.08	0.2	284	1733
Primary school attendance rate	71.99	65.11	6.87	3.05	371	2389
Prim school attend rate male	71.5	64.49	7.01	2.39	259	1630
Prim school attend rate female	69.73	67.08	2.65	0.86	253	1589
Secondary school attendance rate	18.07	19.02	-0.95	-0.44	302	1727
Second school attend rate male	18.92	20.92	-2.01	-0.67	189	1049
Second school attend rate female	18.83	18.11	0.72	0.23	182	1046
Expenditures per capita	34963.91	33156.53	1807.38	3.1	521	3475
Expenditures per adult equiv	41441.12	39494.16	1946.95	2.99	521	3475

1998

1. treatment: borehole

	Treated	Controls	ATT	Tstat	NOB_t	NOB_unt
Treat water	0.04	0.05	0	-0.37	860	4527
Diarrhea	1.26	1.19	0.07	0.26	860	4527
Diarrhea <=12 months	6.78	4.87	1.91	0.82	181	852
Diarrhea <=60 months	5.46	3.78	1.68	1.51	465	2284
Diarrhea with blood	0.2	0.24	-0.04	-0.38	860	4527
Diarrhea with blood <=12 months	0.56	0.73	-0.17	-0.24	181	852
Diarrhea with blood <=60 months	0.44	0.26	0.18	0.54	465	2284
Primary school attendance rate	61.49	58.81	2.68	1.15	516	2806
Prim school attend rate male	62.62	59.99	2.63	0.87	359	1943
Prim school attend rate female	61.15	59.25	1.9	0.64	352	1871
Secondary school attendance rate	19.65	11.13	8.51	4.28	438	2210
Second school attend rate male	22.77	13.49	9.29	3.18	270	1356
Second school attend rate female	17.32	9.55	7.77	3.12	271	1332
Expenditures per capita	13541.28	13775.72	-234.45	-0.77	860	4527
Expenditures per adult equiv	15545	15816.76	-271.76	-0.8	860	4527

2. treatment: safe water source

	Treated	Controls	ATT	Tstat	NOB_t	NOB_unt
Treat water	0.09	0.1	-0.01	-0.92	2028	3359
Diarrhea	1.44	1.17	0.27	1.29	2028	3359
Diarrhea <=12 months	7.03	5.37	1.66	0.93	375	650
Diarrhea <=60 months	4.95	4.09	0.86	1.04	1057	1692
Diarrhea with blood	0.24	0.18	0.05	0.58	2028	3359
Diarrhea with blood <=12 months	0.54	0.58	-0.04	-0.08	375	650
Diarrhea with blood <=60 months	0.48	0.25	0.23	0.82	1057	1692
Primary school attendance rate	62.61	58.34	4.27	2.36	1245	2077
Prim school attend rate male	63.32	58.53	4.79	2.05	844	1458
Prim school attend rate female	63.23	57.99	5.24	2.27	859	1364
Secondary school attendance rate	18.2	10.81	7.39	5.2	989	1659
Second school attend rate male	20.69	13.12	7.56	3.72	611	1015
Second school attend rate female	16.68	7.7	8.98	4.82	605	1011
Expenditures per capita	14099.08	13839.33	259.75	1.09	2028	3359
Expenditures per adult equiv	16191.19	15850.77	340.42	1.29	2028	3359

3. treatment: safe toilet

	Treated	Controls	ATT	Tstat	NOB_t	NOB_unt
Treat water	0.1	0.11	-0.01	-1.02	3109	2277
Diarrhea	1.14	1.26	-0.13	-0.46	3109	2277
Diarrhea <=12 months	5.81	10.21	-4.41	-2.05	584	448
Diarrhea <=60 months	4.24	5.16	-0.92	-0.87	1619	1129
Diarrhea with blood	0.16	0.26	-0.11	-0.82	3109	2277
Diarrhea with blood <=12 months	0.78	0.12	0.66	1.3	584	448
Diarrhea with blood <=60 months	0.44	0.73	-0.3	-0.82	1619	1129
Primary school attendance rate	62.42	46.31	16.1	6.56	2006	1315
Prim school attend rate male	62.55	46.23	16.32	5.05	1401	900
Prim school attend rate female	63.21	46.09	17.12	5.25	1372	851
Secondary school attendance rate	16.86	5.55	11.32	7.17	1622	1026
Second school attend rate male	18.85	7.7	11.15	4.43	1010	616
Second school attend rate female	15.36	3.48	11.87	6.1	996	620
Expenditures per capita	14536.38	13637.62	898.76	2.92	3109	2277
Expenditures per adult equiv	16598.82	15864.34	734.47	2.14	3109	2277

4. treatment: borehole & safe toilet

	Treated	Controls	ATT	Tstat	NOB_t	NOB_unt
Treat water	0.05	0.06	-0.01	-0.48	469	4917
Diarrhea	1.1	1.02	0.08	0.25	469	4917
Diarrhea <=12 months	7.61	4.33	3.28	1	94	922
Diarrhea <=60 months	5.13	3.53	1.6	1.15	253	2473
Diarrhea with blood	0.09	0.19	-0.11	-1.15	469	4917
Diarrhea with blood <=12 months	1.09	0.43	0.66	0.55	94	922
Diarrhea with blood <=60 months	0.61	0.23	0.38	0.77	253	2473
Primary school attendance rate	68.39	60.24	8.15	2.95	301	2995
Prim school attend rate male	68.2	59.44	8.76	2.37	206	2077
Prim school attend rate female	69.36	60.35	9.01	2.63	218	1985
Secondary school attendance rate	26.74	14.57	12.17	4.34	248	2383
Second school attend rate male	28.43	16.16	12.27	3.06	154	1462
Second school attend rate female	25.32	12.2	13.12	3.67	157	1443
Expenditures per capita	14645.49	14164.94	480.55	1.22	469	4917
Expenditures per adult equiv	16727.48	16185.96	541.51	1.25	469	4917

5. treatment: water treatment

	Treated	Controls	ATT	Tstat	NOB_t	NOB_unt
Treat water	1	0	1	.	473	4914
Diarrhea	0.96	1.26	-0.3	-1.24	473	4914
Diarrhea <=12 months	6.97	6.26	0.71	0.29	124	901
Diarrhea <=60 months	3.81	4.64	-0.83	-0.78	281	2468
Diarrhea with blood	0.37	0.18	0.19	1.35	473	4914
Diarrhea with blood <=12 months	0.82	0.69	0.13	0.15	124	901
Diarrhea with blood <=60 months	0.54	0.48	0.06	0.13	281	2468
Primary school attendance rate	64.79	58.02	6.77	2.59	310	3012
Prim school attend rate male	66.55	58.32	8.23	2.5	216	2086
Prim school attend rate female	65.87	58.17	7.7	2.29	209	2014
Secondary school attendance rate	15.87	13.63	2.24	1.02	251	2397
Second school attend rate male	20.13	16.43	3.71	1.12	150	1476
Second school attend rate female	15.16	12.24	2.92	1.04	166	1450
Expenditures per capita	15211.06	14014.12	1196.94	3.31	473	4914
Expenditures per adult equiv	17631.29	16178.46	1452.83	3.62	473	4914

Moderately Poor

2006

1. treatment: borehole

	Treated	Controls	ATT	Tstat	NOB_t	NOB_unt
Treat water	0.17	0.17	-0.01	-0.31	677	1718
Diarrhea	0.76	0.55	0.21	0.84	676	1716
Diarrhea <=12 months	4.35	2.37	1.98	0.76	116	322
Diarrhea <=60 months	3.64	1.97	1.67	1.4	323	854
Diarrhea with blood	0.07	0.14	-0.07	-0.87	676	1716
Diarrhea with blood <=12 months	0	0.63	-0.63	-0.72	116	322
Diarrhea with blood <=60 months	0.23	0.68	-0.45	-1.25	323	854
Primary school attendance rate	77.29	70.81	6.48	2.5	407	971
Prim school attend rate male	75.01	70.36	4.64	1.38	262	647
Prim school attend rate female	80.42	71.85	8.57	2.61	280	639
Secondary school attendance rate	30.86	27.33	3.54	1.15	319	691
Second school attend rate male	35.42	31.86	3.55	0.8	193	384
Second school attend rate female	28.93	28.02	0.91	0.22	197	432
Expenditures per capita	70092.39	69635.69	456.7	0.64	677	1718
Expenditures per adult equiv	81827.26	81535.65	291.61	0.45	677	1718

2. treatment: safe water source

	Treated	Controls	ATT	Tstat	NOB_t	NOB_unt
Treat water	0.2	0.21	-0.01	-0.29	1006	1374
Diarrhea	0.59	0.58	0	0.02	1005	1372
Diarrhea <=12 months	3.25	2.18	1.06	0.46	161	277
Diarrhea <=60 months	3.27	1.55	1.73	1.59	489	688
Diarrhea with blood	0.07	0.16	-0.1	-1.12	1005	1372
Diarrhea with blood <=12 months	0	0.79	-0.79	-0.9	161	277
Diarrhea with blood <=60 months	0.26	0.72	-0.46	-1.11	489	688
Primary school attendance rate	75.31	70.8	4.51	1.73	597	769
Prim school attend rate male	74.79	70.72	4.07	1.25	391	511
Prim school attend rate female	77.51	70.9	6.61	1.9	408	504
Secondary school attendance rate	30.85	24.71	6.14	2	460	539
Second school attend rate male	36.44	24.8	11.63	2.62	275	294
Second school attend rate female	29.17	26.41	2.75	0.67	281	340
Expenditures per capita	69985.56	70341.99	-356.43	-0.52	1006	1374
Expenditures per adult equiv	81532.7	82219.09	-686.39	-1.12	1006	1374

3. treatment: safe toilet

	Treated	Controls	ATT	Tstat	NOB_t	NOB_unt
Treat water	0.22	0.24	-0.02	-0.65	1730	665
Diarrhea	0.72	0.69	0.03	0.11	1727	665
Diarrhea <=12 months	4.07	8.15	-4.07	-1.46	298	140
Diarrhea <=60 months	2.84	2.15	0.69	0.52	845	337
Diarrhea with blood	0.15	0.07	0.07	0.86	1727	665
Diarrhea with blood <=12 months	0.74	0	0.74	1.42	298	140
Diarrhea with blood <=60 months	0.55	0.09	0.46	1.12	845	337
Primary school attendance rate	74.47	67.76	6.72	1.69	1016	362
Prim school attend rate male	74.36	67.79	6.57	1.26	669	240
Prim school attend rate female	77.17	64.42	12.75	2.5	685	234
Secondary school attendance rate	28.69	17.92	10.78	2.96	790	220
Second school attend rate male	31.52	24.18	7.34	1.34	461	116
Second school attend rate female	27.48	14.98	12.51	2.58	471	143
Expenditures per capita	69610.24	70436.37	-826.13	-0.86	1730	665
Expenditures per adult equiv	81379.54	83227.62	-1848.08	-2.15	1730	665

4. treatment: borehole & safe toilet

	Treated	Controls	ATT	Tstat	NOB_t	NOB_unt
Treat water	0.21	0.21	0	-0.04	446	1949
Diarrhea	0.75	0.51	0.25	0.87	445	1947
Diarrhea <=12 months	4.23	2.55	1.68	0.58	72	359
Diarrhea <=60 months	3.45	2.21	1.25	0.94	213	964
Diarrhea with blood	0.07	0.15	-0.09	-1.08	445	1947
Diarrhea with blood <=12 months	0	0.42	-0.42	-0.58	72	359
Diarrhea with blood <=60 months	0.12	0.67	-0.56	-1.9	213	964
Primary school attendance rate	78.7	70.56	8.13	2.97	277	1101
Prim school attend rate male	77.01	68.92	8.09	2.19	181	717
Prim school attend rate female	80.57	71.13	9.44	2.71	196	723
Secondary school attendance rate	35.53	25.94	9.59	2.86	236	774
Second school attend rate male	40.34	33.81	6.53	1.36	145	432
Second school attend rate female	35.11	25.08	10.02	2.22	143	486
Expenditures per capita	70239.55	69751.56	487.98	0.64	446	1949
Expenditures per adult equiv	81855.3	81789.53	65.78	0.09	446	1949

5. treatment: water treatment

	Treated	Controls	ATT	Tstat	NOB_t	NOB_unt
Treat water	0.24	0.23	0.01	0.34	709	1686
Diarrhea	0.54	0.53	0.01	0.04	708	1684
Diarrhea <=12 months	2.86	2.74	0.12	0.05	105	326
Diarrhea <=60 months	3.05	2.24	0.81	0.74	338	844
Diarrhea with blood	0.07	0.14	-0.07	-0.94	708	1684
Diarrhea with blood <=12 months	0	0.42	-0.42	-0.53	105	326
Diarrhea with blood <=60 months	0.22	0.48	-0.25	-0.76	338	844
Primary school attendance rate	76.53	71.89	4.64	1.78	436	942
Prim school attend rate male	76.95	69.6	7.35	2.17	285	624
Prim school attend rate female	78.42	73.24	5.17	1.56	305	614
Secondary school attendance rate	35.48	26.34	9.14	2.92	361	649
Second school attend rate male	41.36	30.91	10.45	2.23	220	357
Second school attend rate female	33.33	23.91	9.42	2.3	210	411
Expenditures per capita	70195.3	70497.51	-302.21	-0.43	709	1686
Expenditures per adult equiv	81494.29	82387.66	-893.38	-1.39	709	1686

1998

1. treatment: borehole

	Treated	Controls	ATT	Tstat	NOB_t	NOB_unt
Treat water	0.04	0.04	0	-0.09	135	861
Diarrhea	0.69	1.27	-0.58	-1.11	135	861
Diarrhea <=12 months	0	1.23	-1.23	-0.66	27	110
Diarrhea <=60 months	4	4.35	-0.35	-0.15	77	458
Diarrhea with blood	0.88	0.23	0.65	1.22	135	861
Diarrhea with blood <=12 months	4.17	1.59	2.58	0.56	27	110
Diarrhea with blood <=60 months	2	0.97	1.03	0.67	77	458
Primary school attendance rate	64.59	72.86	-8.27	-1.38	69	425
Prim school attend rate male	58.7	75.24	-16.54	-2.09	48	253
Prim school attend rate female	67.38	73.35	-5.97	-0.77	48	268
Secondary school attendance rate	22.84	15.07	7.77	1.3	54	352
Second school attend rate male	22.22	21.99	0.23	0.02	27	151
Second school attend rate female	19.74	12.83	6.91	1	38	219
Expenditures per capita	33809.47	33715.77	93.71	0.17	135	861
Expenditures per adult equiv	39122.77	39455.76	-332.99	-0.79	135	861

2. treatment: safe water source

	Treated	Controls	ATT	Tstat	NOB_t	NOB_unt
Treat water	0.12	0.13	-0.01	-0.42	350	625
Diarrhea	1.48	1.22	0.26	0.43	350	625
Diarrhea <=12 months	1.67	4.56	-2.89	-0.87	66	115
Diarrhea <=60 months	5.44	4.24	1.2	0.58	197	324
Diarrhea with blood	0.46	0.22	0.24	0.96	350	625
Diarrhea with blood <=12 months	3.33	0.15	3.18	1.16	66	115
Diarrhea with blood <=60 months	0.96	0.87	0.09	0.12	197	324
Primary school attendance rate	67.59	67.54	0.05	0.01	178	310
Prim school attend rate male	63.39	74.99	-11.6	-2.08	120	222
Prim school attend rate female	72.88	65.58	7.3	1.18	125	188
Secondary school attendance rate	21.91	14.64	7.27	1.82	152	262
Second school attend rate male	21.94	21.21	0.73	0.12	88	158
Second school attend rate female	22.87	10.53	12.34	2.35	102	161
Expenditures per capita	34275.89	34019.42	256.47	0.6	350	625
Expenditures per adult equiv	39545.12	39556.93	-11.81	-0.04	350	625

3. treatment: safe toilet

	Treated	Controls	ATT	Tstat	NOB_t	NOB_unt
Treat water	0.13	0.14	-0.01	-0.19	641	355
Diarrhea	1.35	1.27	0.08	0.11	641	355
Diarrhea <=12 months	5.56	0.36	5.19	1.48	115	77
Diarrhea <=60 months	4.74	2.3	2.44	0.94	357	177
Diarrhea with blood	0.14	0.35	-0.21	-0.58	641	355
Diarrhea with blood <=12 months	1.39	1.6	-0.21	-0.08	115	77
Diarrhea with blood <=60 months	0.44	1.08	-0.64	-0.5	357	177
Primary school attendance rate	68.06	49.96	18.1	2.99	328	160
Prim school attend rate male	68.91	56.76	12.15	1.57	233	109
Prim school attend rate female	70.53	45.25	25.28	3.44	212	101
Secondary school attendance rate	20.49	7.01	13.48	2.97	292	135
Second school attend rate male	22.96	10.03	12.93	1.99	183	71
Second school attend rate female	18	7.97	10.03	1.69	182	91
Expenditures per capita	34405.74	33893.85	511.89	0.94	641	355
Expenditures per adult equiv	39621.84	39417.88	203.97	0.52	641	355

4. treatment: borehole & safe toilet

	Treated	Controls	ATT	Tstat	NOB_t	NOB_unt
Treat water	0.04	0.05	-0.01	-0.41	79	916
Diarrhea	0.5	0.88	-0.37	-0.56	79	916
Diarrhea <=12 months	0	0.6	-0.6	-0.15	15	95
Diarrhea <=60 months	3.33	3.28	0.05	0.02	47	411
Diarrhea with blood	0	0.17	-0.17	-0.75	79	916
Diarrhea with blood <=12 months	0	0.89	-0.89	-0.22	15	95
Diarrhea with blood <=60 months	0	0.61	-0.61	-0.91	47	411
Primary school attendance rate	68.94	74.9	-5.96	-0.86	47	447
Prim school attend rate male	59.14	76.94	-17.8	-1.81	34	267
Prim school attend rate female	74.75	72.42	2.33	0.27	33	283
Secondary school attendance rate	27.31	18.15	9.17	1.22	37	369
Second school attend rate male	21.05	21.89	-0.83	-0.08	23	155
Second school attend rate female	29.17	14.16	15.01	1.58	24	233
Expenditures per capita	34275.25	34307.31	-32.06	-0.04	79	916
Expenditures per adult equiv	39500.44	39752.29	-251.84	-0.45	79	916

water treatment

	Treated	Controls	ATT	Tstat	NOB_t	NOB_unt
Treat water	0.14	0.13	0.01	0.32	248	747
Diarrhea	1.41	1.05	0.36	0.54	248	747
Diarrhea <=12 months	2.78	1.51	1.26	0.33	43	133
Diarrhea <=60 months	4.59	3.62	0.97	0.41	141	393
Diarrhea with blood	0.16	0.15	0.01	0.04	248	747
Diarrhea with blood <=12 months	2.78	1.31	1.47	0.44	43	133
Diarrhea with blood <=60 months	0.24	0.43	-0.19	-0.25	141	393
Primary school attendance rate	74.27	67.83	6.44	1.37	130	358
Prim school attend rate male	65.54	71.19	-5.65	-0.96	89	253
Prim school attend rate female	81.27	59.95	21.33	3.46	91	222
Secondary school attendance rate	28.46	16.37	12.09	2.53	118	308
Second school attend rate male	26.39	21.57	4.82	0.73	71	182
Second school attend rate female	29.45	11.05	18.4	3.04	82	191
Expenditures per capita	34632.82	33977.17	655.64	1.33	248	747
Expenditures per adult equiv	39864.39	39686.4	177.99	0.5	248	747

Non Poor

2006

1. treatment: borehole

	Treated	Controls	ATT	Tstat	NOB_t	NOB_unt
Treat water	0.26	0.26	0	-0.07	782	1877
Diarrhea	0.55	1.03	-0.48	-1.77	781	1872
Diarrhea <=12 months	2.65	5.04	-2.39	-1.08	119	283
Diarrhea <=60 months	2.17	4.62	-2.45	-2.11	330	823
Diarrhea with blood	0.09	0.08	0.01	0.08	781	1872
Diarrhea with blood <=12 months	0	0.11	-0.11	-0.21	119	283
Diarrhea with blood <=60 months	0	0.31	-0.31	-2.37	330	823
Primary school attendance rate	82.63	76.13	6.51	2.46	378	809
Prim school attend rate male	82.79	81.73	1.06	0.32	239	525
Prim school attend rate female	82.18	72.96	9.21	2.53	249	522
Secondary school attendance rate	40.63	38.6	2.02	0.55	308	665
Second school attend rate male	45.75	43.14	2.61	0.47	178	352
Second school attend rate female	39.76	39.42	0.34	0.07	200	437
Expenditures per capita	195925.2	208003	-12077.74	-0.44	782	1877
Expenditures per adult equiv	220377.8	232979.7	-12601.89	-0.48	782	1877

2. treatment: safe water source

	Treated	Controls	ATT	Tstat	NOB_t	NOB_unt
Treat water	0.36	0.38	-0.02	-0.86	1383	1276
Diarrhea	0.79	0.7	0.09	0.27	1380	1273
Diarrhea <=12 months	3.14	5.23	-2.08	-0.87	182	212
Diarrhea <=60 months	2.89	4.3	-1.41	-0.97	578	575
Diarrhea with blood	0.05	0.1	-0.05	-0.49	1380	1273
Diarrhea with blood <=12 months	0	0.23	-0.23	-0.3	182	212
Diarrhea with blood <=60 months	0	0.31	-0.31	-1.28	578	575
Primary school attendance rate	82.08	79.84	2.24	0.68	678	509
Prim school attend rate male	83.62	82.08	1.54	0.39	441	323
Prim school attend rate female	79.68	78.35	1.33	0.32	436	335
Secondary school attendance rate	44.56	42.23	2.33	0.47	561	412
Second school attend rate male	48.71	46.23	2.47	0.32	329	201
Second school attend rate female	42.11	44.66	-2.55	-0.42	356	278
Expenditures per capita	210283.6	219294	-9010.36	-0.79	1383	1276
Expenditures per adult equiv	236704.9	243883.8	-7178.87	-0.59	1383	1276

3. treatment: safe toilet

	Treated	Controls	ATT	Tstat	NOB_t	NOB_unt
Treat water	0.37	0.38	-0.01	-0.38	2009	650
Diarrhea	0.6	0.57	0.03	0.05	2003	650
Diarrhea <=12 months	1.79	4.63	-2.85	-0.55	314	85
Diarrhea <=60 months	1.94	3.1	-1.17	-0.52	880	273
Diarrhea with blood	0.07	0.03	0.04	0.25	2003	650
Diarrhea with blood <=12 months	0.45	0	0.45	1	314	85
Diarrhea with blood <=60 months	0.12	0	0.12	1.42	880	273
Primary school attendance rate	81.04	77.56	3.48	0.67	975	212
Prim school attend rate male	82.63	78.21	4.42	0.74	628	131
Prim school attend rate female	80.26	74.39	5.87	0.83	631	140
Secondary school attendance rate	38.97	27.99	10.99	2.11	805	168
Second school attend rate male	44.57	26.91	17.66	1.99	439	73
Second school attend rate female	34.51	31.93	2.59	0.42	520	114
Expenditures per capita	214409.4	196981.5	17427.88	1.47	2009	650
Expenditures per adult equiv	238887.8	220844.9	18042.82	1.51	2009	650

4. treatment: borehole & safe toilet

	Treated	Controls	ATT	Tstat	NOB_t	NOB_unt
Treat water	0.31	0.3	0	0.09	579	2080
Diarrhea	0.41	0.78	-0.37	-1.31	578	2075
Diarrhea <=12 months	1.16	3.67	-2.51	-1.24	90	312
Diarrhea <=60 months	0.84	3.33	-2.49	-2.35	244	909
Diarrhea with blood	0.06	0.05	0.01	0.14	578	2075
Diarrhea with blood <=12 months	0	0.14	-0.14	-0.27	90	312
Diarrhea with blood <=60 months	0	0.08	-0.08	-0.66	244	909
Primary school attendance rate	84.75	77.54	7.21	2.7	302	885
Prim school attend rate male	84.58	81.95	2.63	0.76	193	571
Prim school attend rate female	84.9	73.62	11.27	3.01	199	572
Secondary school attendance rate	45.48	45.45	0.03	0.01	244	729
Second school attend rate male	47.48	46.65	0.83	0.14	156	374
Second school attend rate female	43.26	46.77	-3.51	-0.56	153	484
Expenditures per capita	199113.6	225276.8	-26163.21	-1.03	579	2080
Expenditures per adult equiv	223530.8	250807	-27276.23	-1.12	579	2080

5. treatment: water treatment

	Treated	Controls	ATT	Tstat	NOB_t	NOB_unt
Treat water	1	0	1	.	917	1742
Diarrhea	0.62	0.57	0.05	0.19	916	1737
Diarrhea <=12 months	3.03	2.15	0.88	0.44	134	268
Diarrhea <=60 months	2.99	2.24	0.76	0.7	427	726
Diarrhea with blood	0.06	0.04	0.02	0.21	916	1737
Diarrhea with blood <=12 months	0	0.3	-0.3	-0.58	134	268
Diarrhea with blood <=60 months	0	0.05	-0.05	-0.43	427	726
Primary school attendance rate	83.71	79.94	3.77	1.54	461	726
Prim school attend rate male	84.84	80.99	3.85	1.27	313	451
Prim school attend rate female	81.94	77.4	4.54	1.36	291	480
Secondary school attendance rate	44.54	39.53	5.01	1.46	414	559
Second school attend rate male	48.86	45.45	3.42	0.68	210	320
Second school attend rate female	41.64	39.34	2.3	0.52	291	319
Expenditures per capita	295541.3	204941.7	90599.6	2.4	917	1742
Expenditures per adult equiv	321692.4	230024.7	91667.68	2.56	917	1742

1998

1. treatment: borehole

	Treated	Controls	ATT	Tstat	NOB_t	NOB_unt
Treat water	0.1	0.1	0	0.09	317	1569
Diarrhea	1.08	0.97	0.11	0.21	317	1569
Diarrhea <=12 months	4.84	2.18	2.66	0.76	72	227
Diarrhea <=60 months	3.02	3.91	-0.89	-0.54	153	712
Diarrhea with blood	0.07	0.25	-0.18	-1.23	317	1569
Diarrhea with blood <=12 months	0	0	0	.	72	227
Diarrhea with blood <=60 months	0	0.02	-0.02	-0.08	153	712
Primary school attendance rate	72.72	70.94	1.79	0.42	143	667
Prim school attend rate male	73.4	70.52	2.87	0.51	106	359
Prim school attend rate female	71.01	73.69	-2.69	-0.49	97	435
Secondary school attendance rate	23.5	26.55	-3.05	-0.67	122	527
Second school attend rate male	30.1	27.54	2.56	0.36	74	197
Second school attend rate female	21.96	24.07	-2.11	-0.35	84	334
Expenditures per capita	125496.9	110632.7	14864.22	0.96	317	1569
Expenditures per adult equiv	138436.1	125577.4	12858.72	0.8	317	1569

safe water

	Treated	Controls	ATT	Tstat	NOB_t	NOB_unt
Treat water	0.18	0.18	0	-0.03	898	988
Diarrhea	0.71	1.45	-0.74	-1.29	898	988
Diarrhea <=12 months	3.68	4.61	-0.93	-0.32	164	147
Diarrhea <=60 months	2.59	4.19	-1.6	-1.15	383	448
Diarrhea with blood	0.18	0.22	-0.03	-0.19	898	988
Diarrhea with blood <=12 months	0	0	0	.	164	147
Diarrhea with blood <=60 months	0.26	0.04	0.22	0.72	383	448
Primary school attendance rate	74.01	66.8	7.21	1.85	367	394
Prim school attend rate male	76.65	67.78	8.87	1.83	250	259
Prim school attend rate female	74.36	68.67	5.69	1.12	247	252
Secondary school attendance rate	27.76	24.57	3.19	0.81	333	316
Second school attend rate male	31.15	27.61	3.54	0.62	204	191
Second school attend rate female	23.93	20.98	2.95	0.63	197	194
Expenditures per capita	108954.1	106965.6	1988.54	0.17	898	988
Expenditures per adult equiv	120872.8	122855	-1982.18	-0.16	898	988

safe toilet

	Treated	Controls	ATT	Tstat	NOB_t	NOB_unt
Treat water	0.18	0.2	-0.02	-0.65	1276	610
Diarrhea	1.02	1.25	-0.22	-0.39	1276	610
Diarrhea <=12 months	3.65	2.07	1.58	0.34	207	114
Diarrhea <=60 months	2.98	2.64	0.33	0.16	590	263
Diarrhea with blood	0.08	0.11	-0.03	-0.1	1276	610
Diarrhea with blood <=12 months	0	0	0	.	207	114
Diarrhea with blood <=60 months	0.26	0	0.26	1.34	590	263
Primary school attendance rate	73.05	66.5	6.56	1.18	591	219
Prim school attend rate male	73.24	63.58	9.65	1.44	372	137
Prim school attend rate female	72.94	67.68	5.25	0.74	379	137
Secondary school attendance rate	27.05	17.12	9.93	1.91	473	176
Second school attend rate male	27.97	5.42	22.55	3.33	242	96
Second school attend rate female	22.33	25.27	-2.94	-0.4	273	118
Expenditures per capita	109474.4	101784.1	7690.31	0.69	1276	610
Expenditures per adult equiv	122315.2	114283.2	8031.99	0.68	1276	610

safe water and safe toilet

	Treated	Controls	ATT	Tstat	NOB_t	NOB_unt
Treat water	0.09	0.1	-0.01	-0.43	204	1682
Diarrhea	1.17	0.87	0.3	0.47	204	1682
Diarrhea <=12 months	5.13	3.42	1.71	0.43	46	253
Diarrhea <=60 months	3.69	3.39	0.3	0.16	105	760
Diarrhea with blood	0.04	0.17	-0.13	-0.94	204	1682
Diarrhea with blood <=12 months	0	0	0	.	46	253
Diarrhea with blood <=60 months	0	0.02	-0.02	-0.1	105	760
Primary school attendance rate	76.06	72.89	3.17	0.71	105	705
Prim school attend rate male	78.83	74.15	4.68	0.88	77	388
Prim school attend rate female	72.77	74.66	-1.89	-0.31	72	460
Secondary school attendance rate	26.79	32.15	-5.36	-1	80	569
Second school attend rate male	35.76	27.39	8.38	1.02	50	221
Second school attend rate female	21.03	26.4	-5.37	-0.82	56	362
Expenditures per capita	145439.3	108219.1	37220.18	1.68	204	1682
Expenditures per adult equiv	160156.3	123789.5	36366.85	1.59	204	1682

water treatment

	Treated	Controls	ATT	Tstat	NOB_t	NOB_unt
Treat water	1	0	1	.	338	1548
Diarrhea	1.86	0.9	0.96	1.7	338	1548
Diarrhea <=12 months	7.84	1.98	5.86	1.37	54	262
Diarrhea <=60 months	6.05	2.26	3.79	1.95	157	708
Diarrhea with blood	0.48	0.06	0.42	1.31	338	1548
Diarrhea with blood <=12 months	0	0	0	.	54	262
Diarrhea with blood <=60 months	0.96	0	0.96	1.35	157	708
Primary school attendance rate	80.72	69.88	10.84	3.12	157	639
Prim school attend rate male	80.93	72.94	7.99	1.59	104	429
Prim school attend rate female	80.68	71.61	9.07	1.92	104	417
Secondary school attendance rate	26.29	29.83	-3.54	-0.84	135	478
Second school attend rate male	29.46	26.89	2.57	0.41	84	290
Second school attend rate female	25.76	25.23	0.53	0.1	89	310
Expenditures per capita	137707.7	118280.3	19427.39	1.04	338	1548
Expenditures per adult equiv	151068.2	131150	19918.16	1.05	338	1548

All rural households

2006

1. treatment: borehole

	Treated	Controls	ATT	Tstat	NOB_t	NOB_unt
Treat water	0.17	0.17	0	-0.33	2496	6561
Diarrhea	0.52	0.73	-0.21	-1.77	2494	6553
Diarrhea <=12 months	3.13	4.1	-0.97	-0.84	447	1135
Diarrhea <=60 months	2.28	2.77	-0.48	-0.91	1218	3139
Diarrhea with blood	0.1	0.13	-0.03	-0.75	2494	6553
Diarrhea with blood <=12 months	0.45	0.23	0.22	0.51	447	1135
Diarrhea with blood <=60 months	0.38	0.37	0	0.02	1218	3139
Primary school attendance rate	73.14	68.57	4.57	3.33	1500	3832
Prim school attend rate male	72.72	69.23	3.49	1.97	991	2574
Prim school attend rate female	74.76	69.18	4.98	2.82	1023	2516
Secondary school attendance rate	28.73	24.4	4.33	2.78	1172	2845
Second school attend rate male	31.09	27.56	3.53	1.62	723	1625
Second school attend rate female	27.85	23.68	4.17	2.02	720	1779
Expenditures per capita	93806.99	96437.81	-2630.82	-0.34	2496	6561
Expenditures per adult equiv	107089.2	109750.8	-2661.68	-0.35	2496	6561
Extremely poor	41.56	43.85	-2.28	-1.76	2496	6561
Moderately poor	27.13	26.55	0.58	0.5	2496	6561
Non-poor	31.3	29.6	1.7	1.41	2496	6561

2. treatment: safe water source

	Treated	Controls	ATT	Tstat	NOB_t	NOB_unt
Treat water	0.22	0.23	0	-0.37	3842	5215
Diarrhea	0.59	0.65	-0.05	-0.41	3838	5209
Diarrhea <=12 months	3.18	4.36	-1.17	-1.04	649	933
Diarrhea <=60 months	2.58	2.62	-0.04	-0.07	1838	2519
Diarrhea with blood	0.09	0.12	-0.03	-0.72	3838	5209
Diarrhea with blood <=12 months	0.32	0.28	0.03	0.08	649	933
Diarrhea with blood <=60 months	0.34	0.41	-0.07	-0.35	1838	2519
Primary school attendance rate	73.31	69.76	3.55	2.33	2291	3041
Prim school attend rate male	73.38	69.47	3.91	2.21	1537	2028
Prim school attend rate female	73.94	70.71	3.23	1.65	1523	2016
Secondary school attendance rate	29.9	25.37	4.53	2.86	1790	2227
Second school attend rate male	33.82	24.99	8.83	3.62	1092	1256
Second school attend rate female	29.08	24.89	4.19	1.98	1094	1405
Expenditures per capita	104417.5	102296.8	2120.7	0.61	3842	5215
Expenditures per adult equiv	118969.2	116116	2853.08	0.75	3842	5215
Extremely poor	38.31	43.62	-5.31	-3.94	3842	5215
Moderately poor	27.19	25.35	1.84	1.53	3842	5215
Non-poor	34.5	31.03	3.47	2.85	3842	5215

3. treatment: safe toilet

	Treated	Controls	ATT	Tstat	NOB_t	NOB_unt
Treat water	0.24	0.25	-0.01	-0.84	6272	2785
Diarrhea	0.58	0.61	-0.03	-0.18	6262	2785
Diarrhea <=12 months	3.35	6.06	-2.71	-1.77	1059	517
Diarrhea <=60 months	2.15	3.03	-0.89	-1.12	2972	1385
Diarrhea with blood	0.09	0.07	0.03	0.44	6262	2785
Diarrhea with blood <=12 months	0.56	0.01	0.54	1.4	1059	517
Diarrhea with blood <=60 months	0.34	0.1	0.24	0.84	2972	1385
Primary school attendance rate	72.29	65.82	6.47	3.12	3807	1525
Prim school attend rate male	72.31	66.34	5.97	2.22	2545	1020
Prim school attend rate female	73.11	64.73	8.39	3.1	2541	998
Secondary school attendance rate	26.42	17.3	9.12	4.73	2963	1054
Second school attend rate male	29.54	20.81	8.72	2.87	1755	573
Second school attend rate female	24.62	16.7	7.91	3.25	1815	684
Expenditures per capita	99372.52	94607.9	4764.63	1.22	6272	2785
Expenditures per adult equiv	112661.1	107459.1	5201.98	1.28	6272	2785
Extremely poor	41.04	45.01	-3.97	-2.26	6272	2785
Moderately poor	27.81	25.7	2.11	1.4	6272	2785
Non-poor	31.15	29.29	1.86	1.23	6272	2785

4. treatment: borehole & safe toilet

	Treated	Controls	ATT	Tstat	NOB_t	NOB_unt
Treat water	0.21	0.21	0	-0.29	1641	7416
Diarrhea	0.48	0.61	-0.13	-1.06	1639	7408
Diarrhea <=12 months	2.13	3.82	-1.69	-1.52	282	1300
Diarrhea <=60 months	1.69	2.71	-1.02	-1.89	782	3575
Diarrhea with blood	0.07	0.1	-0.04	-0.86	1639	7408
Diarrhea with blood <=12 months	0.35	0.25	0.1	0.24	282	1300
Diarrhea with blood <=60 months	0.2	0.3	-0.1	-0.55	782	3575
Primary school attendance rate	75.82	70.03	5.79	3.98	1018	4314
Prim school attend rate male	74.87	70.22	4.65	2.4	679	2886
Prim school attend rate female	77.06	70.03	7.04	3.79	700	2839
Secondary school attendance rate	33.14	27.06	6.08	3.5	844	3173
Second school attend rate male	34.96	29.42	5.54	2.33	541	1807
Second school attend rate female	32.57	26.55	6.02	2.59	501	1998
Expenditures per capita	102877.6	113116.2	-10238.73	-1.43	1641	7416
Expenditures per adult equiv	116838.7	126695.1	-9856.36	-1.41	1641	7416
Extremely poor	37.56	40.65	-3.09	-2.18	1641	7416
Moderately poor	27.2	26.79	0.41	0.32	1641	7416
Non-poor	35.24	32.56	2.68	1.96	1641	7416

5. treatment: water treatment

	Treated	Controls	ATT	Tstat	NOB_t	NOB_unt
Treat water	1	0	1	.	1933	7124
Diarrhea	0.54	0.6	-0.05	-0.42	1930	7117
Diarrhea <=12 months	2.4	3.18	-0.78	-0.72	340	1242
Diarrhea <=60 months	2.25	2.31	-0.06	-0.11	977	3380
Diarrhea with blood	0.12	0.07	0.05	0.97	1930	7117
Diarrhea with blood <=12 months	0.9	0.25	0.65	1.17	340	1242
Diarrhea with blood <=60 months	0.42	0.23	0.2	0.92	977	3380
Primary school attendance rate	78.43	73.48	4.95	3.51	1159	4173
Prim school attend rate male	78	74.21	3.79	2.06	795	2770
Prim school attend rate female	78.11	72.94	5.18	2.83	781	2758
Secondary school attendance rate	32.81	30.41	2.4	1.4	964	3053
Second school attend rate male	33.69	32.2	1.49	0.64	562	1786
Second school attend rate female	33.62	30.97	2.64	1.13	622	1877
Expenditures per capita	166632.1	121585.1	45046.99	2.5	1933	7124
Expenditures per adult equiv	183892.7	138197.6	45695.02	2.67	1933	7124
Extremely poor	27.02	38.47	-11.45	-8.8	1933	7124
Moderately poor	25.67	26.62	-0.94	-0.76	1933	7124
Non-poor	47.3	34.92	12.39	9.26	1933	7124

1998

1. treatment: borehole

	Treated	Controls	ATT	Tstat	NOB_t	NOB_unt
Treat water	0.06	0.06	0	-0.28	1312	6957
Diarrhea	1.15	1.15	0	-0.01	1312	6957
Diarrhea <=12 months	5.45	4.02	1.43	0.85	281	1268
Diarrhea <=60 months	4.74	3.81	0.93	1.09	695	3454
Diarrhea with blood	0.24	0.23	0.01	0.12	1312	6957
Diarrhea with blood <=12 months	0.73	0.74	-0.01	-0.01	281	1268
Diarrhea with blood <=60 months	0.51	0.29	0.21	0.76	695	3454
Primary school attendance rate	63.69	63.06	0.63	0.33	729	3906
Prim school attend rate male	64.74	63.71	1.03	0.41	514	2684
Prim school attend rate female	63.78	63.57	0.21	0.09	498	2580
Secondary school attendance rate	20.81	14.5	6.31	3.65	614	3109
Second school attend rate male	24.02	16.54	7.48	2.94	371	1903
Second school attend rate female	18.37	13.37	5	2.33	393	1914
Expenditures per capita	48624.82	38444.3	10180.53	1.76	1312	6957
Expenditures per adult equiv	53568.59	43760.86	9807.73	1.66	1312	6957
Extremely poor	65.55	63.49	2.06	1.3	1312	6957
Moderately poor	10.29	12.67	-2.38	-2.3	1312	6957
Non-poor	24.16	23.84	0.32	0.23	1312	6957

2. treatment: safe water source

	Treated	Controls	ATT	Tstat	NOB_t	NOB_unt
Treat water	0.12	0.13	-0.01	-0.57	3297	4972
Diarrhea	1.25	1.22	0.03	0.13	3297	4972
Diarrhea <=12 months	5.46	4.88	0.58	0.42	605	916
Diarrhea <=60 months	4.41	4.12	0.29	0.43	1685	2464
Diarrhea with blood	0.24	0.19	0.06	0.68	3297	4972
Diarrhea with blood <=12 months	0.66	0.45	0.21	0.47	605	916
Diarrhea with blood <=60 months	0.48	0.3	0.19	0.84	1685	2464
Primary school attendance rate	65.94	61.67	4.27	2.66	1854	2781
Prim school attend rate male	66.15	62.64	3.5	1.76	1259	1939
Prim school attend rate female	66.93	61.02	5.91	2.89	1274	1804
Secondary school attendance rate	21.08	15.22	5.86	4.36	1486	2237
Second school attend rate male	23.38	17.13	6.26	3.32	910	1364
Second school attend rate female	19.05	11.34	7.71	4.71	941	1366
Expenditures per capita	41259.08	39938.61	1320.47	0.48	3297	4972
Expenditures per adult equiv	46314.01	45710.41	603.6	0.21	3297	4972
Extremely poor	62.5	63.62	-1.13	-0.84	3297	4972
Moderately poor	11.24	12.91	-1.66	-1.82	3297	4972
Non-poor	26.26	23.47	2.79	2.39	3297	4972

3. treatment: safe toilet

	Treated	Controls	ATT	Tstat	NOB_t	NOB_unt
Treat water	0.13	0.14	-0.01	-0.91	5026	3242
Diarrhea	1.12	1.29	-0.16	-0.7	5026	3242
Diarrhea <=12 months	5.16	7.27	-2.11	-1.23	908	640
Diarrhea <=60 months	3.99	4.33	-0.34	-0.39	2578	1569
Diarrhea with blood	0.13	0.22	-0.08	-0.73	5026	3242
Diarrhea with blood <=12 months	0.72	0.33	0.39	0.84	908	640
Diarrhea with blood <=60 months	0.4	0.56	-0.16	-0.45	2578	1569
Primary school attendance rate	65.65	50.4	15.24	7.33	2940	1694
Prim school attend rate male	65.96	51.3	14.66	5.4	2051	1146
Prim school attend rate female	66.07	50.27	15.8	5.75	1989	1089
Secondary school attendance rate	19.58	7.43	12.14	8.76	2387	1337
Second school attend rate male	21.99	8.84	13.16	6.26	1492	783
Second school attend rate female	17.76	6.46	11.3	6.42	1478	829
Expenditures per capita	41199.74	39673.82	1525.91	0.57	5026	3242
Expenditures per adult equiv	46385.87	44862.53	1523.34	0.53	5026	3242
Extremely poor	62.07	63.97	-1.91	-1.25	5026	3242
Moderately poor	12.76	12.23	0.54	0.52	5026	3242
Non-poor	25.17	23.8	1.37	1.04	5026	3242

4. treatment: borehole & safe toilet

	Treated	Controls	ATT	Tstat	NOB_t	NOB_unt
Treat water	0.06	0.07	-0.01	-0.73	752	7515
Diarrhea	1.05	0.99	0.06	0.23	752	7515
Diarrhea <=12 months	5.84	4.87	0.98	0.45	155	1393
Diarrhea <=60 months	4.44	3.65	0.8	0.78	405	3742
Diarrhea with blood	0.06	0.2	-0.13	-1.92	752	7515
Diarrhea with blood <=12 months	0.65	0.53	0.12	0.16	155	1393
Diarrhea with blood <=60 months	0.37	0.24	0.13	0.41	405	3742
Primary school attendance rate	70.21	65.59	4.62	2.1	454	4180
Prim school attend rate male	69.86	65.5	4.37	1.54	318	2879
Prim school attend rate female	70.85	65.1	5.75	2.1	324	2754
Secondary school attendance rate	26.86	17.79	9.07	3.97	365	3358
Second school attend rate male	29.96	20.66	9.29	2.87	227	2047
Second school attend rate female	24.71	15.88	8.83	3.1	237	2070
Expenditures per capita	63612.25	41631.62	21980.64	2.24	752	7515
Expenditures per adult equiv	69448.42	47278.93	22169.49	2.23	752	7515
Extremely poor	62.37	60.74	1.63	0.81	752	7515
Moderately poor	10.51	12.43	-1.92	-1.49	752	7515
Non-poor	27.13	26.83	0.3	0.16	752	7515

5. treatment: water treatment

	Treated	Controls	ATT	Tstat	NOB_t	NOB_unt
Treat water	1	0	1	.	938	7332
Diarrhea	1.27	1.11	0.17	0.68	938	7332
Diarrhea <=12 months	6.78	4.87	1.92	1.01	201	1348
Diarrhea <=60 months	4.67	3.92	0.75	0.81	508	3641
Diarrhea with blood	0.41	0.15	0.26	1.77	938	7332
Diarrhea with blood <=12 months	0.5	0.68	-0.18	-0.33	201	1348
Diarrhea with blood <=60 months	0.59	0.36	0.24	0.71	508	3641
Primary school attendance rate	70.13	63	7.13	3.7	548	4087
Prim school attend rate male	71.23	63.35	7.89	3.19	373	2825
Prim school attend rate female	70.72	63.24	7.49	3.01	368	2710
Secondary school attendance rate	19.96	18.04	1.92	1.04	449	3275
Second school attend rate male	22.66	21.05	1.61	0.61	269	2006
Second school attend rate female	20.42	16.52	3.9	1.6	297	2010
Expenditures per capita	61922.56	51514.05	10408.51	1.52	938	7332
Expenditures per adult equiv	68675.95	57883.46	10792.49	1.55	938	7332
Extremely poor	50.43	61.83	-11.4	-6.5	938	7332
Moderately poor	13.54	12.53	1.01	0.84	938	7332
Non-poor	36.03	25.65	10.39	6.24	938	7332

Annex 8: Propensity score matching results (LCMS) WSS for peri-urban areas

2006   **1998**

1. treatment: safe water source

2006

	Treated	Controls	ATT	Tstat	NOB_t	NOB_unt
Treat water	0.26	0.28	-0.02	-0.48	472	270
Diarrhea	0.9	0.94	-0.04	-0.11	471	270
Diarrhea <=12 months	3.33	0	3.33	1	56	48
Diarrhea <=60 months	2.14	4.05	-1.91	-0.9	200	118
Diarrhea with blood	0.17	0.15	0.01	0.13	471	270
Diarrhea with blood <=12 months	0	0	0	.	56	48
Diarrhea with blood <=60 months	0.84	0.65	0.19	0.22	200	118
Primary school attendance rate	66.48	70.99	-4.51	-1	347	202
Prim school attend rate male	64.53	74.51	-9.97	-1.66	230	138
Prim school attend rate female	69.95	68.54	1.4	0.23	247	143
Secondary school attendance rate	30.39	22.92	7.47	1.43	266	154
Second school attend rate male	28.11	21.04	7.07	1.08	152	107
Second school attend rate female	33.33	26.12	7.21	0.95	122	79
Expenditures per capita	38716.98	37550.63	1166.36	1.05	472	270
Expenditures per adult equiv	44397.18	43681.6	715.58	0.58	472	270

1998

	Treated	Controls	ATT	Tstat	NOB_t	NOB_unt
Treat water	0.18	0.18	0	0.12	1478	297
Diarrhea	1.22	1.02	0.2	0.47	1478	297
Diarrhea <=12 months	4.74	4.77	-0.03	-0.01	281	54
Diarrhea <=60 months	5.53	3.9	1.63	0.67	842	155
Diarrhea with blood	0.17	0.18	-0.01	-0.08	1478	297
Diarrhea with blood <=12 months	1.08	1.68	-0.6	-0.21	281	54
Diarrhea with blood <=60 months	0.84	0.53	0.31	0.49	842	155
Primary school attendance rate	67.44	66.41	1.02	0.24	1082	200
Prim school attend rate male	68.84	69.16	-0.32	-0.06	762	144
Prim school attend rate female	67.31	64.16	3.15	0.55	757	135
Secondary school attendance rate	25.06	17.18	7.88	1.8	901	167
Second school attend rate male	26.77	15.81	10.96	1.96	565	100
Second school attend rate female	25.26	16.9	8.36	1.55	591	103
Expenditures per capita	17804.02	16178.56	1625.46	2.65	1478	297
Expenditures per adult equiv	20423.95	18675.19	1748.77	2.62	1478	297

2. treatment: safe toilet

2006

	Treated	Controls	ATT	Tstat	NOB_t	NOB_unt
Treat water	0.28	0.26	0.01	0.24	582	149
Diarrhea	0.46	2.71	-2.25	-2.77	582	148
Diarrhea <=12 months	0	10.59	-10.59	-1.49	89	22
Diarrhea <=60 months	2.03	5.7	-3.67	-1.22	272	70
Diarrhea with blood	0.08	0.31	-0.24	-0.88	582	148
Diarrhea with blood <=12 months	0	0	0	.	89	22
Diarrhea with blood <=60 months	0.38	0.51	-0.13	-0.06	272	70
Primary school attendance rate	71.01	56.67	14.33	2.11	439	100
Prim school attend rate male	68.14	64.48	3.66	0.47	302	62
Prim school attend rate female	74.84	53.57	21.27	2.45	311	70
Secondary school attendance rate	28.26	31.04	-2.78	-0.33	344	61
Second school attend rate male	22.69	29.66	-6.97	-0.74	207	42
Second school attend rate female	23.65	23.01	0.64	0.05	152	36
Expenditures per capita	38345.5	37700.5	645	0.44	582	149
Expenditures per adult equiv	44001.4	44050.57	-49.17	-0.03	582	149

1998

	Treated	Controls	ATT	Tstat	NOB_t	NOB_unt
Treat water	0.2	0.18	0.02	0.66	1386	389
Diarrhea	1.11	1.12	-0.01	-0.02	1386	389
Diarrhea <=12 months	6.25	3.51	2.74	0.6	256	70
Diarrhea <=60 months	4.95	5.55	-0.6	-0.26	793	204
Diarrhea with blood	0.09	0.29	-0.2	-0.87	1386	389
Diarrhea with blood <=12 months	1.56	0	1.56	1.95	256	70
Diarrhea with blood <=60 months	0.58	1.33	-0.75	-0.63	793	204
Primary school attendance rate	69.74	61.2	8.54	1.9	1038	244
Prim school attend rate male	71.58	66.02	5.55	0.9	693	174
Prim school attend rate female	68.5	60.03	8.47	1.43	725	167
Secondary school attendance rate	25.32	12.37	12.94	3.11	832	196
Second school attend rate male	25.46	13.71	11.75	1.82	531	108
Second school attend rate female	24.89	8.77	16.11	3.07	543	133
Expenditures per capita	17712.57	16421.46	1291.11	2.05	1386	389
Expenditures per adult equiv	20311.19	19230.45	1080.74	1.53	1386	389

3. treatment: safe water & safe toilet

2006

	Treated	Controls	ATT	Tstat	NOB_t	NOB_unt
Treat water	0.28	0.28	0	0.05	382	360
Diarrhea	0.47	1.35	-0.88	-2.39	382	359
Diarrhea <=12 months	0	1.65	-1.65	-0.76	53	61
Diarrhea <=60 months	1.36	3.65	-2.29	-1.33	179	163
Diarrhea with blood	0.08	0.28	-0.2	-1.71	382	359
Diarrhea with blood <=12 months	0	0	0	.	53	61
Diarrhea with blood <=60 months	0.29	1.04	-0.75	-0.86	179	163
Primary school attendance rate	67.76	67.81	-0.05	-0.01	288	261
Prim school attend rate male	65.1	73.46	-8.36	-1.63	193	175
Prim school attend rate female	73.91	64.04	9.87	1.97	207	183
Secondary school attendance rate	31.79	26.27	5.52	1.23	231	189
Second school attend rate male	31.69	27.42	4.27	0.71	130	129
Second school attend rate female	34.15	27.36	6.8	1.04	133	104
Expenditures per capita	38686.58	38344.9	341.68	0.38	382	360
Expenditures per adult equiv	44424.32	44389.16	35.16	0.04	382	360

1998

	Treated	Controls	ATT	Tstat	NOB_t	NOB_unt
Treat water	0.19	0.18	0.01	0.24	1165	610
Diarrhea	1.07	1.35	-0.28	-0.79	1165	610
Diarrhea <=12 months	4.48	5.6	-1.12	-0.34	228	107
Diarrhea <=60 months	4.85	5.84	-1	-0.57	683	314
Diarrhea with blood	0.1	0.18	-0.08	-0.6	1165	610
Diarrhea with blood <=12 months	1.24	1.49	-0.24	-0.18	228	107
Diarrhea with blood <=60 months	0.61	0.9	-0.3	-0.4	683	314
Primary school attendance rate	69.83	68.77	1.05	0.35	886	396
Prim school attend rate male	71.83	70.96	0.88	0.23	620	286
Prim school attend rate female	68.42	68.93	-0.51	-0.13	626	266
Secondary school attendance rate	26.49	16.83	9.67	3.48	735	333
Second school attend rate male	29.04	17.11	11.92	3	475	190
Second school attend rate female	26.19	16.28	9.9	2.4	488	214
Expenditures per capita	17916.51	17262.09	654.42	1.47	1165	610
Expenditures per adult equiv	20583.54	20149.92	433.61	0.88	1165	610

4. treatment: water treatment

2006

	Treated	Controls	ATT	Tstat	NOB_t	NOB_unt
Treat water	1	0	1	.	195	547
Diarrhea	0.47	0.85	-0.38	-0.86	194	547
Diarrhea <=12 months	0	2.81	-2.81	-0.94	29	74
Diarrhea <=60 months	1.52	2.51	-1	-0.49	89	259
Diarrhea with blood	0.19	0.1	0.1	0.62	194	547
Diarrhea with blood <=12 months	0	0	0	.	29	74
Diarrhea with blood <=60 months	0	0.63	-0.63	-0.69	89	259
Primary school attendance rate	72.26	67.38	4.88	1.1	156	393
Prim school attend rate male	71.74	70.71	1.03	0.17	116	259
Prim school attend rate female	74.69	67.56	7.13	1.34	109	281
Secondary school attendance rate	37.7	28.14	9.56	1.87	123	297
Second school attend rate male	31.43	29.98	1.45	0.22	81	178
Second school attend rate female	42.4	30.2	12.21	1.64	70	159
Expenditures per capita	40282.21	39684.59	597.62	0.59	195	547
Expenditures per adult equiv	46312.12	45562.66	749.46	0.68	195	547

1998

	Treated	Controls	ATT	Tstat	NOB_t	NOB_unt
Treat water	1	0	1	.	332	1443
Diarrhea	1.19	1.16	0.03	0.1	332	1443
Diarrhea <=12 months	2.94	7.08	-4.14	-1.49	69	266
Diarrhea <=60 months	4.58	5.33	-0.76	-0.48	205	792
Diarrhea with blood	0.08	0.15	-0.08	-0.85	332	1443
Diarrhea with blood <=12 months	0	2.01	-2.01	-2.35	69	266
Diarrhea with blood <=60 months	0.25	0.79	-0.55	-1.27	205	792
Primary school attendance rate	73.21	70.09	3.12	1.08	242	1040
Prim school attend rate male	75.37	73.21	2.16	0.59	160	746
Prim school attend rate female	72.86	68.68	4.18	1.13	177	715
Secondary school attendance rate	29.69	26.68	3.02	0.95	215	840
Second school attend rate male	29.17	28.07	1.09	0.25	135	521
Second school attend rate female	29.4	26.68	2.71	0.66	145	549
Expenditures per capita	18138.91	17658.47	480.44	1.1	332	1443
Expenditures per adult equiv	20995.16	20369.04	626.12	1.29	332	1443

Moderately Poor

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1. treatment: safe water source

	Treated	Controls	ATT	Tstat	NOB_t	NOB_unt		Treated	Controls	ATT	Tstat	NOB_t	NOB_unt
Treat water	0.35	0.37	-0.02	-0.37	850	281	Treat water	0.24	0.28	-0.04	-0.55	919	102
Diarrhea	0.69	1.36	-0.67	-1.45	849	279	Diarrhea	1.94	1.38	0.57	0.65	919	102
Diarrhea <=12 months	6	6.24	-0.24	-0.05	128	45	Diarrhea <=12 months	4.48	11.87	-7.39	-0.78	148	15
Diarrhea <=60 months	2.66	3.53	-0.87	-0.39	401	129	Diarrhea <=60 months	6.08	11.85	-5.77	-1.24	518	64
Diarrhea with blood	0.07	0	0.07	1.85	849	279	Diarrhea with blood	0.42	0.09	0.32	0.93	919	102
Diarrhea with blood <=12 months	0.5	0	0.5	1	128	45	Diarrhea with blood <=12 months	2.99	0	2.99	1.43	148	15
Diarrhea with blood <=60 months	0.57	0	0.57	1.64	401	129	Diarrhea with blood <=60 months	0.92	0.26	0.67	0.64	518	64
Primary school attendance rate	75.71	82.86	-7.15	-1.78	608	186	Primary school attendance rate	74.58	59.41	15.17	1.33	593	49
Prim school attend rate male	78.26	77.39	0.87	0.16	402	132	Prim school attend rate male	74.43	84.76	-10.33	-1.31	362	29
Prim school attend rate female	75.15	78.35	-3.2	-0.56	415	129	Prim school attend rate female	79.48	47.59	31.89	2.29	413	36
Secondary school attendance rate	42.86	37.7	5.16	0.85	460	145	Secondary school attendance rate	28.36	11.08	17.28	1.7	437	32
Second school attend rate male	43.8	32.22	11.58	1.33	287	90	Second school attend rate male	35.54	34.83	0.72	0.05	206	16
Second school attend rate female	43.95	43.88	0.06	0.01	288	93	Second school attend rate female	25.28	7.32	17.96	2.15	159	26
Expenditures per capita	73123.98	73723.82	-599.84	-0.44	850	281	Expenditures per capita	34398.76	32946.34	1452.42	1.6	919	102
Expenditures per adult equiv	84164.58	85083.55	-918.96	-0.76	850	281	Expenditures per adult equiv	39683.1	38954.55	728.56	1.12	919	102

2. treatment: safe toilet

	Treated	Controls	ATT	Tstat	NOB_t	NOB_unt		Treated	Controls	ATT	Tstat	NOB_t	NOB_unt
Treat water	0.38	0.36	0.01	0.36	890	241	Treat water	0.26	0.27	-0.01	-0.14	754	268
Diarrhea	0.86	0.26	0.59	1.69	888	240	Diarrhea	1.24	1.74	-0.49	-0.42	754	268
Diarrhea <=12 months	3.78	0.79	2.99	0.68	144	51	Diarrhea <=12 months	4.49	2.48	2.01	0.21	106	45
Diarrhea <=60 months	2.52	1.26	1.26	0.56	417	113	Diarrhea <=60 months	4.28	9.33	-5.05	-1.09	423	140
Diarrhea with blood	0.07	0	0.07	1.85	888	240	Diarrhea with blood	0.3	0.24	0.05	0.12	754	268
Diarrhea with blood <=12 months	0	0	0	.	144	51	Diarrhea with blood <=12 months	2.25	0	2.25	1.42	106	45
Diarrhea with blood <=60 months	0.52	0	0.52	1.64	417	113	Diarrhea with blood <=60 months	0.81	0.55	0.25	0.17	423	140
Primary school attendance rate	79.71	70.4	9.31	1.91	645	149	Primary school attendance rate	74.5	64.44	10.06	1.53	446	127
Prim school attend rate male	80.33	68.45	11.88	1.82	441	86	Prim school attend rate male	77.18	69.7	7.48	0.87	300	74
Prim school attend rate female	79.6	70.78	8.82	1.37	436	108	Prim school attend rate female	78.45	65.67	12.78	1.48	309	97
Secondary school attendance rate	45.04	39.57	5.47	0.82	493	112	Secondary school attendance rate	28.6	14.74	13.86	1.79	391	94
Second school attend rate male	44.16	37.2	6.96	0.74	306	71	Second school attend rate male	30.72	19.67	11.04	0.88	211	46
Second school attend rate female	46.58	55.91	-9.33	-0.81	316	65	Second school attend rate female	26.38	14.49	11.89	1.1	255	67
Expenditures per capita	73023.99	72410.14	613.84	0.5	890	241	Expenditures per capita	34494.7	33195.35	1299.35	1.8	754	268
Expenditures per adult equiv	84239.1	83754.13	484.97	0.44	890	241	Expenditures per adult equiv	39588.73	38350.88	1237.85	2.34	754	268

3. treatment: safe water & safe toilet

	Treated	Controls	ATT	Tstat	NOB_t	NOB_unt		Treated	Controls	ATT	Tstat	NOB_t	NOB_unt
Treat water	0.37	0.37	0	-0.06	665	466	Treat water	0.25	0.24	0.02	0.35	686	335
Diarrhea	0.79	0.68	0.11	0.35	665	463	Diarrhea	1.18	1.88	-0.71	-0.78	686	335
Diarrhea <=12 months	4.87	2.9	1.97	0.38	114	81	Diarrhea <=12 months	4.6	8.84	-4.24	-0.6	112	58
Diarrhea <=60 months	2.4	2.39	0.01	0.01	315	215	Diarrhea <=60 months	4.61	9.61	-5	-1.45	394	188
Diarrhea with blood	0.09	0	0.09	1.85	665	463	Diarrhea with blood	0.3	0.43	-0.13	-0.37	686	335
Diarrhea with blood <=12 months	0.44	0	0.44	1	114	81	Diarrhea with blood <=12 months	2.3	0	2.3	1.42	112	58
Diarrhea with blood <=60 months	0.64	0	0.64	1.64	315	215	Diarrhea with blood <=60 months	0.79	0.62	0.17	0.16	394	188
Primary school attendance rate	78.65	75.28	3.38	1.12	494	300	Primary school attendance rate	78.16	68.94	9.22	1.75	479	163
Prim school attend rate male	79.84	73.79	6.05	1.47	340	194	Prim school attend rate male	80.14	82.55	-2.41	-0.36	327	98
Prim school attend rate female	78.95	73.6	5.35	1.35	329	215	Prim school attend rate female	80.73	63.02	17.71	2.71	328	121
Secondary school attendance rate	45.29	43.34	1.95	0.45	374	231	Secondary school attendance rate	32.19	20.6	11.58	1.73	397	116
Second school attend rate male	45.81	43.77	2.05	0.35	234	143	Second school attend rate male	34.89	23.76	11.13	0.93	238	58
Second school attend rate female	44.69	50.32	-5.62	-0.91	238	138	Second school attend rate female	31.26	15.31	15.95	1.53	254	86
Expenditures per capita	73252.91	73588.23	-335.32	-0.36	665	466	Expenditures per capita	34728.93	33657.63	1071.3	1.81	686	335
Expenditures per adult equiv	84282.24	84439.96	-157.72	-0.19	665	466	Expenditures per adult equiv	39671.73	39005.91	665.83	1.53	686	335

4. treatment: water treatment

	Treated	Controls	ATT	Tstat	NOB_t	NOB_unt		Treated	Controls	ATT	Tstat	NOB_t	NOB_unt
Treat water	1	0	1	.	419	712	Treat water	1	0	1	.	258	764
Diarrhea	0.58	0.77	-0.19	-0.62	418	710	Diarrhea	1.06	1.24	-0.18	-0.4	258	764
Diarrhea <=12 months	6.94	5.36	1.58	0.39	73	122	Diarrhea <=12 months	4.35	6.19	-1.84	-0.46	46	126
Diarrhea <=60 months	2.66	2.46	0.19	0.14	208	322	Diarrhea <=60 months	4.52	4.28	0.24	0.12	167	416
Diarrhea with blood	0.09	0.03	0.07	0.88	418	710	Diarrhea with blood	0.19	0.35	-0.16	-0.79	258	764
Diarrhea with blood <=12 months	0.69	0	0.69	1	73	122	Diarrhea with blood <=12 months	2.17	0.61	1.57	0.65	46	126
Diarrhea with blood <=60 months	0.72	0.08	0.64	1.13	208	322	Diarrhea with blood <=60 months	0.9	0.62	0.29	0.35	167	416
Primary school attendance rate	81.9	76.52	5.38	1.87	313	481	Primary school attendance rate	83.38	77.81	5.57	1.7	186	457
Prim school attend rate male	79.39	81.09	-1.7	-0.46	227	307	Prim school attend rate male	83.58	83.67	-0.1	-0.02	128	294
Prim school attend rate female	82.42	77.36	5.06	1.36	221	323	Prim school attend rate female	85.89	77.75	8.15	1.97	127	322
Secondary school attendance rate	50.96	40.99	9.97	2.46	255	350	Secondary school attendance rate	37.7	34.73	2.97	0.66	147	367
Second school attend rate male	52.19	43.13	9.06	1.61	155	222	Second school attend rate male	41.39	37.36	4.03	0.59	93	209
Second school attend rate female	52.54	43.52	9.02	1.59	164	217	Second school attend rate female	38.54	32.43	6.11	1.01	99	242
Expenditures per capita	74554.22	72390.03	2164.19	2.4	419	712	Expenditures per capita	34168.84	34171.29	-2.45	-0.01	258	764
Expenditures per adult equiv	86161.87	83683.86	2478.01	2.96	419	712	Expenditures per adult equiv	39592.2	39593.96	-1.77	-0.01	258	764

Non Poor

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1. treatment: safe water source

	Treated	Controls	ATT	Tstat	NOB_t	NOB_unt		Treated	Controls	ATT	Tstat	NOB_t	NOB_unt
Treat water	0.53	0.54	-0.01	-0.23	3804	596	Treat water	0.32	0.36	-0.04	-0.64	2218	169
Diarrhea	0.38	0.96	-0.58	-1.73	3800	596	Diarrhea	1.33	0.89	0.44	0.54	2218	169
Diarrhea <=12 months	2.35	10.91	-8.56	-1.55	467	72	Diarrhea <=12 months	7.69	0.4	7.3	1.18	335	29
Diarrhea <=60 months	1.81	3.93	-2.12	-1.09	1577	241	Diarrhea <=60 months	5.88	0.49	5.39	2.11	1093	80
Diarrhea with blood	0.06	0.02	0.05	0.3	3800	596	Diarrhea with blood	0.18	0.03	0.14	0.37	2218	169
Diarrhea with blood <=12 months	0.24	0	0.24	1	467	72	Diarrhea with blood <=12 months	1.44	0	1.44	1.74	335	29
Diarrhea with blood <=60 months	0.13	0	0.13	1.41	1577	241	Diarrhea with blood <=60 months	0.67	0.04	0.62	0.28	1093	80
Primary school attendance rate	81.99	82.09	-0.09	-0.03	2031	320	Primary school attendance rate	82.09	76.04	6.05	0.71	1009	68
Prim school attend rate male	82.48	86.48	-4	-0.83	1193	190	Prim school attend rate male	84.39	72.66	11.73	1.03	625	48
Prim school attend rate female	81.85	79.04	2.81	0.62	1344	230	Prim school attend rate female	82.28	71.14	11.14	1.03	673	40
Secondary school attendance rate	57.28	47.53	9.76	1.92	1617	228	Secondary school attendance rate	39.81	34.62	5.19	0.54	810	50
Second school attend rate male	61.86	68.62	-6.77	-1.04	797	125	Second school attend rate male	43.41	24.2	19.21	1.37	430	28
Second school attend rate female	56.63	41.9	14.72	2.33	1055	154	Second school attend rate female	36.36	45.66	-9.3	-0.74	530	31
Expenditures per capita	279006.6	279007.4	-0.79	0	3804	596	Expenditures per capita	97184.32	117123.9	-19939.54	-0.69	2218	169
Expenditures per adult equiv	305256.8	304373.1	883.67	0.06	3804	596	Expenditures per adult equiv	109294.5	133859.2	-24564.78	-0.8	2218	169

2. treatment: safe toilet

	Treated	Controls	ATT	Tstat	NOB_t	NOB_unt		Treated	Controls	ATT	Tstat	NOB_t	NOB_unt
Treat water	0.58	0.54	0.04	1.33	3543	857	Treat water	0.34	0.32	0.02	0.67	1720	667
Diarrhea	0.36	0.44	-0.08	-0.23	3541	855	Diarrhea	1.01	2.33	-1.32	-1.72	1720	667
Diarrhea <=12 months	2.93	1.68	1.26	0.64	449	133	Diarrhea <=12 months	8.19	4.94	3.25	0.62	267	113
Diarrhea <=60 months	1.91	2.46	-0.54	-0.39	1452	366	Diarrhea <=60 months	5	6.18	-1.18	-0.44	859	314
Diarrhea with blood	0.05	0.07	-0.02	-0.13	3541	855	Diarrhea with blood	0.18	0.06	0.12	0.57	1720	667
Diarrhea with blood <=12 months	0	0.39	-0.39	-0.31	449	133	Diarrhea with blood <=12 months	0	0.7	-0.7	-0.33	267	113
Diarrhea with blood <=60 months	0.07	0.2	-0.13	-0.29	1452	366	Diarrhea with blood <=60 months	0.45	0.5	-0.05	-0.05	859	314
Primary school attendance rate	83.36	82.86	0.5	0.14	1987	364	Primary school attendance rate	83.01	74.29	8.72	1.56	821	223
Prim school attend rate male	83.64	77.6	6.04	1.18	1285	216	Prim school attend rate male	84.46	80.05	4.41	0.57	530	121
Prim school attend rate female	83.16	83.5	-0.34	-0.08	1336	238	Prim school attend rate female	83.65	71.46	12.18	1.7	520	145
Secondary school attendance rate	59.67	49.06	10.61	1.88	1629	216	Secondary school attendance rate	45.25	27.55	17.7	2.49	763	164
Second school attend rate male	62.5	35.7	26.79	2.86	946	97	Second school attend rate male	49.34	30.75	18.59	1.64	378	75
Second school attend rate female	56.18	52.68	3.5	0.55	1064	145	Second school attend rate female	43.08	23.37	19.71	1.95	497	102
Expenditures per capita	276278.7	229818.1	46460.69	3.63	3543	857	Expenditures per capita	101515.6	102883.3	-1367.69	-0.14	1720	667
Expenditures per adult equiv	303574.9	256741.1	46833.8	3.62	3543	857	Expenditures per adult equiv	113802.7	117473.6	-3670.82	-0.35	1720	667

3. treatment: safe water & safe toilet

	Treated	Controls	ATT	Tstat	NOB_t	NOB_unt		Treated	Controls	ATT	Tstat	NOB_t	NOB_unt
Treat water	0.56	0.57	0	-0.07	3020	1380	Treat water	0.35	0.33	0.03	0.82	1586	801
Diarrhea	0.31	0.55	-0.24	-1.22	3018	1378	Diarrhea	0.98	1.84	-0.87	-1.39	1586	801
Diarrhea <=12 months	2.57	3.61	-1.03	-0.49	397	185	Diarrhea <=12 months	8.37	4.24	4.13	0.88	276	137
Diarrhea <=60 months	1.67	2.84	-1.17	-1.12	1251	567	Diarrhea <=60 months	5.21	4.08	1.13	0.52	796	377
Diarrhea with blood	0.04	0.09	-0.05	-0.6	3018	1378	Diarrhea with blood	0.16	0.16	0.01	0.03	1586	801
Diarrhea with blood <=12 months	0	0.23	-0.23	-0.26	397	185	Diarrhea with blood <=12 months	0.49	0.74	-0.24	-0.13	276	137
Diarrhea with blood <=60 months	0.08	0.06	0.02	0.09	1251	567	Diarrhea with blood <=60 months	0.5	0.6	-0.1	-0.1	796	377
Primary school attendance rate	83.32	81.85	1.47	0.69	1705	646	Primary school attendance rate	84.65	77.83	6.82	1.41	822	279
Prim school attend rate male	84.18	77.45	6.73	2.2	1112	389	Prim school attend rate male	86.58	80.76	5.82	0.89	526	160
Prim school attend rate female	82.8	85.73	-2.93	-1.11	1131	443	Prim school attend rate female	84.17	76.87	7.3	1.36	551	177
Secondary school attendance rate	59.98	54.45	5.54	1.67	1415	430	Secondary school attendance rate	47.31	27.27	20.04	3.39	716	211
Second school attend rate male	62.24	59.7	2.54	0.57	829	214	Second school attend rate male	51.78	25.83	25.96	2.27	384	100
Second school attend rate female	59.83	52.23	7.61	1.8	919	290	Second school attend rate female	43.8	23.74	20.06	3.17	466	133
Expenditures per capita	285280.4	257692.2	27588.26	2.97	3020	1380	Expenditures per capita	100146.3	107649.7	-7503.45	-0.72	1586	801
Expenditures per adult equiv	312697.1	284316.4	28380.73	3.02	3020	1380	Expenditures per adult equiv	112513.2	120811.9	-8298.72	-0.75	1586	801

4. treatment: water treatment

	Treated	Controls	ATT	Tstat	NOB_t	NOB_unt		Treated	Controls	ATT	Tstat	NOB_t	NOB_unt
Treat water	1	0	1	.	2410	1990	Treat water	1	0	1	.	767	1620
Diarrhea	0.32	0.51	-0.2	-1.44	2406	1990	Diarrhea	1.11	0.98	0.13	0.44	767	1620
Diarrhea <=12 months	1.57	4.13	-2.56	-1.54	337	245	Diarrhea <=12 months	9.47	3.34	6.13	1.84	132	290
Diarrhea <=60 months	1.7	2.09	-0.39	-0.53	1026	792	Diarrhea <=60 months	6.41	3.25	3.16	2.18	394	779
Diarrhea with blood	0.07	0.06	0.01	0.16	2406	1990	Diarrhea with blood	0.13	0.13	0	0.05	767	1620
Diarrhea with blood <=12 months	0	0.59	-0.59	-1.2	337	245	Diarrhea with blood <=12 months	0.76	0.7	0.06	0.05	132	290
Diarrhea with blood <=60 months	0.1	0.15	-0.06	-0.31	1026	792	Diarrhea with blood <=60 months	0.89	0.55	0.33	0.59	394	779
Primary school attendance rate	82.65	83.19	-0.54	-0.35	1389	962	Primary school attendance rate	85.36	84.48	0.88	0.38	408	693
Prim school attend rate male	81.75	86.11	-4.36	-2.09	892	609	Prim school attend rate male	85.12	87.9	-2.78	-0.93	248	438
Prim school attend rate female	83.71	81.99	1.71	0.83	917	657	Prim school attend rate female	87.2	83.45	3.75	1.27	265	463
Secondary school attendance rate	60.54	57.07	3.47	1.44	1094	751	Secondary school attendance rate	45.94	46.72	-0.78	-0.23	333	594
Second school attend rate male	64.81	60.6	4.21	1.27	643	400	Second school attend rate male	51.33	53.49	-2.16	-0.41	172	303
Second school attend rate female	58.33	57.4	0.94	0.31	695	514	Second school attend rate female	43.33	44.15	-0.82	-0.18	231	381
Expenditures per capita	305148.3	240217.6	64930.67	7.44	2410	1990	Expenditures per capita	102611.2	88452.49	14158.7	1.54	767	1620
Expenditures per adult equiv	334980.4	265992.2	68988.23	7.84	2410	1990	Expenditures per adult equiv	115086.2	101932.7	13153.46	1.4	767	1620

	Treated	Controls	ATT	Tstat	NOB_t	NOB_unt
Diarrhea	0.48	1.14	-0.66	-2.76	5120	1145
Diarrhea <=12 months	2.62	6.35	-3.73	-1.14	727	165
Diarrhea <=60 months	1.94	3.82	-1.88	-1.41	2208	488
Diarrhea with blood	0.07	0.02	0.06	0.65	5120	1145
Diarrhea with blood <=12 months	0.22	0	0.22	1.34	727	165
Diarrhea with blood <=60 months	0.25	0.04	0.21	1.01	2208	488
Primary school attendance rate	78.8	83.84	-5.03	-2.02	2986	708
Prim school attend rate male	79.33	83.67	-4.33	-1.28	1950	460
Prim school attend rate female	79.28	82.5	-3.23	-0.94	2006	502
Secondary school attendance rate	51.37	45.97	5.4	1.51	2343	527
Second school attend rate male	53.3	54.8	-1.5	-0.32	1357	322
Second school attend rate female	51.45	42.69	8.76	1.93	1506	326
Expenditures per capita	222596.9	213880.8	8716.1	0.95	5126	1147
Expenditures per adult equiv	244449	235795.8	8653.19	0.9	5126	1147
Extremely poor	9.23	15.21	-5.97	-2.63	5126	1147
Moderately poor	16.59	21.93	-5.34	-2.3	5126	1147
Non-poor	74.17	62.86	11.31	4.19	5126	1147

	Treated	Controls	ATT	Tstat	NOB_t	NOB_unt
Diarrhea	1.31	0.97	0.34	0.8	4615	568
Diarrhea <=12 months	6.95	5.77	1.17	0.29	831	101
Diarrhea <=60 months	5.54	3.75	1.8	0.95	2453	299
Diarrhea with blood	0.2	0.1	0.11	0.62	4615	568
Diarrhea with blood <=12 months	0.98	0.46	0.52	0.31	831	101
Diarrhea with blood <=60 months	0.8	0.26	0.53	0.75	2453	299
Primary school attendance rate	75.81	69.81	6	1.47	2708	317
Prim school attend rate male	77.31	75.49	1.82	0.35	1806	221
Prim school attend rate female	76	65.78	10.21	1.92	1858	211
Secondary school attendance rate	32.93	23.4	9.54	2.32	2259	249
Second school attend rate male	35	21.63	13.37	2.5	1309	144
Second school attend rate female	30.2	23.23	6.97	1.33	1494	160
Expenditures per capita	59015.74	62746.4	-3730.65	-0.38	4615	568
Expenditures per adult equiv	66659.15	72227.04	-5567.88	-0.54	4615	568
Extremely poor	32.25	46.34	-14.09	-3.54	4615	568
Moderately poor	20	14.48	5.52	1.8	4615	568
Non-poor	47.75	39.18	8.57	2.34	4615	568

2. treatment: safe toilet

	Treated	Controls	ATT	Tstat	NOB_t	NOB_unt
Treat water	0.51	0.47	0.04	1.77	5026	1247
Diarrhea	0.46	0.59	-0.14	-0.56	5022	1243
Diarrhea <=12 months	3.16	3.64	-0.48	-0.28	686	206
Diarrhea <=60 months	2.04	2.97	-0.94	-0.9	2147	549
Diarrhea with blood	0.06	0.09	-0.03	-0.35	5022	1243
Diarrhea with blood <=12 months	0.07	0.17	-0.1	-0.14	686	206
Diarrhea with blood <=60 months	0.19	0.27	-0.09	-0.22	2147	549
Primary school attendance rate	80.82	76.22	4.6	1.79	3081	613
Prim school attend rate male	80.82	76.38	4.44	1.29	2046	364
Prim school attend rate female	81.25	73.43	7.83	2.38	2092	416
Secondary school attendance rate	52.69	43.8	8.89	2.32	2481	389
Second school attend rate male	54.26	39.63	14.63	2.51	1469	210
Second school attend rate female	52.86	47.4	5.46	1.11	1586	246
Expenditures per capita	212251.5	172434.4	39817.1	4.42	5026	1247
Expenditures per adult equiv	234120.5	193645.3	40475.2	4.39	5026	1247
Extremely poor	11.81	11.92	-0.11	-0.07	5026	1247
Moderately poor	17.71	22.95	-5.24	-2.84	5026	1247
Non-poor	70.48	65.13	5.35	2.47	5026	1247

	Treated	Controls	ATT	Tstat	NOB_t	NOB_unt
Treat water	0.27	0.25	0.03	1.39	3860	1324
Diarrhea	1.08	1.56	-0.48	-1.1	3860	1324
Diarrhea <=12 months	6.03	3.3	2.73	0.8	711	229
Diarrhea <=60 months	4.65	6.24	-1.59	-0.94	2095	658
Diarrhea with blood	0.17	0.2	-0.03	-0.21	3860	1324
Diarrhea with blood <=12 months	1.03	0.32	0.71	0.61	711	229
Diarrhea with blood <=60 months	0.64	0.82	-0.18	-0.25	2095	658
Primary school attendance rate	76.48	65.54	10.95	3.37	2432	594
Prim school attend rate male	77.99	70.27	7.72	1.78	1569	369
Prim school attend rate female	76.15	65.28	10.87	2.76	1660	409
Secondary school attendance rate	34.68	17.6	17.08	5.14	2055	454
Second school attend rate male	36.54	24.6	11.94	2.26	1153	230
Second school attend rate female	33.23	13.81	19.41	4.69	1353	302
Expenditures per capita	57792.4	54656.3	3136.09	0.68	3860	1324
Expenditures per adult equiv	65213.3	62678.49	2534.81	0.5	3860	1324
Extremely poor	36.48	37.73	-1.25	-0.53	3860	1324
Moderately poor	19.6	19.98	-0.38	-0.18	3860	1324
Non-poor	43.93	42.29	1.64	0.63	3860	1324

3. treatment: safe water & safe toilet

	Treated	Controls	ATT	Tstat	NOB_t	NOB_unt
Treat water	0.51	0.51	0	0	4067	2206
Diarrhea	0.4	0.64	-0.24	-1.57	4065	2200
Diarrhea <=12 months	2.79	3.98	-1.19	-0.69	565	327
Diarrhea <=60 months	1.76	2.92	-1.16	-1.45	1751	945
Diarrhea with blood	0.05	0.08	-0.03	-0.58	4065	2200
Diarrhea with blood <=12 months	0.09	0.07	0.02	0.05	565	327
Diarrhea with blood <=60 months	0.2	0.15	0.05	0.22	1751	945
Primary school attendance rate	80.51	79.44	1.07	0.67	2487	1207
Prim school attend rate male	81.05	77.13	3.92	1.81	1652	758
Prim school attend rate female	81.15	81.99	-0.84	-0.39	1667	841
Secondary school attendance rate	54.18	50.18	4.01	1.65	2020	850
Second school attend rate male	55.96	54.64	1.31	0.39	1193	486
Second school attend rate female	54.08	48.91	5.17	1.62	1295	537
Expenditures per capita	227415.2	206043.9	21371.28	3.11	4067	2206
Expenditures per adult equiv	250124.8	228572.6	21552.23	3.06	4067	2206
Extremely poor	9.41	11.98	-2.57	-2.23	4067	2206
Moderately poor	16.38	18.31	-1.93	-1.48	4067	2206
Non-poor	74.21	69.72	4.5	2.91	4067	2206

	Treated	Controls	ATT	Tstat	NOB_t	NOB_unt
Treat water	0.28	0.25	0.03	1.49	3437	1746
Diarrhea	1.03	1.5	-0.47	-1.39	3437	1746
Diarrhea <=12 months	6.06	5.61	0.44	0.18	635	305
Diarrhea <=60 months	4.87	5.57	-0.71	-0.55	1873	879
Diarrhea with blood	0.16	0.23	-0.07	-0.58	3437	1746
Diarrhea with blood <=12 months	1.01	1.11	-0.11	-0.11	635	305
Diarrhea with blood <=60 months	0.61	0.81	-0.2	-0.38	1873	879
Primary school attendance rate	77.43	73.13	4.3	1.72	2187	838
Prim school attend rate male	79.02	77.11	1.9	0.59	1483	544
Prim school attend rate female	76.86	71.18	5.68	1.95	1505	564
Secondary school attendance rate	37.55	23.88	13.67	4.9	1848	660
Second school attend rate male	39.3	28	11.3	2.73	1105	348
Second school attend rate female	34.72	21.36	13.36	4.06	1221	433
Expenditures per capita	59298.18	58163.06	1135.11	0.24	3437	1746
Expenditures per adult equiv	66878.97	65834.06	1044.91	0.21	3437	1746
Extremely poor	34.1	39.11	-5.01	-2.4	3437	1746
Moderately poor	19.96	16.37	3.59	2.08	3437	1746
Non-poor	45.94	44.52	1.42	0.65	3437	1746

4. treatment: water treatment

	Treated	Controls	ATT	Tstat	NOB_t	NOB_unt
Treat water	1	0	1	.	3024	3249
Diarrhea	0.37	0.58	-0.22	-1.76	3018	3247
Diarrhea <=12 months	2.34	3.79	-1.46	-1.08	440	452
Diarrhea <=60 months	1.84	2.28	-0.44	-0.72	1323	1373
Diarrhea with blood	0.08	0.06	0.03	0.64	3018	3247
Diarrhea with blood <=12 months	0.12	0.41	-0.29	-0.95	440	452
Diarrhea with blood <=60 months	0.19	0.16	0.03	0.13	1323	1373
Primary school attendance rate	81.6	80.58	1.02	0.75	1858	1836
Prim school attend rate male	80.3	82.86	-2.56	-1.45	1235	1175
Prim school attend rate female	82.63	79.51	3.13	1.79	1247	1261
Secondary school attendance rate	56.99	52.1	4.88	2.5	1472	1398
Second school attend rate male	59.55	54.16	5.38	2.03	879	800
Second school attend rate female	56.33	52.01	4.32	1.72	929	903
Expenditures per capita	256050.6	205747.8	50302.84	7.11	3024	3249
Expenditures per adult equiv	281807.3	227999.8	53807.49	7.47	3024	3249
Extremely poor	6.46	9.7	-3.24	-3.4	3024	3249
Moderately poor	13.88	16.4	-2.53	-2.25	3024	3249
Non-poor	79.66	73.89	5.77	4.37	3024	3249

	Treated	Controls	ATT	Tstat	NOB_t	NOB_unt
Treat water	1	0	1	.	1357	3827
Diarrhea	1.12	1.08	0.04	0.22	1357	3827
Diarrhea <=12 months	6.71	5.14	1.57	0.79	247	693
Diarrhea <=60 months	5.38	4.32	1.06	1.13	766	1987
Diarrhea with blood	0.13	0.18	-0.05	-0.69	1357	3827
Diarrhea with blood <=12 months	0.81	0.9	-0.09	-0.12	247	693
Diarrhea with blood <=60 months	0.72	0.66	0.06	0.15	766	1987
Primary school attendance rate	81.48	78.71	2.76	1.72	836	2190
Prim school attend rate male	81.89	81.6	0.29	0.14	536	1492
Prim school attend rate female	82.59	77.66	4.93	2.42	569	1500
Secondary school attendance rate	39.26	37.59	1.67	0.8	695	1814
Second school attend rate male	41.73	39.53	2.2	0.74	400	1053
Second school attend rate female	37.66	36.82	0.84	0.31	475	1180
Expenditures per capita	68985.22	60728.06	8257.16	1.9	1357	3827
Expenditures per adult equiv	77753.31	70041.22	7712.09	1.72	1357	3827
Extremely poor	24.47	32.08	-7.61	-5	1357	3827
Moderately poor	19.01	19.68	-0.67	-0.5	1357	3827
Non-poor	56.52	48.24	8.28	4.94	1357	3827

Annex 9: Answers to Evaluation Questions 4 and 5

4.1. How did the economy, in particular the enterprises, perform and interact with the economic and institutional environment? *For SBS, this question will highlight the relationship between the overall economic context and the sector performance.*

Roads

- In the observation period 2006-2009, the roads sector received considerable funding from sectoral budget support as well as from other GRZ resources (budget, Road Fund), while project aid played a minor role.
- Target achievements concerning paved and unpaved roads clearly show that a high priority was given to rehabilitating and maintaining the trunk road network, while targets concerning unpaved (feeder) roads were not achieved. Accordingly, the condition of the feeder road system has been deteriorating while the trunk network is maintained in a fair or even good condition. It cannot be ruled out, however, that rural roads would have received even less attention if they had not been reflected in the PAF indicators for the sector.
- In addition, the efficiency of the road works was not as desired, as evidenced by high and rising unit costs and severe deficiencies in the quality of works as pointed out by the report of the Auditor General.
- The findings presented on the interaction between roads and the economy suggest that improved (trunk) roads contribute positively to the macroeconomic development of Zambia, in particular in the sectors trade, mining, agriculture, and tourism. Indications for the importance of the roads sector are, for instance, the large share of export and import goods transported on the roads along with the large increase in trade volumes.
- At the microeconomic level, findings are related to the transport situation in rural areas. Here, the road and transport situation remains mostly inadequate and continues to be a constraint for development: Walking remains the predominant mode of travel, travel speed is low, road projects still rank very high among the desired projects by the locals, and bad roads have been identified as bottlenecks to the expansion of private enterprises and entrepreneurial activities of households.
- Although evidence for a positive influence of road improvements on the economy was found, the effects could have been more pronounced and of a higher longevity if road works had been carried out with less inefficiency and less shortcomings in quality. Furthermore, effects could have been more widespread (more road projects in more areas) if potential efficiency gains had been realised and road improvements had not been biased towards trunk roads.

Water Supply and Sanitation

- Beside user fees in the urban sector, the water sector is mainly financed by project aid. GRZ is only contributing a minor share to the financing of the WSS sector.
- The findings show that the WSS coverage has slightly improved over the last years, especially in urban areas.
- The operational efficiency of many CUs, responsible for WSS provision in urban areas, has improved since their foundation. However, as UFW and collection efficiency remain inadequate for many CUs, more could have been achieved within the past years.

4.2. How did the overall livelihoods (impact), including citizens' security and access to services (outcome), of the target groups change over time (for example, with respect to the key social sectors, in particular health and education and/or justice for entrepreneurs, all citizens and especially the low income population)? *For SBS, this question will focus on the specific sectors.*

Roads

- One of the main reasons why households in rural areas are not using important facilities such as health centres is that – according to the LCMS – the facilities are too far away, indicating that – taking the distance to the health centre as given -the transport infrastructure is too weak to reach health consultation.
- In cases where a road project took place, secondary school attendance rates and the consultations of modern health facilities registered statistically significant increases. However, in 2006 only 22% of households reported that a road project had been carried out in their area, implying that the countrywide impact was limited.

Water Supply and Sanitation

- The WSS coverage improved slightly over the past years. While access to safe water is at an acceptable level in urban areas, access to adequate sanitation is considerably lower. In rural areas, access rates are not only low, but improvements have also been slow. Yet, the quality of infrastructure provided in rural areas has made significant progress over the last years. However, improvements in WS quality have been slower for poorer than for richer quintiles in rural areas.
- In rural and peri-urban areas, having access to safe WSS has a positive health impact, in particular on reducing diarrhoea with blood incidences for children younger than 5 years. Furthermore, positive effects on school attendance rates were found. The effects were strongest if households had access to both safe water and adequate sanitation, while effects of safe water in rural areas could only be identified for boreholes (piped water is more or less inexistent). Moreoever, significant effects of water treatment could be demonstrated. Of course, the results only hold for those households with access to safe WSS or treating water which implies that aggregate effects could have been considerably stronger if more households had access to such facilities.

4.3. To what extent have there been changes in the income of the citizens and the income distribution (e.g. Gini index, income growth per income quintile) with a special focus on the poorest parts of the population?

Roads

- In communities where a road project had been carried out recently, significant and relatively strong effects could be found on reducing the share of households living in extreme poverty.
- The report differentiated between the extremely poor, the moderately poor and the non-poor. As a general conclusion, no significant distributional effects can be demonstrated. The effects at the macro-level suggest that roads have an even impact across the income distribution, i.e. that the poor benefit proportionally to the rest of the population.

Water Supply and Sanitation

- Also for WSS, significant and relatively strong effects could be found on reducing the share of households living in extreme poverty. Here, the combined effect of having access to safe water and adequate sanitation is again the strongest. Water treatment has a sizeable effect on poverty reduction as well. However, even if numerous other influence factors were controlled for (except distance to roads), some degree of reverse causality cannot be fully ruled out.
- With respect to distributional effects, somewhat stronger effects of WSS emerged for the extremely and moderately poor compared to the non-poor. Again it should be mentioned here that the improvements in WS quality were more pronounced for the non-poor segments of the rural population.

4.4. To what extent can significant changes be identified in *key* cross cutting issues in the society, such as gender equality, good governance and democratic accountability, environment protection and youth participation?

Roads
-    No differential gender effect could be demonstrated, e.g. when it comes to school attendance, boys and girls seem to benefit equally from access to roads.

Water Supply and Sanitation
-    For safe sanitation, the findings suggest that girls benefit more with respect to school attendance compared to boys. The reason for this result may be that girls benefit disproportionately from fewer illnesses in the household as they are often in charge of caring for the sick. However, there may be other reasons which were not identified.
-    The case study in rural and peri-urban areas clearly showed that especially the type of toilet facility available impacts the micro-environmental conditions in those areas. If adequate toilet facilities are used, nitrate and nitrite infiltration can be prevented, which is important for ensuring adequate environmental conditions in the long run.

5.1. To what extent can changes in the performance of the economy, in particular in the performance of enterprises, be related to changes in macroeconomic and fiscal management and/or changes in other government policies or policy processes, and/or to other external or internal factors?

Roads
-    In general, it is questionable whether the creation of the three road institutions led to efficiency gains in the sector. Yet, as the sector setup is good in principle and as the audit report (the commissioning of which can be related to SBS) has highlighted the various shortcomings and deficiencies still existent, a thorough overhaul of the sector may lead to such gains in the future.
-    Unit rates are very high in Zambia and have been increasing in recent years. One of the main reasons for the high unit costs is that the "perceived risk of doing business" in Zambia is exceptionally high. In response, contractors price a "risk premium" which is, in the end, government-created.

Water
-    In general, the decentralization and commercialization policies and the DTF (basket) had a positive effect on the development of the WSS sector in Zambia (e.g. coverage rates, operational efficiency).
-    In rural and urban areas, also the infrastructure standardization policies had a positive effect on sector development.
-    With respect to possible crowding-out effects of GRZ spending for the WSS sector through project aid, no conclusive evidence could be found in favor or against it. Yet, other studies highlight that such a risk exists and should not be underestimated.

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