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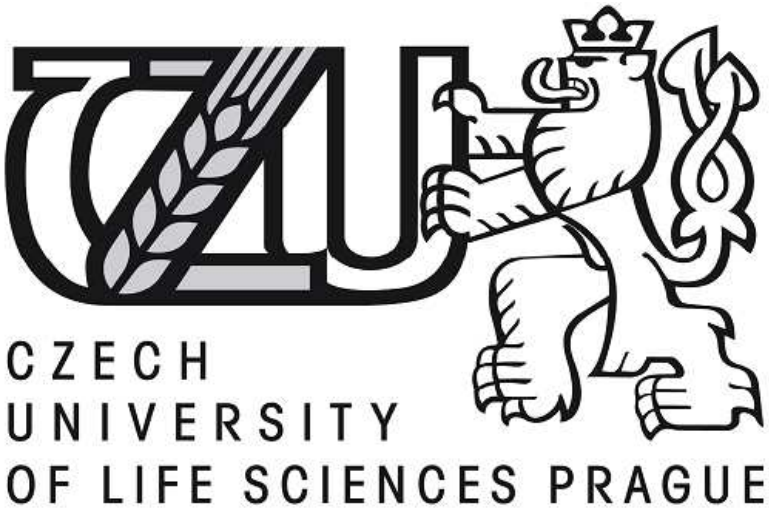

BACHELOR THESIS

Water Scarcity in Sub-Saharan Africa as a Result of Underdevelopment and Poverty

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Declaration

I herby declare that I have worked on my bachelor thesis titled “Water Scarcity in Sub-Saharan Africa as a Result of Poverty and Underdevelopment” by myself and I have used only the sources mentioned at the end of the thesis.

In Prague on 30th March 2011

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Signature

Acknowledgement

I would like to thank to my supervisor Ing. Petr Procházka, MSc, Ph.D. for his valuable advice, support and contribution during the work on my Bachelor Thesis.

Water Scarcity in Sub-Saharan Africa as a Result of Underdevelopment and Poverty

Nedostatek vody v Sub-Saharské Africe jako důsledek chudoby a nedostatku rozvoje

Souhrn

Tato bakalářská práce se zabývá problémem nedostatku vody v sub-Saharské Africe a definuje jeho příčiny. Hlavním cílem je identifikovat vzájemné vztahy mezi nedostatkem vody, chudobou a korupcí a dokázat, že problém nedostatečného přístupu k vodě v sub-Saharské Africe není způsoben fyzickou absencí vodních zdrojů, ale ekonomickým stupněm rozvoje regionu, podplacenou a neefektivní vládou, korupcí a nedostatkem investic nutných k zajištění infrastruktury. Praktická část je věnována analýze vlivu vybraných ekonomických ukazatelů na množství domácností s přístupem k vodnímu zdroji. Tento vztah je definován pomocí regresní a komparativní analýzy. Na závěr analytické části je popsán trh s vodou v sub-Saharské Africe a uvedeny příklady jeho externalit. Autor dále navrhuje případné změny, které by přispěly k zlepšení současné situace.

Klíčová slova

Nedostatek vody, Sub-Saharská Afrika, chudoba, korupce, rozvoj

Summary

This bachelor thesis deals with problem of water scarcity in sub-Saharan Africa and defines causes and effects of this issue. The main goal is to identify links among water scarcity, poverty and corruption and to prove that problem of water scarcity in Africa is not issue of physical water availability, but it is caused by lack of development, corrupted and inefficient government, inappropriate policies and absence of finance to assure infrastructure. The practical part analyzes impact of physical water availability, corruption and GDP on percentage of the population with improved water source. Methods utilized in order to analyze the issue include data processing, regression analysis and comparative analysis. At the end, market for water in sub-Saharan Africa and its externalities are discussed, followed by author's suggestions for improvement of current situation.

Key words

Water scarcity, Sub-Saharan Africa, poverty, corruption, development

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1. Introduction

Environmental and developmental problems of third world countries create a serious challenge of today. One of the most alarming issues is water scarcity and poverty. Water is vital source for agriculture, household and industry and also for earth's ecosystem. This fundamental source is, however, endangered. The question is whether there will be enough water for providing global food security for increasing population? Access to drinking water and sanitation is crucial in sense of human health. More than one billion people around the world (one sixth of total population) are forced to use contaminated water or water in insufficient quantities. It is estimated that 3 million deaths annually are caused due to water-related diseases in developing countries, particularly among poor rural families with no access to water and sanitation. (United Nations Educational, Scientific and Cultural Organization, 2009) Around 340 million people from sub-Saharan Africa have no access to safe drinking water and around 500 million have no access to appropriate sanitation. This number is expected to rise to two thirds by the year 2025 as with the increasing population, water availability decreases. (The United Nations Educational, Scientific and Cultural Organization, 2009) Moreover, 43% of children in Sub-Saharan Africa drink unsafe water and suffer from water-born diseases such as typhus, cholera and diarrhoea. According to UNICEFF 4000 children around the world die every day, because of lack of water. Access to water reduces water related diseases and if water crises will not be solved, 135 million people will die from water related diseases by the year 2020. This thesis is focused on domestic water sector and analyzes how problem of insufficient access to water results from human made action and is created artificially through government interventions, policies and pricing system, inefficient water management, institutional and individual poverty, lack of finance for investment and corruption in the water sector. It is emphasized that water scarcity in sub-Saharan Africa is not issue of physical lack of water caused by natural conditions and that sub-Saharan Africa has enough water, however poor are excluded from the access to water as a result of their poverty.

2. Objectives and Methodology

The aim of this thesis is to analyze whether or not water scarcity is cause of poverty, underdevelopment and corruption. The hypothesis tested in this work is: “The main problem in Sub-Saharan Africa is not physical water scarcity but poverty, poor and corrupted governance with lack of care to serve the poor, shortage of finance and insufficient infrastructure.” It is expected that water scarcity is caused by poverty due to lack of capital, low level of development and absent technologies. On the other hand, in some cases, water scarcity may contribute to poverty as well. The main goal of this thesis is to examine relationship between poverty, corruption, amount of water available and water scarcity. By using some of the quantitative methods of econometric research this causation is analyzed. Several steps are undergone in order to analyze the actual impact of several selected socio-economic variables on water availability measured by access to water, including data collection, data processing and data analyzing. Next, comparative analysis is applied followed by descriptive analysis. In order to examine whether insufficient access is influenced by low level of GDP per capita and high corruption and to prove that physical water availability does not cause insufficient access to water among population of sub-Saharan Africa, regression analysis is used and by means equations dependence among several variables is explained. The theoretical background was processed based on information from books, scientific papers, articles and internet sources.

3. Literature Review

3.1. Water Scarcity

Thanks to extremely high cost of cultivation of new water resource, degraded soil in irrigated areas, groundwater exhaustion, water pollution and wasting of current water resources, the problem of water scarcity is becoming even more severe. (Rosegrant, Cai, Cine, 2002) It is estimated that water scarcity will lead to violent conflicts in the future. Population growth will contribute to water shortages and it will also influence food security. (Mertha, 2000) To reduce amount of people with no access to drinking water by half by 2015 is one of the Millenium development Goals. (Rosegrant, Cai, Cline, 2002). According to Gleick, More people died from water related diseases than in all post World War II conflicts. (Gleick, 2002)

FAO identifies two types of water scarcity:

3.1.1. Physical

Physical water scarcity occurs when there is not enough water physically. This water scarcity is usually associated with arid areas and arises from natural conditions, such as lack of rainfall and precipitation and high level of evaporation.

3.1.2. Economic

Economic water scarcity is associated with lower level of development and occurs in third world countries of Africa, south East Asia and South America. Access to water is limited by institutional and financial capital even though water is not scares. Thus also countries with high level of water resources can face water scarcity thanks to financial condition, lack of infrastructure and institutional capacity. (FAO, 2010)

3.2. Water Consumption

Average consumption of water is 800 m3 per capita per year. Average daily consumption in Germany is 129 liter per day per person and people in USA consume even 1000 litre per day. On the contrary in Mozambique average daily consumption per person is 10 liter and in Uganda, Ethiopia and Nigeria the water consumption is less than 30 liter per day. Another problem of water resources is relationship between amount of money spent for water and price of water. Majority of those without access to water are people living under the absolute poverty level and have to survive with 1 dollar per day. (Dogan, Ocal,2007) Minimum requirememnt for healthy life is 20 litres per person per day from source less than 1 km from house. (Watkin, 2006)

3.3.Basic Definitions

Water Scarcity occurs when water demand exceeds water supply.

3.3.1. Water Demand

Water demand usually refers to water withdrawal and water consumption.

Water withdrawal: "Water withdrawal is water removed from a source and used for human needs, some of which may be returned to the original source and reused downstream with changes in water quality and quantity." (Rosegrant, Cai and Cline 2002, citing Gleick 1998)

Water Consumption: "Water withdrawn from a source and made unusable for reuse in the same basin through irrecoverable losses including evaporation, seepage to a saline sink, or contamination." (Rosegrant, Cai and Cline 2002, citing Gleick 1998)

3.3.2. Water Supply

"**Water supply** refers to water available for use from many sources." (Rosegrant, Cai and Cline 2002)

"**Renewable water** is water that can be renewed by natural cycling through the atmosphere and the earth. For each region, the total renewable water includes internal renewable water and the inflow of surface and groundwater from other regions." (Rosegrant, Cai and Cline 2002)

"**Total water availability** it is the sum of renewable water, artificial basin/ regional water transfer, desalinated water, non-renewable groundwater and salt water. "(Rosegrant, Cai and Cline 2002)

3.4. Water Scarcity in Sub-Saharan Africa

Inadequate and unequal access in sub-Saharan is cause of poverty. To exemplify Africa has more water per capita than Europe and is not able to assure water for its inhabitants. (Kulndwa, Lein, 2008) Since poor people miss access to safe drinking water, they are forced to drink contaminated water which causes many health problems, sometimes connected with death. Even though water is not physically scare and is found underground, thanks to missing financial and technological resources this water is not accessed. Simple solution would be to building wells or dams, but problem is in lack of finance. Storing water is vital for irrigation purposes, proper water supply, hydropower and flood management. Sub-Saharan Africa is able to save only 4% of their renewable flow where as developed countries manage to save from 70% to 90%. (The United Nations Educational, Scientific and Cultural Organization, 2009)

According Abrams, even though water coverage has been improved and level of served household increased, the overall situation has not improved. This is caused by the increasing population. (Abrams, 1999)

Scarcity is caused by public policies, which favor overusing of water by rich as a result of subsidies and low prices. In other words scarcity is result of political process disadvantaging poor. Fair distribution and introduction of pricing policies which would reflect water scarcity is needed. (Watkin, 2006)

3.4.1. Poor Without Access to Water System

Insufficient access to water is usually consequence of poor policies and management. Public services in developing countries serve just some of the rich urban population and the rest has to rely on other unhygienic or contaminated natural sources or expensive sources such as water vendors or water tanks. (Gulyani, Talukdar, Karikuri, 2005) Inhabitants of high income areas have house connection for low price where as inhabitants of slums and people from poor rural and urban areas have access to less than 20 liters of water per day and are forced to pay much higher price, sometimes from 5 till 10 higher price than the rich. Poor pay more than they can afford. With rising income access to water is higher as well. One third of people without access to water are people living on less than 1 USD per day. 2 from 3 people living for less than 2 USD per day have no access to water. (Watkin, 2006) Moreover, poor people in developing countries spent 10% of their income for water, where as in England poor family spends around 3% of their income for water. (Dogan, Ocal, 2007) Two thirds of the poorest 20% buy water from water vendors. Two main indicators of service quality are price of water and quantity. Both the poor and non poor are badly served since they are using low amount of water and paying lot for it. (Gulyani, Talukdar, Karikuri, 2005)

3.4.2. Health Consequences of Water Scarcity

Insufficient quantity and quality of drinking water as well as lack of sanitation account for millions of deaths of the world's poorest population, mainly children and women. Water and health are closely linked to each other. Main cause of disease and malnutrition of children still remains drinking water unsuitable to human consumption. There are 4 billion cases of diarrhoea worldwide per year, causing 2.2 million deaths, where from 1.7 million are children under the age of five mostly in developing countries. 88% of all diarrheal diseases are cause of unsafe drinking water supply, poor sanitation and hygiene. Other water related diseases include intestinal worms, blind from trachoma, malaria and schistosomiasis. Improved hygiene, access to water and sanitation will positively influence health, morbidity and mortality. (Günther, Fink, 2010)

3.5. Water Scarcity and Poverty

In Sub-Saharan Africa economic water scarcity resulting from underdevelopment and poverty occurs. Sub-Saharan Africa is one of the top world's region affected by poverty. Number of people living in absolute poverty has not changed and no progress has been achieved. (United Nations Educational, Scientific and Cultural Organization, 2009) Poverty can be classified into absolute and relative.

Absolute poverty: individuals are not able to meet basic needs
Relative poverty: those having less income than others based on comparison of individual to other community's members (Kulndwa, Lein, 2008)

3.5.1. Water Poverty

a) **Institutional poverty** can be characterized as public institution not being able to raise funds from taxes and revenues as a result of poverty of individuals. Furthermore, condition and salaries of public sector employees are very poor and public spending are very low. Public sector doesn't attract people to work on and level of corruption is very high. Moreover, Abrams claims that economies have foreign debt, which is connected with an inability to compete on international markets. (Abrams, 1999)

b) **Individual poverty** is according to Abrams characterized by low level of formal employment and bad access to basic services, health problems and diseases, low standard of education and low literacy levels. (Abrams, 1999)

3.5.2. Impact of Poverty on Water Scarcity

Poor people from rural and urban areas are most often affected with water scarcity. Water scarcity is effect of both institutional and individual poverty. Poor people are not served with piped water and sanitation is missing. When it comes to the poor, main fault is in institutions and infrastructure and bad management. (FAO, 2010)

The main problem of insufficient access to water is according to Len Abrams is in poverty and the fact that political and social realities are working separately rather than together on achieving common goal. Population is usually trapped into so called poverty cycle and is unable to escape. (Abrams, 1999)

Investment into water sector are crucial and since economies are weak, investment into water sector are almost impossible. Costs of developing irrigation technologies are extremely high in sub-Saharan Africa. To exemplify, the average investment were forecasted to be $18 300 per hectare. Financial costs of constructing dams which would guarantee drinking water as well as water for irrigation are high as well. (Rosegrant, Cai, Cline, 2002)

3.5.2.1.Inefficient Water Management

To efficiently use existing water supply and save current resource is one of the most important challenges. Efficiency is very low in developing countries and lot of water is being wasted. Old leaking pipes contribute to water lost and plenty of water is wasted before it is actually lost before it reaches the consumer. Moreover leaking drinking water and sewage pipes seriously affect water quality. (Richards, 2002) “Unaccounted-for water” (UFW) is usually defined as the difference between water supplied to a system and water sold as a proportion of water supplied.” (Rosegrant, Cai, Cline, 2002, citing Gleick et al.2002) In large cities of Africa, UFW represented around 39% of urban water supply in 1990. Decrease in percentage of UFW requires strict changes in management and commercial losses and metering needs to be improved as well amount of leaks has to be decreased. (R, Cai and Cline, 2002, cit Yepes 1995) Effective water management, i.e. cost of service provision management, infrastructure management and rehabilitation and additional investment management, is important in social and economic development, poverty alleviation and achieving MDG. Poor households are dependent on alternative sources than piped water and spend around 42 minutes daily collecting water. Utilities are not efficient, money are lost through bad management even when tariffs are high enough to allow cost recovery, thanks to bad management this is not possible. (Gulyani, Talukdar, Karikuri, 2005)

3.5.2.2. Underinvesting into Water Sector

Investment into water sector means necessary step in reaching Milenium Development Goals. In countries with low investment, GDP growth was slow, resulting in dramatic social consequences. (United Nations Educational, Scientific and Cultural Organization, 2009) Efficient system, which would reduce water losses require large amount of capital. The basic question is whether poor will be able to pay for the more expensive water saving technology since consumer's willingness to pay is limited by the ability to pay for better service. Nowadays governments of third world countries invest from 25 to 30 billion of USD in water-related infrastructure. (Richards, 2002)

There is a need for national investment program with the financial aid of donors, since inadequate financing is major problem in water delivery. Financial injection is needed. Tariffs increases can be used in order to reduce financial losses and gain finance for further investment. However, by means of reducing leakages and waste water current situation could have been improved without rising tariffs. (Dovi, 2007)

Water and sanitation sector is underfinanced, accounting for less than 0,5% of GDP in Sub-Saharan Africa. National plans need to be supported internationally, since investments are large and pay back period long. (Watkin, 2006) Economic uncertainty is key issue in water investments. In developing countries thanks to currency risk, investments are very risky. (Kulndwa, Lein, 2008)

During financial crises, spending on infrastructure decreases. Private investment decline as well, however it is not very much influencing water sector, since private sector's contribution is small. Lack of knowledge and incomplete information makes decision making and long term planning in water sector more difficult. Decision of human and financial sources location is determined by leaders in government, private sector and civil society rather than by water managers and experts. (United Nations Educational, Scientific and Cultural Organization, 2009)

3.5.3. Impact of Water Scarcity on Poverty

Water scarcity is major threat to poverty reduction. Water scarcity is both cause and effect of income poverty. Water crises slow down economic growth, limits prosperity and

makes way out of poverty is impossible. Diseases and productivity losses due to unsafe water consumption and absence of sanitation account for 5% of GDP in Sub-Saharan Africa. Women spend in average 4 hours per day collecting water and carrying about children, which suffer from water-born diseases. They could be involved in working process and contribute to the economy growth. Economic rate of return is 8 USD per every 1 USD invested into water sector in terms of time savings, increasing productivity and reduction of health costs. Gains in terms of reduction of water related diseases treatment is 2 USD per capita. Total economic benefit for sub-Saharan Africa is estimated to be 15 billion of USD if access to water will be introduced. (Watkin, 2006) Total loss in Africa as a cause of lack of access to drinking water and sanitation is approximately $28.4 billion annually. (United Nations, 2009) Here are several examples of how water contributes to poverty and worsening of equity. Rural poor are forced to carry water several kilometers every day. Moreover, thanks to insufficient irrigation, farmers are losing land and people are losing their jobs. Also water pollution contributes to increasing health problems and water borne diseases. (Barker, van Koppen, Shah, 2000) As a consequence of illnesses caused by insufficient access to water, people are not able to work or attend school and thus cycle of illnesses and poverty starts. (United Nations Educational, Scientific and Cultural Organization, 2009)

3.5.3.1. How Can Investment into Water Sector Reduce Poverty

Investment into water brings benefits in form of economic growth, increasing GDP and reduced spending in the health sector. Moreover, it has also social contribution in terms of declining number of death resulting from water-borne diseases, improvements in education since more children are able to attend school. From the economical point of view, water investments are crucial to economic growth and in the past, 80% of poverty decline was thanks to growth. Thus investing into water sector followed by economic growth is a major tool of poverty alleviation. (United Nations, 2009) To exemplify, community dug well in Kano, Nigeria saved 8 USD per capita monthly. (Aderinwale, Ajayi, 2008)

3.5.3.2.Irrigation as a Tool of Poverty Reduction

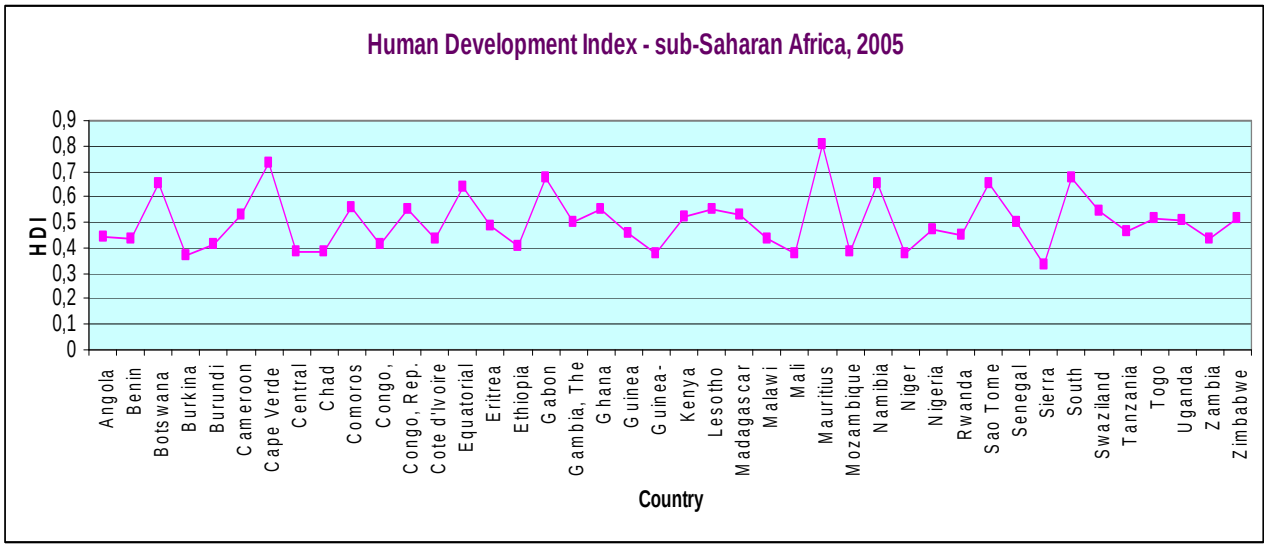
Irrigation is important tool for poverty reduction and economic growth, especially since it provides food security and creates employment opportunities. In the past, irrigation had a key role in poverty eradication. Poverty in the third world countries is usually associated with hunger. More food can be produced through more intensive agriculture and irrigation. However this alone will not be enough to eradicate hunger and poverty. Main challenge is in producing more food with less water. Therefore, efficiency of canal irrigation systems needs to be improved. New strategies need to be developed in order to improve productivity of water in irrigated and rain-fed agriculture. Moreover, poor needs to have access to water as well as technologies. Strategies ensuring water security for poor people is key action in poverty alleviation. Thanks to the green revolution between 1960s and 1990s and subsidization of food grain production by developed countries, food grain prices fell by 50%. Without new irrigation technologies and irrigation investments green revolution would not have had such an impact. More than half of poor people income are spend for cereals, thus the fell in prices have had a great impact on poverty reduction. Another impact of irrigation is creation of new jobs and thus employment of poor. To exemplify, in India and Bangladesh number of people below poverty line fell as a result of introduction canal irrigation and tube well irrigation. (Barker, van Koppen, Shah, 2000)

3.6.Water Scarcity and Development

There is relationship between water scarcity and sustainable development. Development is closely linked to water scarcity and water is crucial for sustainable development, social and economic development and poverty reduction. (Aderinwale, Ajayi, 2008) On the contrary, inadequate access to water limits progress and development. Water is key driver to economic growth and water poverty is both cause and effect of economic poverty. (Transparency International, 2009) With increasing percentage of people without access human development index increases as well. In order fasten development access to safe water is crucial. One of the easiest ways of measuring development is by means of human development index (HDI), which combines indicators

of life expectancy, education and income. (Aderinwale, Ajayi, 2008) The higher the HDI, the more developed the country is.

Chart 1: Human Development Index, sub-Saharan Africa, 2005



Data source: United Nations, own processing

3.7. Water Scarcity and Corruption

Poor have been continuously suffering from a corrupted system and corruption is perceived as biggest obstacle to economic and human development. In order to improve water scarcity and serve the poor, major challenge is in using current resources efficiently, in corruption reduction, prevention of it in the water sector and in improvement in corruption control. It would contribute to per capita income increase and reduction of infant mortality. (Shordt, Stravato, Dietvorst, 2006)

Developing countries are usually associated with high rate of corruption. World Bank stated that reducing role of politics is crucial in order to fight with corruption. In order to reduce corruption there is need of cooperation of different kind of politics. Interference by politicians contributed to inefficient management and inadequate finance. (Hall, Lobina, 2006)

Corruption is defined as "Misuse of office for private gain." (Shordt, Stravato, Dietvorst, 2006) Major forms of corruption in the water sector include grand corruption,

state corruption, high risk procurement, state and regulatory capture and mismanagement of public resources. (Chene, 2009)

3.7.1. Why is Water Sector Vulnerable to Corruption

There is high risk of corruption in water sector, especially due to increasing competition for water resources. Large scale infrastructure projects also have high risk of corruption, since there is large uncontrollable flow of money. Donor fundings decisions and water extraction rights are also under corruption risk. (Chene, 2009) Water resource management in developing countries is usually characterized by lack of resources and capacity, low wages of officials and lack of regulation. (Chene, 2009) Moreover, politicians who make the decisions are very often financially dependent on bribes of companies in order to finance their election campaign. (Kulndwa, Lein, 2008)

3.7.2. How Corruption Affects Water Scarcity

Major cause of corruption is limited access for poor, for those with connection low quality of services and rising prices of water services. (Transparency International, 2009) Corruption affects utility and costs of large scale infrastructure projects and contributes to pollution and overusing of water. In water sector from 20% to 70% of costs could be saved if corruption will be mitigated. Estache and Kouassi were examining impact of corruption of 21 companies and realized that two third of costs were resulting from corruption. Bribes are tool of influencing allocation of water project funding and it may also happen that politicians accept large capital intensive project with expensive technology rather than low cost efficient project which would help in serving the poor. (Chene, 2009) Political corruption is also a problem, especially since corrupted politicians are not invested into rural water supply and instead of using finance where is it needed they are using it in urban areas. (Transparency International, 2009)

Impact of corruption includes financial, economic, environmental and socio-political losses. Investment in infrastructure is reduced by corruption. Economic resources which would improve situation are missing. Poor are affected by inefficiencies produced by corruption, increased cost and removed access. (Transparency International, 2008)

3.7.3. Why is it Important to Reduce Corruption in order to Improve Access to Water

There is crucial need for effectiveness maximization and corruption minimization in order to assure access for the poor, which do not have voice in corrupt system. World Bank claims that after reduction of corruption in water project in Indonesia, from 20% to 30% of costs were saved. (Shordt, Stravato, Dietvorst, 2006) As a result of bribes, pollution remains not punished. Moreover corruption increases price for connected households to water network by 30%, also investment which could be used in extending coverage among the poor usually ends up in pockets of corrupted officials. Projects benefiting middle and high class rather than the poor are often accepted. (Transparency International, 2008)

3.8. Economics of Water Scarcity

"In the classical approach, scarcity is theorized as the fundamental issue of economics. The word scarcity refers to the rare goods and services in economic point of view. Therefore, scare resources have economic value and any goods with economic value are scare." According to economic literature water used to be classified as public good, however recently water has been described as a private good and water was given economic value and issues such as supply, demand, production and distribution are discussed. Scare resource is determined by the buying and selling conditions of market economy. Thus, water has been identified as a scare resource as soon as water became market value. The main reasons for water being considered as scare resource include today's market economy, human development and environmental change. If water will be traded under market condition and in buyer-seller relationship it will be available only for those who can pay for it. Thus, poor will have no access to water. The current trend of development of new policies creates danger converting water into complete economic good and treating it based on market conditions which will destroy its characteristic of a natural resource with social value. Water must be treated as public good. As a result of

privatization and water will become private good, control will be given to market players. (Dogan, Ocal, 2007)

3.8.1. Water as an Economic Good

In order to express scare value of water, water has to have price. Free water is wasted water and absence of pricing is very inefficient. Market is supposed to solve water scarcity problems and there is a need to shift towards demand management in water supply in developing countries. In addition, poor might not be able to pay since they can get free water from water hole. It is necessary to develop pricing mechanism which would tax rich not the poor and prevent rich from water thefts. (Mertha, 2000)

3.8.2. Water as a Public and Private Good

Water is public good, meaning that usage and administration belongs to public as a whole and everybody benefits from it. (Pindyck, Rubinfeld, 2005) However especially in developing countries, public supply of water have had some structural problems which have caused uneven supply of water. In order to improve the situation, in some countries, administration of public resources is managed by the private sector and water can be thus treated as a private good. Dogan and Ocal claim that water is an economic good with social value. (Dogan, Ocal, 2007)

Table 1: Definition of Public and Private Good

Rivality

Excludability	Non rival	Rival
Non exclusive	**Public good**	
Exclusive		**Private good**

Source: own processing

Non rival good is good for which the marginal cost of its provision to an additional consumer equals to zero.

Non exclusive good is good that anybody can not be excluded from consuming it, i.e. is difficult or impossible to charge for their use. (Pindick, Rubinfeld, 2005)

3.8.3. Privatization

Despite the privatization movements in last 15 years, majority of the water services were provided by public sector. Public utilities were not optimally managed and government is incompetent. Thus, utilities are losing money and are unable to invest. There have been several discussions whether privatization will solve the problem since private companies are more productive and profitable. (Auriol, Blanc, 2009) In the 1980 World Bank started with privatization as a tool of delivering finance for investments, efficiency improvements and better governance. Multinational companies were supposed to be attracted by profitable market and moreover inhabitants will welcome this process as a tool for corruption mitigation and inefficiency which was connected with the public sector. However, privatization attempt failed. It was proved that change of ownership does not make any efficiency difference. (Hall, Lobina, 2006) Privatization contributed to tariffs, billing and collection rates improvement, however high prices harmed the poor resulting in increasing use of unsafe water. Privatization benefited private companies above all, especially in terms of increased revenues. (Bayliss, 2001) Public-private partnership has been preferred in the water sector. The main task of government is to establish universal conditions for all kind of operators – public, private, mixed and community providers. (United Nations Educational, Scientific and Cultural Organization, 2009)

3.9. Water Finance

Management of water resources requires financial investment. In order to reduce cost of water, there is need for more efficient collection of water charges and reducing leakage and illegal connections. Improvement in revenue collection is necessary and exclusion of low value properties could decrease tax burden on the poor. (Hall, 2004)

3.9.1. Financing of Water Sector

There are several opportunities of financing water sector in developing countries:

a) **Taxes** - Water expenditure and loans are financed by means of taxation or user charges. There is less need for payment from users and since poor pay less taxes they pay less for water as well. However, this might be problem in society consisting of poor people since there are few rich people to pay the taxes.
b) **Tariffs -** Another method of charge collection is block tariffs system, where people are paying less for low consumption and with increasing consumption they pay more. Giving low amount of consumption for free is one way of benefiting the poor.
c) **Central government financing** - Central government financing collect taxes by everybody and use it where is it most needed
d) **Investment finance:** profit from operation or borrowings from investors.
e) **Local capital and local government finance** - Borrowing money within a country. (Hall, 2004)

3.9.2. Water Pricing

Water pricing is important instrument for affecting water consumption in domestic, agricultural and industrial sector. The total consumption decreases with increasing water prices and water is used more efficiently. (Rosegrant, Cai, Cline, 2002) Water pricing is crucial tool for water allocation improvement and similarly to encourage users to treat water as scare resource. Prices reflect water's economic and scarcity value which informs users to make choices reagarding consumption of water. Moreover, demand for higher quantity of water has increased recently worldwide, however development of new water supply is extremely costly. Pricing contributes to self sufficiency of utilities since operations can be funded through customer charges. (Dinar, Subramanian, 1997)

3.9.2.1.Pricing Inequalities

Every fifth person of third world countries is missing access to clean water. Moreover according to United Nations Development Program people in the slums of third world countries usually pay from 5 till 10 times more per water than people served with piped water (United Nations, 2006). Water scarcity in Sub-Saharan Africa is problem of poverty and inequality, especially mistake of inadequate institutional and political choices not in water availability. Poor people in are paying extremely high price for poor quality service. (Water and sanitation program, 2000) People living per 1 USD per day have to spend all its income for water, thus usage of alternative unhygienic sources. (Aderinwale, Ajayi, 2008) The main reason why poor pay high prices is that poor do not have house connection and as water passes through intermediaries, extra marketing and transport occurs which increases. Utility price is cheaper however connection fee is usually not affordable for the poor. High income families are using water from utilities and paying extremely low price, for this reason it is impossible to finance operation and management costs. Technology and infrastructure is needed in order to reach the poor and investment into network which would reach the poor from the government is needed. (Watkin, 2006)

3.9.2.2.Willingness to Pay

According to World Bank, it has been proved that urban and rural residents are willing to pay more than current rate for water and sanitation based on the condition that the current service will be improved. However, governments keep ignoring this fact and as a consequence, revenues are low, costs high quality of water is bad, resulting in financial crisis. Increasing tariffs would guarantee additional revenue. Policy makers, however, claim that poor will not be able and willing to pay. Currently poor not connected to piped system are paying far more for services of water vendors than official tariff rate. Politicians should review tariffs and identify willingness to pay, design investment and finally shift towards financial sustainability and freedom. As soon as suppliers will be selling water at the price of its real cost, consumers will be willing to pay for tariff increases. Willingness-to-pay studies needs to be made. Sometimes, however, tariffs are increasing without increasing quality of services. (Water and sanitation program, 2000)

3.9.2.3. How Do Low Tariffs Contribute to Water Scarcity

In order to assure access to the poor, policy of low tariffs was introduced. However, this policy only helped the rich and led to worsening of quality of services instead of benefiting the poor. In order to solve the problem, World Bank suggests to adopt a "demand-driven approach" where services people want are willing to pay for are delivered. In order to improve service, full cost of water should be charged and high quality for high price should be delivered to those who are willing to pay for it. (Gulyani, Talukdar, Karikuri, 2005) Many projects have failed thanks to people being unable to pay for the tariffs and thus operation and maintenance costs were not covered. Instead lower level of service at lower capital and operating costs should be provided. (Kulndwa, Lein, 2008) Since user fees are too low, costs of the system can not be covered. Thus the system has to be financed from general budget. (Richards, 2002) On average only 35% of costs were charged by users. (Kulndwa, Lein, 2008) Increasing prices might contribute to efficient use of water, increase cost recovery and enable to raise capital in order to satisfy future demand. Low water charges have contributed to wasting of water. (Rosegrant, Cai and Cline 2002)

3.9.3. Subsidies for Water

"**Subsidy is payment reducing the buyer's price below the seller's price; i.e., a negative tax."**(Pindyck, Rubinfeld, 2005)

As a result of subsidy seller's price is higher than buyer's price and quantity increases. Benefit of subsidy is divided between buyers and sellers, according to relative elasticity of supply and demand. (Pindyck, Rubinfeld, 2005)

3.9.3.1.How Subsidies Harm Poor and Benefit Rich

In majority of developing countries, domestic and agricultural users receive subsidies on water use. However subsidies usually contribute to worsening of equity rather than its improvement. Water subsidies usually go to the users who are better off, especially to urban connected users who are connected to piped system and irrigated farmers. Poor

are not connected to public utilities and therefore they do not receive any subsidy. On the contrary, poor who are forced to rely on expensive services of water vendors and are forced to pay far more than urban users who get subsidized water from public piped systems. To exemplify, in Cote d'Ivoire subsidies usually receive 60% of the rich. As a result, poor people end up spending three times as much for water as the rich do. (Rosegrant, Cai and Cline 2002) Consequences of subsidies on equity are even worse when subsidies are financed from regressive taxes, which is very common in developing countries. In order to improve this situation urban water prices needs to be increased in order to pay delivery cost of water and revenues could be used for expansion of supply network to reach the poor. General subsidies should be targeted to the poor. (Rosegrant, Cai and Cline 2002) Another problem is the fact that government, and the elite do not pay bills. Water used by the rich is subsidized with scare public funds. Many reforms accepted by corrupted government hurts poor and benefited rich in terms of increasing prices set up to benefit rich rather than tax them and increasing unemployment. (Auriol, Blanc, 2009)

3.10. Role of Government and Politicians in the Water Sector

Government involvement in service provision is important tool of poverty reduction. (Kulindwa, 2008) "Water supply is important political issue linked to the problems of extreme income inequaity" (Schulz, 2008) In sub-Saharan Africa, there is almost no infrastructure available and political actions are missing. Water related poverty is created artificially by human actions, bad policies and inefficient management. (Mascarenhas, 2008) Water scarcity is function of resource availability, consumption patterns and mismanagement of resources. Thus water scarcity is problem of water governance, inappropriate investment and absence of good and transparent public management not shortage in absolute sense. (Kulndwa, Lein, 2008) Water's role must be recognized by governmental leaders, private sector and civil society and decisions which will allocate human and financial resources to fight against water scarcity must be made. (United Nations Educational, Scientific and Cultural Organization, 2009)

3.10.1. Policies and Laws

Important tool for effective water management is adaption of water resource laws, policies and strategies, which show relationship between water, social and economic sector. However, funding of infrastructure, institutional and human capacity of the sector is crucial and policies and laws itself will not work without it. It is necessary to develop legal framework and effective policies in order to protect the water resources. Moreover, it is can contribute to declining corruption, which is mainly issue of poor governance and contributes to uncontrolled pollution of water sources, depletion of groundwater, poor planning, environmental degradation, poor flood protection. (United Nations Educational, Scientific and Cultural Organization, 2009) It can happen that corrupted policymakers may discriminate certain users while designing water pricing schemes or use water charges as a source of revenue. (Dinar, Subramanian, 1997)

4. Economic Analysis

4.1. Introduction

Core issue analyzed in the economic research was, whether percentage of connected households to improved water source is influenced by selected determinants. Furthermore, within the analysis, market for water in sub-Saharan Africa as well and its externalities are discussed. In the end of this section, solutions of current situation are suggested.

Variables chosen for the purposes of this research include: Improved water source, Renewable internal freshwater resources per capita, Corruption perception Index and GDP per capita. As a base year 2008 was selected since data for other years were incomplete. Data were collected from sources of two NGOs: World Bank and Transparency International. Economic poverty was analyzed through GDP per capita since it reflect both level of economic development of certain country and poverty. It is assumed, that there is relationship between GDP and access to water measured by improved water source. The higher GDP per capita the richer the economy of given country is. Thus, the more likely the government provides infrastructure to assure access to water. The more rich the country is the more likely can afford to buy simple solution to assure access to water. For the purposes of measuring corruption level, corruption perception index (CPI) was used. It is supposed that there is relationship between corruption and improved water source. If CPI (the higher the CPI score the less corrupted the country is) increases access to water among rural population increases. The less corrupted the government is, the more the government is willing to care about the poor and provide improved water access. Within the research, link between economic and physical water scarcity was examined and question whether environmental conditions, such as high level of evaporation and lack of precipitation influences access to water was answered. Per capita renewable freshwater sources ware used as a tool of measuring physical scarcity and was further compared with improved water source, measuring actual percentage of households with access to water source. It is assumed, that physical water availability does not influence actual number of connected households with improved water source.

Steps undergone in the bachelor thesis research include:

- Data collection
- Data processing
- Data analyzing
- Comparative analysis
- Descriptive analysis
- Regression analysis

4.2.Definition of Variables

4.2.1. Improved Water Source

"Access to an improved water source refers to the percentage of the population with reasonable access to an adequate amount of water from an improved source, such as a household connection, public standpipe, borehole, protected well or spring, and rainwater collection. Unimproved sources include vendors, tanker trucks, and unprotected wells and springs. Reasonable access is defined as the availability of at least 20 liters a person a day from a source within one kilometer of the dwelling." (World Bank, 2011) This variable is determined for rural and urban population separately.

4.2.2. Improved Water Source, Mean

It is the percentage of total population with access to improved water source, computed as arithmetic average of rural and urban population with access. This indicator is simplified for the purposes of this research, since in some countries contain higher percentage of rural dwellings where as some have more of urban population.
Source: own computation based on world banks' data

4.2.3. Renewable Internal Freshwater Resources per Capita

"Renewable internal freshwater resources flows refer to internal renewable resources (internal river flows and groundwater from rainfall) in the country. Renewable internal freshwater resources per capita are calculated using the World Bank's population estimates." Renewable Internal Freshwater Resources per Capita are measured in squared meters. (World Bank, 2011)

4.2.4. Corruption Perception Index:

According to Transparency International, corruption is defined as “abuse of entrusted power for private gain”. Corruption Perception Index (CPI) classifies countries by perception of corruption in the public sector based on different source of information. Corruption perception index measures corruption level in certain country, ranging from 0 (highly corrupted) to 10 (very clean). (Transparency International, 2010)

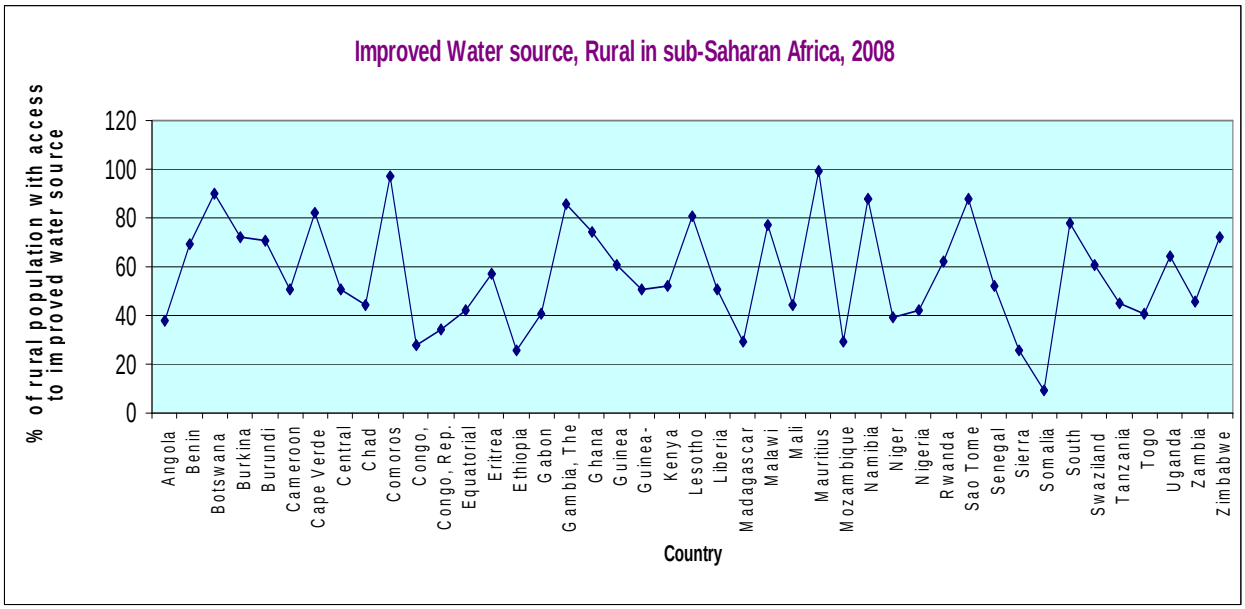
4.2.5. Gross Domestic Product per Capita (GDP)

"GDP is the total dollar value of all final goods and services produced within a nation's border during a year." (Maitah, 2009) There are two ways of calculating GDP. It can be calculated as a sum of incomes during given period of time or by sum of final good and services produced in a country in a given period in given period of time. GDP per capita is total output of a country (GDP) divided by number of inhabitants. It is used for comparison among countries since it reflects standard of living, the higher per capita GDP the higher standards of living.

4.2.6. People Without Access to Water

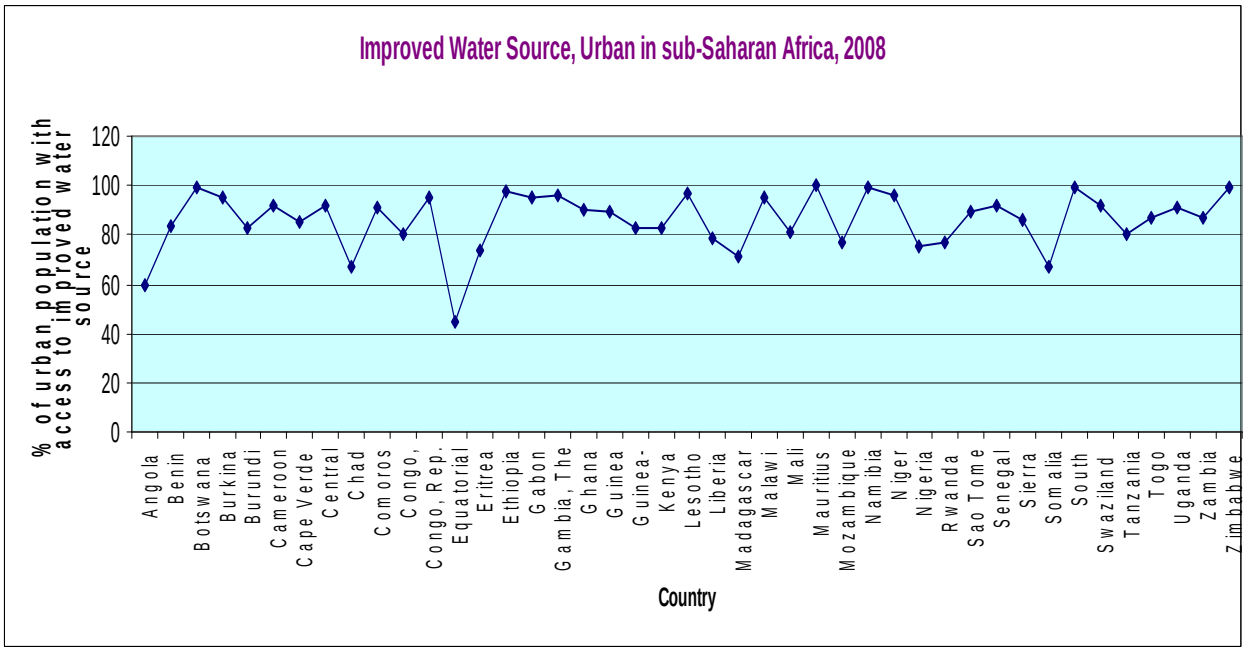
People without access to water are those living more than 1 kilometre away from improved water source, such as well or public tap. (Watkin, 2006)

Chart 2: Improved Water Source, Rural in sub-Saharan Africa, 2008



Data source: World Bank, own processing

Chart 3: Improved Water Source, Urban in sub-Saharan Africa, 2008



Data source: World Bank, own processing

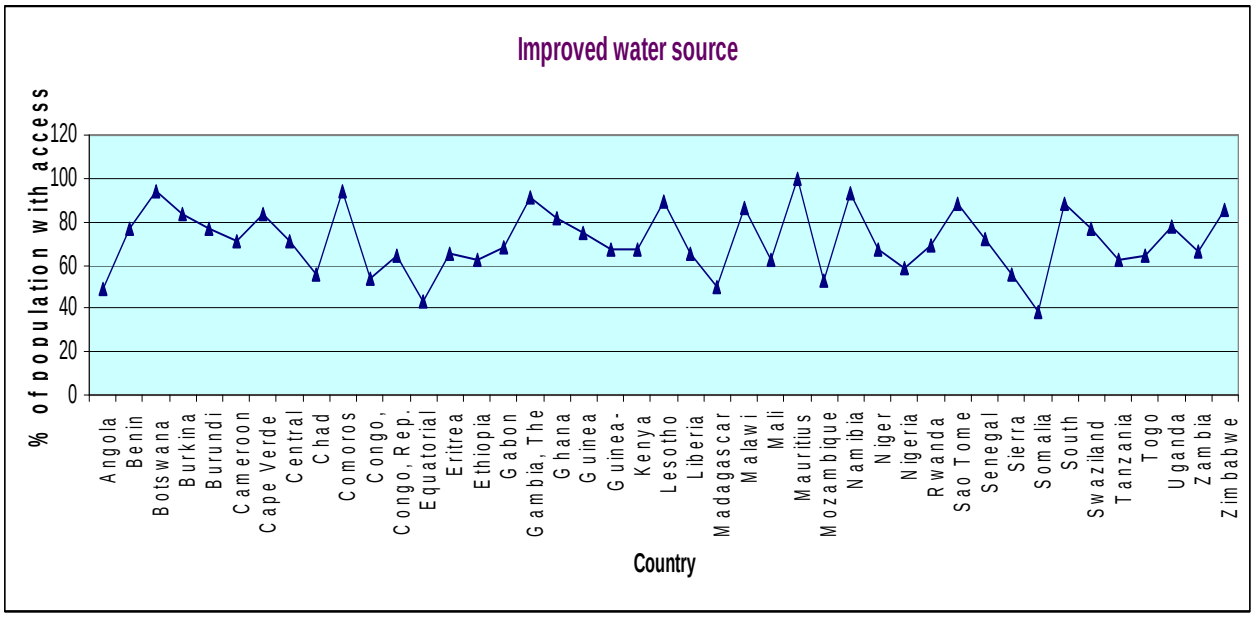
4.3. Comparative Analysis

Assumption: It is assumed, that water scarcity in Sub-Saharan Africa is not influenced by natural conditions, such as physical availability of water sources, precipitation and evaporation in given region, but is influenced corruption and poverty. Water scarcity was measured by number of households connected with improved water source.

Sample size: As a sample for this research, 43 countries of Sub-Saharan Africa were tested. From this study two countries were excluded due to unavailability of data, including Cote d'Ivoire and Seychelles.

For the purposes of comparative analysis, variables were compared to *improved water source (mean),* since it is a simplification and express arithmetic average of urban and rural access to water. However there is basic limitation in this research, since mean can be used only under assumption that there is equal proportion of population of rural and urban areas in a given country.

Chart 4: Improved Water Source, Mean, sub-Saharan Africa, year 2008

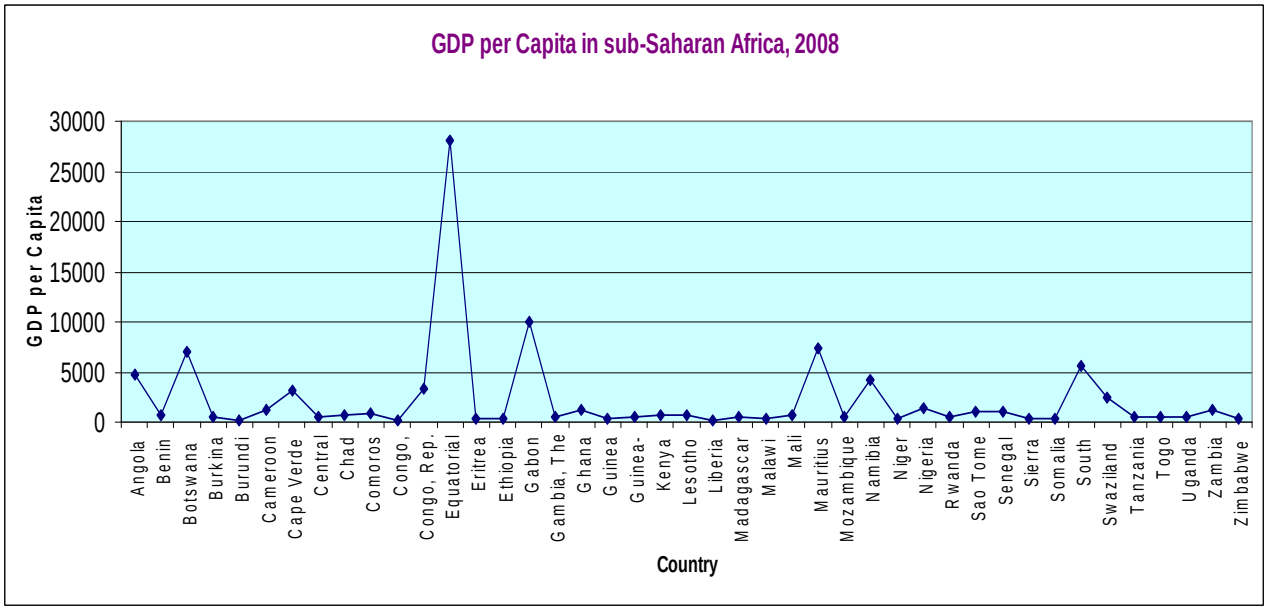


Data source: World Bank, own processing

4.3.1. Analysis of the Impact of GDP per Capita

It has been proved, that some countries with lower GDP have lower percentage of population with access to improved water source where as some countries with higher GDP have higher percentage of population with access to improved water source. Since there are plenty of exceptions it is not possible to determine influence of GDP per capita on total population with access to improved water sources.

Chart 5: GDP per Capita in sub-Saharan Africa, 2008



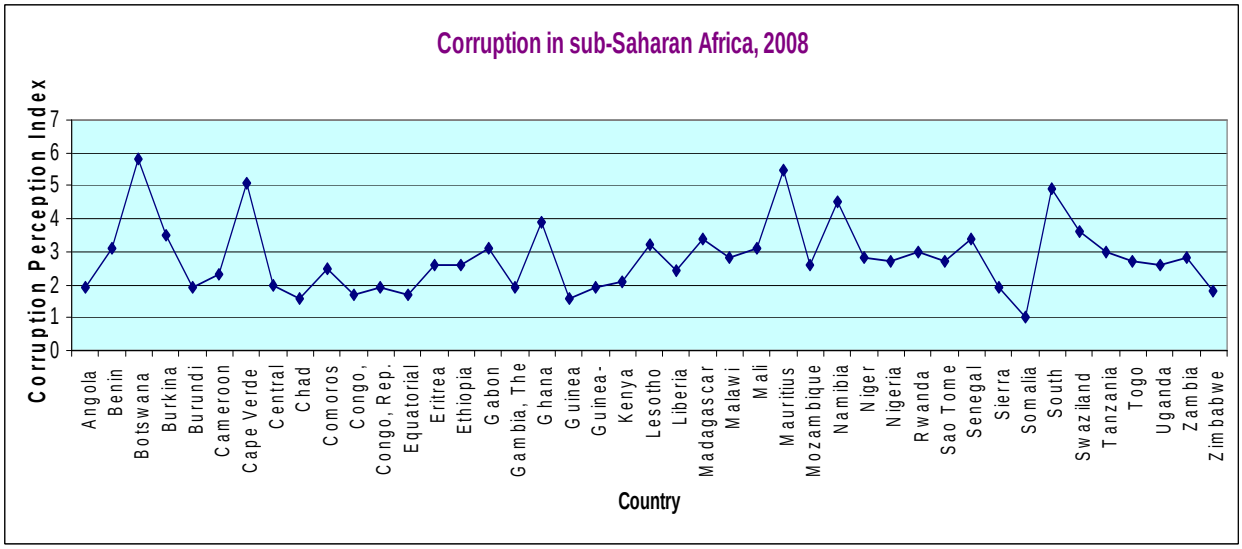
Data source: World Bank , own processing

4.3.2. Analysis of the Impact of Corruption

While comparing percentage of total population with access to improved water source and corruption index, it is obvious that the lower the CPI the higher access to water. Corruption thus directly influences access to water source. This might be because countries with higher corruption will more likely have government who does not care about the population and access to improved water source will be thus worse. The most corrupted countries such as Somalia, Angola, Congo, Sierra Leone and Chad have the worst infrastructure and thus coverage access to improved water source is worse. On the other

hand, the less corrupted African countries such as Mauritius, Botswana and Namibia have highest access to water.

Chart 6: Corruption in sub-Saharan Africa, 2008

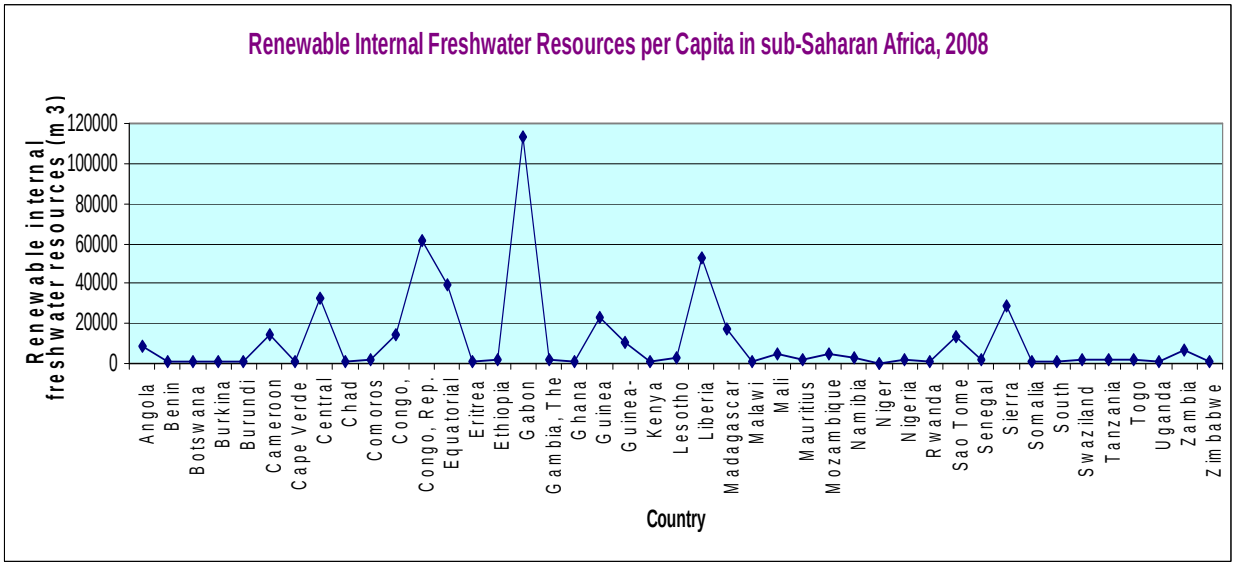


Data source: Transparency International, own processing

4.3.3. Analysis of the Impact of Physical Water Scarcity

It was observed, that there is no correlation between physical and economic water scarcity. To exemplify, countries with highest coverage, such as Mauritius, Comoros, Cape Verde and South Africa or Botswana have had one of the lowest value of per capita freshwater resources. On the other hand countries such as Sierra Leone, Congo or Madagascar have much higher internal freshwater resources however access to water is very low.

Chart 7: Renewable Internal Freshwater Resources per Capita, sub-Saharan Africa, 2008



Data source: World Bank, own processing

4.3.4. Countries with Water Scarcity, Low GDP per Capita and High Corruption

First of all, countries with very low access, low GDP per capita and high corruption are analyzed. While comparing countries according to number of households with improved water source, **Somalia** had the lowest coverage from all of the countries of Sub-Saharan Africa. Only 9% of rural areas and 67% of urban areas have access to water. Renewable internal freshwater resources per capita are one of the lowest as well as GDP per capita and corruption is the highest from all of the countries of Sub-Saharan Africa.

Second worst coverage among rural population has **Sierra Leone**. Urban access is better however average access to improved water source is one of the lowest. Sierra Leone has one of highest renewable freshwater resources per capita, which confirms our hypothesis that availability of water resources does not influence amount of households connected with piped water. Sierra Leone is poor country with very high level of corruption. Is one of the poorest and most corrupted countries of sub-Saharan Africa.

Another country with very low coverage was **Democratic Republic of Congo** (26% with connection among rural population and 80% among urban). Again, renewable

internal freshwater resources were very high, slightly above average of the Sub-Saharan region, which again means that availability of water does not secure access for the poor. GDP per capita was the lowest from all of the countries and corruption was second worst, confirming that GDP and corruption have very strong influence on water availability.

Next country with very low water connection (29% of rural and 77% of urban population connected to improved water source) is **Mozambique**. Amount of freshwater resources is low in Mozambique and corruption very high (CPI equals to 2.6 which is below average). Moreover, GDP is very poor country with very low GDP per capita.

4.3.5. Rich Countries with High Coverage with Water Source and Low Corruption

Rich countries of Sub-Saharan Africa highest corruption perception index number (lower corruption) have shown the highest coverage of piped water network among rural and urban inhabitants. To exemplify, in **Ghana** 82% of total population have access to improved water source, GDP was at the average level of sub-Saharan region, however corruption was very low compared to other countries. Ghana's natural water balance was very low.

Furthermore, **Cape Verde** (83.5 % of population with access) have very low level of corruption (CPI=5.1) and GDP was very high. Another rich country of sub-Saharan region is **South Africa** with GDP per capita equals to 5666 USD and low level of corruption (CPI=4.9). 88.5% of South Africa's inhabitants have access to water source. Cape Verde as well as South Africa have very low amount of renewable freshwater resources. Similarly, **Namibia** is also very rich country with low level of corruption and high percentage of people connected to improved water source. Namibia has very low amount of renewable freshwater resources. The highest coverage from all of the countries tested has had **Mauritius**, followed by **Botswana**. 99.5% of households are connected to improved water source and also GDP was second highest (7337 USD per capita) and corruption second lowest (CPI=5.5) from all of the countries examined in this study. Second country with best access was Botswana (94.5%). Botswana was the third richest country (GDP equals to 7050) and was country with highest CPI score (5.8) and thus the less corrupted country. Neither Mauritius nor Botswana was water-rich countries.

4.3.6. Exceptions

First exception is **Madagascar** which has very low access to water source as well as very low GDP per capita. However, corruption in Madagascar is lower than average of Sub-Saharan Africa. Amount of renewable water resources per capita is higher than region's average. Another exception from this group is **Angola** with very low average improved water source. Even though there is quite high number of rural population with access (38%), there is low amount of urban population with access (60%), the lowest from all sub-Saharan Africa. GDP per capita is fifth highest of whole region, however corruption is one of the highest and amount of renewable freshwater resources is below region's average.

Some countries have high coverage rate, but either have had low level of corruption or high GDP per capita. To exemplify, **Burkina Faso** with lower GDP than average rate of SSA, however corruption was lower than in majority of African countries. Moreover **Sao Tome and Principe** was relatively rich with relatively low level of corruption. **Lesotho** has had very low level of corruption, but GDP was not that high like Sao Tome and Principe's one. Similarly, **Comoros** have high coverage rate and CPI at the around the average level of sub-Saharan Africa and lower GDP per capita than average level. All of these countries have had lower physical water availability than region's average.

Another exception include following countries: **Zimbabwe, Malawi and Gambia**, which have had very high percentage of connected households to improved water source and were very poor and corrupted. To exemplify, Zimbabwe (85.5% with access) is one of the poorest country of the region (GDP per capita 313) have had similar level of corruption such as countries with very bad access (CPI=1.8). Similarly, Malawi (CPI=2.8; GDP per capita = 288) and Gambia (CPI=1.9 and GDP 495) have had very high percentage of total population connected with improved water source. All of these countries have very low amount of renewable freshwater resources.

Gabon is an exception, since only 68% of inhabitants have house connection, CPI equals to 3.1, which is fairly good compared to other cases, however GDP per capita is 10037 USD per capita, which is the highest per capita GDP from whole sub-Saharan Africa. Renewable freshwater resources are less than average of the region in Gabon.

4.3.7. Other Countries

Another group is group of countries with slightly higher access however these countries usually have either low GDP or high corruption. To exemplify, **Republic of Congo** have low rural access (34%), but on the contrary very high access among urban population was very high (95%). GDP was far more above average (3261 USD per capita), however average access was low due to high corruption (CPI equals to 1.9). Amount of renewable freshwater resources was highest from whole sub-Saharan Africa, again confirming that it does not influence access of population to water.

Niger have very low rural access, but higher urban access, however the average access to improved source was still 67.5%, which is still very bad. Even though Niger corruption was equal to the average of the region, GDP was very low. Similarly, 64% of inhabitants of **Togo** (average of rural and urban) have access to water source as a result of very low GDP (449 per capita). Even though corruption was not that bad, GDP per capita was very low therefore access to water source was bad. Amount of renewable freshwater resources was low for both of these countries.

Chad's average connection was 55.5% corruption was high, amount of renewable freshwater resources extremely low and GDP per capita low.

In Nigeria, where 58% of population having improved water connection, have very low amount of renewable freshwater resources, lower corruption than region's average and GDP per capita same as average level of whole region. In this case, physical water scarcity might have influenced insufficient access to water. Similarly, **Zambia** (66.5%) have very bad connection but relatively high level of GDP per capita (Zambia 1165 USD per capita and Nigeria 1370 USD per capita, which is both relatively good, however still bellow average of SSA. Corruption perception index in Nigeria equals to 2.7, where as in Zambia CPI is 2.8. **Mali** and **Tanzania** have both around 62% of country's population connected with improved water source GDP was lower than countries with similar percentage of connected households however corruption in these two countries was lower as well. Both countries have had low amount of renewable freshwater resources. On the other hand, **Liberia** or **Eritrea** have had slightly higher coverage with improved water source (65%) than Mali and Tanzania, but have been poorer and more corrupted than these two

countries. In Liberia amount of renewable freshwater resources were very high, in Eritrea very low.

In **Kenya** 67.5% of total population have had access to water which is better than in the countries mentioned above. Moreover, corruption was lower and GDP per capita was higher than in previous cases. Kenya just had 534 m3 of renewable freshwater resources, which is very low compared to other countries.

Rwanda and **Central African Republic** have both relatively low level of GDP per capita. Corruption was above the region's average. Rwanda has very low annual renewable freshwater resources, on the contrary, Central African Republic very high. **Cameroon** and **Senegal** have similar coverage with piped water network, GDP per capita was far higer for **Cameroon** and **Central African Republic** and corruption was on the similar level. Both countries have had low freshwater availability.

On the contrary, **Guinea** and **Burundi** have had high access to improved water source, even though these two countries are poor countries with low GDP per capita and very high level of corruption. Swaziland and Benin have had similar level of coverage (around 75%) as Guinea and Burundi, however, corruption was relatively low compared to other countries of Sub-Saharan region and GDP relatively high. Guinea have high amount of water resources, where Burundi low. **Uganda** have had relatively high coverage, corruption was equal to the average level of corruption in SSA, water balance of the country was low and GDP per capita was lower than average.

4.3.8. Results of Comparative Analysis

To sum up, among some countries, there was observed impact of GDP and corruption on improved water source. Impact of renewable freshwater resources has not been observed during the study. Even though influence was observed, comparative analysis is not the best method for this study since detecting final conclusion have been shown as extremely hard thanks to existence of too many exceptions. Impact of corruption and GDP were observed among following countries:

a) Countries with low access to improved water source, low GDP per capita and high corruption: Somalia, Mozambique, Democratic Republic of Congo, Sierra Leone, Togo, Liberia, Eritrea, Zambia, Guinea-Bissau and Niger, Chad, Mali, Tanzania, Nigeria, Kenya, Rwanda

b) Countries with high access to improved water source and high GDP per capita and low corruption: Swaziland, Benin, Ghana, Cape Verde, South Africa, Namibia, Botswana and Mauritius.

Among other countries corruption and GDP does not have impact on access to water.

4.4.Regression Analysis

Since comparative analysis was proved as unreliable tool for determining mutual relations, regression analysis was further applied. However, there are several limitations, such as possible spurious regression and omitted variables. Dependent variable is improved water source, where as explanatory variables are renewable freshwater resources per capita, corruption and GDP per capita. For the purposes of regression analysis, impact of explanatory variables was analyzed separately for rural and urban population. Again two countries were excluded from this study, Seychelles and Cote d'Ivoire because data have not been available.

4.4.1. Model

Model used for the purposes of regression analysis is stated bellow.

$$\mathbf{Y = a_0 + a_1 x_1 + b x_2 + c x_3 + \varepsilon}$$

Table 2: Variables Used for Regression Analysis

Y	X1	X2	X3
Improved water source (% of population with access)	Renewable internal freshwater resources per capita (cubic meters)	CPI	GDP per capita

Source: own processing

4.4.2. Hypothesis

H_0 – explanatory variables have influence on improved water source
H_1 – explanatory variables do not have influence on improved water source

4.4.3. Discussion of Results

4.4.3.1. Improved Water Source – Rural Population

First of all, dependence of explanatory variables on water source among rural population was tested

Hypothesis H_0 was confirmed => corruption is significant variables and thus influence percentage of households with access to improved water source among rural population, where as amount of freshwater resources and GDP per capita are insignificant variables.

Equation of dependence:

$$\mathbf{Y = 24.5 + 11.46\ X_2 + \varepsilon}$$

R-Squared = 0.56

There is a positive relationship between CPI and improved water source, if CPI increases by one unit, percentage of connected households to improved water source increases by 11.46 units (With decreasing corruption access to water improves). With CPI equals to zero, improved water source equals to 24.5. Relationship between GDP per capita was insignificant, thus GDP per capita does not influence amount of rural household with access to improved water source. 56% of variables are explained by this model.

Figure 1: Regression Analysis (Rural Population)

RESULT

Regresion analysis	
R-Squared	0,59474438
Level of reliability of R	0,35372088
Setted level of reliability	0,3040071
Error	18,2270046
Number of observations	43

ANOVA

	Difference	*SS*	*MS*	*F*	*Significance F*
Regression	3	7091,461926	2363,820642	7,11514764	0,000633045
Residues	39	12956,72412	332,2236954		
Total	42	20048,18605			

	Coefficients	*Error of middle value*	*t stat*	*P Value*	*Bottom 95%*	*Upper 95%*	*Bottom 95%*	*Upper 95%*
Border	28,9546454	8,464747322	3,420615444	0,00147851	11,83307803	46,07621281	11,833078	46,0762128
X 1	-0,0002085	0,000148109	-1,407499208	0,16720012	-0,00050804	9,11151E-05	-0,00050804	9,1115E-05
X 2	10,5499749	2,742282666	3,847150786	0,00043126	5,003184717	16,09676511	5,00318472	16,0967651
X 3	0,00018628	0,000679483	0,27415169	0,78541496	-0,001188103	0,001560666	-0,0011881	0,00156067

Source: own processing

Variable "Renewable internal freshwater resources" and "GDP per capita" was removed from regression analysis since these variables were insignificant and mutual relations were tested for significant variable separately.

Figure 2: Regression Analysis – Impact of Corruption (Rural Population)

RESULT

Regresion analysis	
R-Squared	0,564633937
Level of reliability of R	0,318811483
Setted level of reliability of R	0,302197129
Error	18,25068934
Number of observations	43

ANOVA

	Difference	*SS*	*MS*	*F*	*Significance F*
Regression	1	6391,591931	6391,592	19,18892	8,01005E-05
Residues	41	13656,59412	333,0877		
Total	42	20048,18605			

	Coefficients	*Error of middle value*	*t stat*	*P Value*	*Bottom 95%*	*Upper 95%*	*Bottom 95%*	*Upper 95%*
Border	24,46664946	7,876549278	3,106265	0,003433	8,559635662	40,373663	8,55963566	40,3736633
X 2	11,46105758	2,616371726	4,380516	8,01E-05	6,177187745	16,744927	6,17718775	16,7449274

Source: own processing

4.4.3.2.Improved Water Source – Urban Population

Results of regression analysis, while analyzing dependence of explanatory variables on access to water among urban population were following: "renewable internal freshwater

resources" was proved to be insignificant variable, where as CPI and GDP per capita significant variables. Thus, among urban population access to water is influenced by corruption and GDP.

Hypothesis H0 was confirmed => corruption and GDP per capita influence percentage of households with access to improved water source among urban population. Improved water source does not have any impact.

Equation of dependence:

Y = 72.7 + 5.5X2 – 0.001 X3 + ε

R-Squared = 0.615

Based on the equation gained through regression analysis, if CPI increases by one unit, percentage of households connected to improved water source increase by 5.5 units. Moreover, it was proved that there is negative relationship between GDP per capita and water source. When GDP per capita increases by one unit, percentage of households connected to improved water source decreases by 0.001 units. 61% of variables are explained by this model.

Figure 3: Regression Analysis (Urban Population)

RESULT

Regresion analysis	
R-Squared	0,66240274
Level of reliability of R	0,43877739
Setted level of reliability	0,39560641
Error	9,13519722
Number of observations	43

ANOVA

	Difference	*SS*	*MS*	*F*	*Significance F*
Regression	3	2544,541486	848,1804953	10,1637138	4,44551E-05
Residues	39	3254,621305	83,45182833		
Total	42	5799,162791			

	Coefficients	*Error of middle value*	*t stat*	*P Value*	*Bottom 95%*	*Upper 95%*	*Bottom 95%*	*Upper 95%*
Border	69,4965493	4,242448943	16,38123409	4,4526E-19	60,91538639	78,07771214	60,9153864	78,0777121
X 1	0,00015204	7,42306E-05	2,048274255	0,04730726	1,89907E-06	0,00030219	1,8991E-06	0,00030219
X 2	6,29863253	1,374405373	4,582805518	4,6258E-05	3,518635283	9,078629767	3,51863528	9,07862977
X 3	-0,0013845	0,00034055	-4,065355113	0,00022513	-0,002073286	-0,00069563	-0,00207329	-0,0006956

Source: own processing

Equation of dependence of corruption and GDP upon improved water source was examined further, after removing variable improved water source in order to increase level of reliability.

Figure 4: Regression Analysis (Urban Population) – Impact of Corruption and GDP per Capita

RESULT

Regresion analysis	
R-Squared	0,61514537
Level of reliability of R	0,37840383
Setted level of reliability of R	0,34732402
Error	9,49307299
Number of observations	43

ANOVA

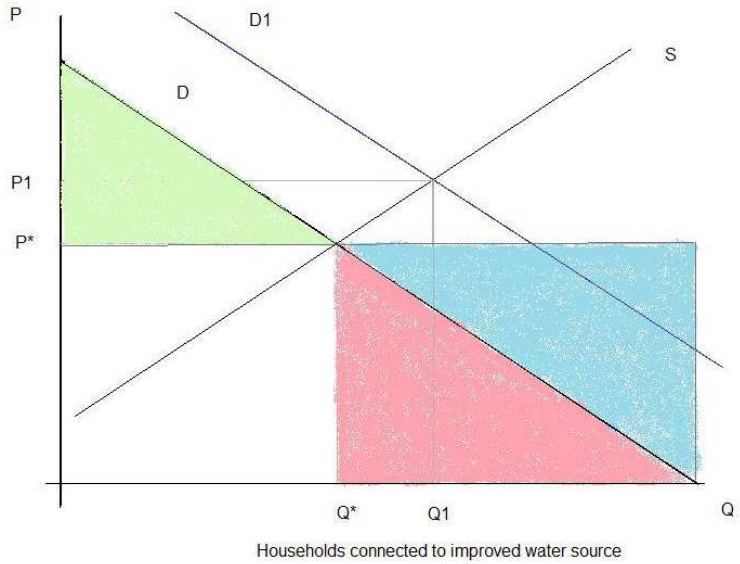
	Difference	*SS*	*MS*	*F*	*Significance F*
Regression	2	2194,425397	1097,213	12,17523	7,41595E-05
Residues	40	3604,737394	90,11843		
Total	42	5799,162791			

	Coefficients	*Error of middle value*	*t stat*	*P Value*	*Bottom 95%*	*Upper 95%*	*Bottom 95%*	*Upper 95%*
Border	72,6900714	4,10013562	17,7287	1,5E-20	64,40338829	80,976755	64,4033883	80,97675
X 2	5,53681366	1,374957846	4,026897	0,000245	2,757920222	8,3157071	2,75792022	8,315707
X 3	-0,00108946	0,000320685	-3,397274	0,001551	-0,00173758	-0,0004413	-0,00173758	-0,000441

Source: own processing

4.5.Market for Water

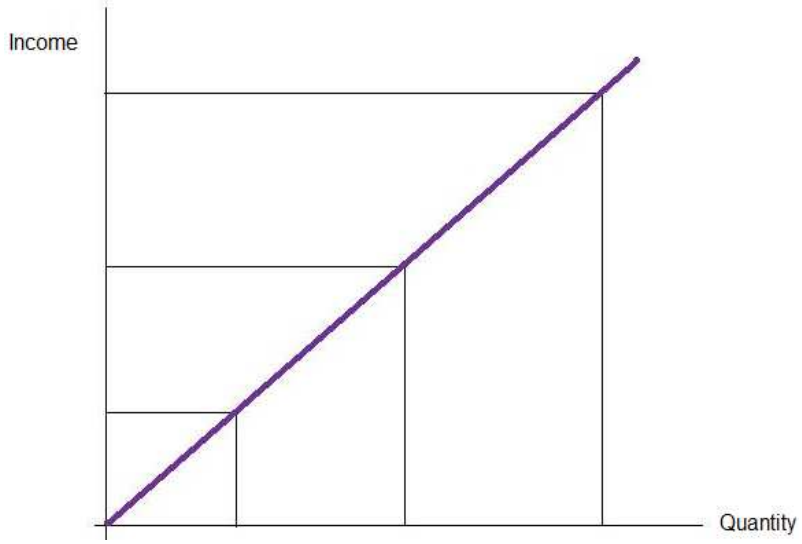
Figure 5: Market for Water



Source: own processing

Figure 1 applies principles of economic law of supply and demand on the domestic market for water in sub-Saharan Africa. Vertical axis represents demand for water (in our case amount of households which are connected to improved water source), where as horizontal axis represent price of water. Market equilibrium is found at intersection of supply and demand curve. Initially, consumers are demanding Q* amount of water P* price. With rising income, demand curve moves to D1. Consumers are now demanding Q1 at price P1. Pink triangle represents ability of the poor households to pay for improved water source. Blue triangle graphs missing income which is needed in order to have water connection. Green triangle is consumer surplus. Water is a **normal good,** thus as income rises, consumers tend to demand more of given good.

Figure 6: Water as a Normal Good



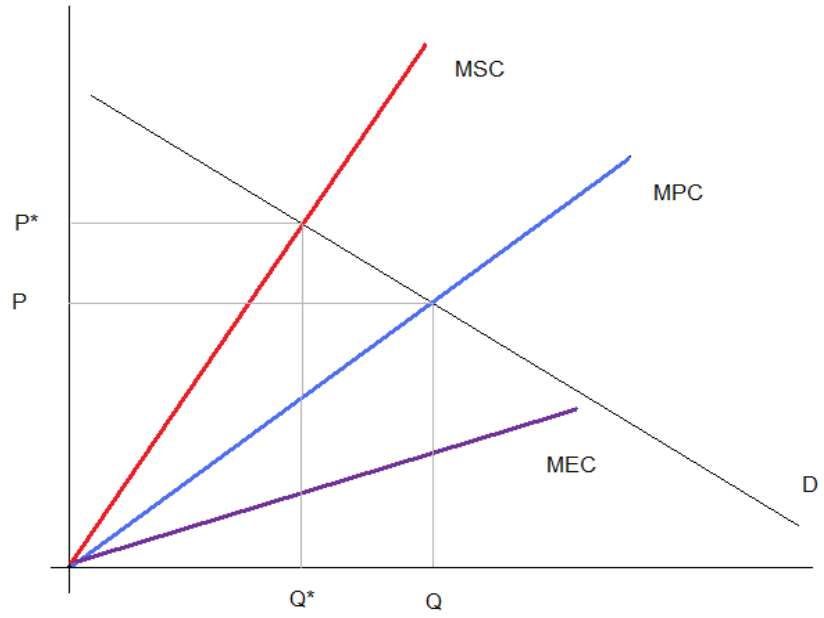
Source: own processing

4.5.1. Externalities

Externality is action undergone by a producer or a consumer which is not reflected in market price, however affects other producers or consumers either positively or negatively. (Pindyck, Rubinfeld, 2005)

4.5.1.1.Negative Production Externality

Figure 7: Negative Production Externality



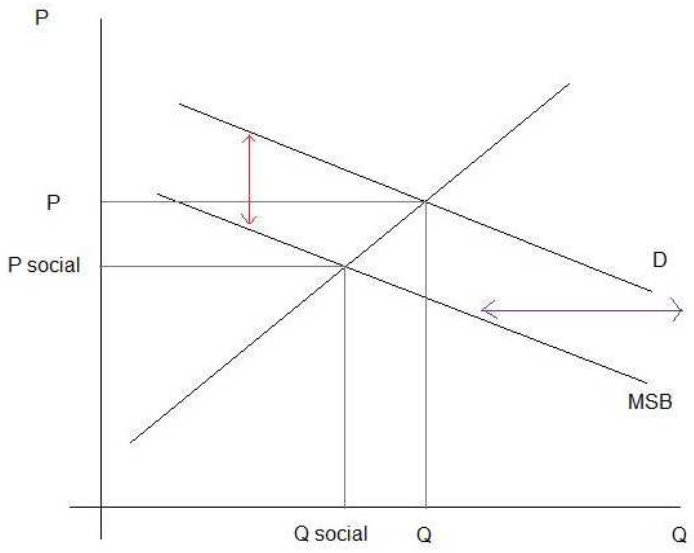
Source: own processing

Poor management practices are typical example of negative production externality. Due to this externality, quality of service is bad. More efficient infrastructure is needed, and leaking pipes needs to be replaced. Investment into infrastructure is vital in order to achieve more efficient system.

4.5.1.2.Negative Consumption Externality

As soon as scares resource is shared and used undesirably, negative externality occurs. Response arises in terms of economic, social and ecological losses. Once one consumer demands more of a scare resource, cost of resource for another consumer increases. Thus, in order to meet needs of all consumers, it is necessary to share added costs from increased demand in order to internalize the externality. (Singletary, 2010) In the drawing bellow, red arrow represents negative consumption externality

Figure 8: Negative Consumption Externality



Source: own processing

4.6. Solutions

According to Abrams the solution is not in water sector, but in eradication of poverty at national, institutional, and individual level. Otherwise it is not possible to achieve universal coverage. Eradication of poverty is closely connected to development. Furthermore, Abrams points out, that there are many people who die from water related disease, however, there are just very few people who die of thirst, which shows that everybody has water supply, however, not safe. In order to solve problem of water coverage, poverty need to be eradicated at first. Furthermore, movement from single sector (water service provision) to economies, society and politics will help to solve this issue and save millions of lives. (Abrams, 1999) In order to fight against water scarcity international and intersectoral and international cooperation is necessary. (FAO, 2010)

Poor would be served with getting access to piped water rather than by general subsidies. Tariffs should be increased in order to cover the costs of service in order to enlarge coverage. Subsidy needs to be targeted directly to the poor expansion of piped water network should be emphasized. Moreover, poor people need to have opportunity to decide amount of consumption. Fair metering has to be introduced in order to increase

operation efficiency and meters needs to be installed. Increasing tariffs at the level of the cost will, however, influence real income of the poor which spend majority of their income for water. (Walker, Ordonez, Serrano, Halpern, 2000)

4.6.1. Groundwater as a Solution

From 300 million people of Sub-Saharan Africa 80% live in rural areas. In order to meet demand for water, groundwater is the only opportunity for rural Africa. However it is not easily accessible and thus knowledge and research are vital. Other options are not reliable, difficult and expensive to develop, moreover, surface water has high potential to get contaminated and there is a need for piping it at the point of need. Additionally, rainwater harvesting is expensive and there is need for regular rainfall through the year, which is often not possible. Groundwater usage has many advantages compared to alternative water sources. Groundwater is very important because it is not influenced by draught and it can be accessed exactly where it is needed. Moreover it has perfect natural quality and based on natural conditions it is secured against contamination. Furthermore no prior treatment is needed and accessing groundwater is cheap. However, basic problem in this issue is lack of finance, which limits development of technologies needed for accessing groundwater and slows down progress towards achieving universal coverage with water system. (MacDonald, 2009)

5. Conclusion

Insufficient access to water as well as consumption of water of poor quality and quantity contributes to considerable number of deaths among the worlds poorest population. Water scarcity in sub-Saharan Africa is both cause and effect of poverty and without eradication of poverty and sustainable development, assuring access to water is impossible in majority of developing countries. Sub-Saharan Africa is trapped in a water poverty cycle and is unable to escape, since inadequate access to water slows down development as well. Insufficient access to water is caused by financial and institutional capacity, lack of infrastructure, poor and inefficient management practices, corruption and it results from political process, actions of the government and policies designed by corrupted officials who favor the rich and disadvantage the poor. As a result of poverty the region, water taxes and charges are too low, thus it is hard to cover operation and management costs of water projects.

Furthermore, problem regarding to privatization of water sector was discussed within the thesis and water financing was analyzed. Moreover, current pricing system was criticized and it was explained how low tariffs and inappropriate subsidies harm the poor and contribute to water scarcity.

Economic analysis has proved the hypothesis tested in this work and has shown that amount of renewable freshwater resources does not have impact on access to improved water source, where as corruption influences access to water. Regression analysis detected negative relationship between corruption and percentage of households connected to improved water source, i.e. the higher corruption the lower coverage with improved water source. In addition, based on results of regression analysis, there is negative relationship of GDP per capita on access to water among urban population, which refused initial assumption that the richer country is the more likely it will provide infrastructure to assure water coverage. Negative relationship could be explained due to relative decrease of proportion investment into urban water system. GDP growth can also have negative influence on a sector as other investments may become feasible that were not feasible before and hence funds for water system are shifted to another type of placement. Since water sector accounts just for insignificant portion of investment in sub-Saharan Africa,

government is indifferent to invest into water sector and for this reason finance is used elsewhere.

In order to improve the current situation, attention as well as investments of the local government needs to be attracted to water sector, water tariffs for those who are willing and able to pay needs to be increased, corruption from the water sector has to be mitigated and effectiveness of subsidies needs to be improved by means of targeting subsidies directly to the poor. Investment into water sector, as essential tool for efficiency improvement and enlarging network of water coverage, would contribute to GDP growth followed by poverty reduction gains in terms of social and economic benefit and reduced spending in the health sector. The solution lies in improving effectiveness of the current management practices, reducing wastewater and leakages, installation of metering system and reducing losses. Solutions which will access underground water, such as building wells or dams for water storage are impossible due to missing capital since sub-Saharan Africa belongs to one of the world's poorest regions. Thus, the only option for such a solution would be through injecting economy externally by means of help from international donors.

6. References

ABRAMS, Len. Poverty and water supply and sanitation services. Caterham, 1999. Regional Workshop on Financing Community Water Supply and Sanitation paper. Water Policy International. Available at WWW: <http://www.africanwater.org/poverty.htm>.

ADERINWALE Ayodele; AJAYI, Olumide A. Poverty and water : Explorations of the Reciprocal Relationship. 1st edition. New York : CROP, 2008. The link between poverty and water supply: the Nigerian example, s. 210. ISBN 9781842779613Hb.

AURIOL, Emmanuelle; BLANC, Aymeric. Capture and corruption in public utilities: The cases of water and electricity in Sub-Saharan Africa [online]. Paris : Corruption and Infrastructure Services , 2009. [cit. 2010-12-12]. 13 p. Scientific paper. Toulouse School of Economics. Available at WWW: <http://ideas.repec.org/a/eee/juipol/v17y2009i2p203-216.html>.

BARKER, Randolph; VAN KOPPEN, Barbara.; SHAH, Tushaar. 2000 A global perspective on Water Scarcity/ Poverty Achievements and Challenges for Water Resource Management. Colombo, Sri Lanka: International Water Management Institute (IWMI). ISBN 92-9090-410-0

BAYLISS, Kate . Water privatisation in Africa: lessons from three case studies [online]. Greenwich : University of Greenwich, 2001. [cit. 2010-11-22]. 12 s. Research paper. PSIRU. Available at WWW: <www.psiru.org/reports/2001-05-W-Africases.doc>.

CHENE, Marie. Good practice in adressing corruption in water resource projects [online]. U4 Helpdesk, 2009. [cit. 2010-11-22]. 10 s. U4 Expert Answers. Transparency International. Available at WWW: <http://www.u4.no/helpdesk/helpdesk/query.cfm?id=208>.

DINAR, Ariel; SUBRAMANIAN, Ashok. Water pricing experiences : An International Perspective. [online]. Washington, D.C., 1997. [cit. 2010-11-02]. 178 s. World Bank technical paper no 386.

DOĞAN, Cem. ÖCAL, Nilay.: ECONOMY OF WATER RESOURCES. [online]. 2007. [cit. 2010-09-22]. 16 p. Scientific paper. Mustafa Kemal Üniversitesi Tayfur Sökmen Kampüsü İktisadi ve İdari Bilimler Fakültesi. Available at WWW: <http://www.dsi.gov.tr/english/congress2007/chapter_2/29.pdf>.

DOVI, Efam. Renewal online [online]. New York : 2007 [cit. 2011-03-15]. Bringing water to Africa's poor. Available at WWW: <http://www.un.org/ecosocdev/geninfo/afrec/vol21no3/213-water.html>.

GLEICK , Peter H. . Dirty Water: Estimated Deaths from Water-Related Diseases 2000-2020 . [online]. 2002. 12 p. Report. Pacific Institute for Studies in Development, Environment, and Securit. Avaiable at WWW: <http://www.pacinst.org/reports/water_related_deaths/water_related_deaths_report.pdf>.

GÜNTHER, Isabel; FINK, Günther. Water, Sanitation and Children's Health : Evidence from 172 DHS Surveys. [online]. 2010. [cit. 2010-10-22]. 38 p. Policy research working paper. The World Bank. Available at WWW: <http://www-wds.worldbank.org/servlet/WDSContentServer/WDSP/IB/2010/04/19/000158349_20100419124219/Rendered/PDF/WPS5275.pdf>

HALL, David; LOBINA, Emanuele: Pipe dreams: the failure of the private sector to invest in water services in developing countries. [online]. 2006. [cit. 2010-11-22]. Discussion Paper. PSIRU; World Development Movement, London, UK. Available at WWW: < http://gala.gre.ac.uk/3601/>

HALL, David. Water finance : A discussion note [online]. London, UK : PSIRU, 2004. [cit. 2010-11-24]. 12 p. Research paper. University of Greenwich. Available at WWW: <www.psiru.org/reports/2004-01-W-finance.doc>.

IAN, Walker; ORDONEZ, Fidel; SERRANO, Pedro; HALPERN, Jonathan. Pricing, Subsidies and the Poor : Demand for Improved Water Services in Central America. [online]. Washington, D.C., 2000. 30 s. Policy research working paper. The World Bank. Available at WWW: <http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2000/12/15/000094946_00111805312992/Rendered/PDF/multi_page.pdf>.

KULINDWA, Kassim; LEIN, Haakon. Poverty and water : Explorations of the Reciprocal Relationship. 1st edition. New York : CROP, 2008. Water and poverty: the inextricable link, s. 210. ISBN 9781842779613Hb.

KULINDWA, Kassim. Poverty and water : Explorations of the Reciprocal Relationship. 1st edition. New York : CROP, 2008.Rural water supply projects appraisal and poverty eradication in Tanzania, s. 210. ISBN 9781842779613Hb.

MAC DONALD, Alan. Groundwater and Rural Water Supply in Africa. Burdound Groundwater network. [online]. 2009. [cit. 2010-11-24]. Available at WWW: www.iah.org/downloads/occpub/IAH_ruralwater.pdf

MANSOON, Maitah. Macroeconomics. Prague : Czech University of Life Sciences, Faculty of Economics and Management, 2009. 181 s. ISBN 978-80-213-1904-2.

MASCARENHAS, Adolfo. Poverty and water : Explorations of the Reciprocal Relationship. 1st edition. New York : CROP, 2008. Conclusion: water for the poor pays, s. 210. ISBN 9781842779613Hb.

MEHTA, Lyla . Water for the twenty-first century: challenges and misconceptions [online]. Institute of Development Studies, 2000. [cit. 2010-10-10]. 20 p. IDS Working Paper 111. Available at WWW: <https://entwicklungspolitik.uni-hohenheim.de/uploads/media/Water_for_the_Twenty-First_Century-ids-workingpaper_111_04.pdf>. ISBN 1858643023.

RICHARDS, Alan. Coping with Water Scarcity: The Govearnce Challenge [online].: Institute on Global Conflict and Cooperation, 2002. [cit. 2010-12-15]. 34 p. Policy Paper 54. Available at WWW: <http://escholarship.org/uc/item/8941v354#page-1>. ISSN 1088-2081.

ROBERT S., Pindyck; DANIEL L., Rubinfeld. Microeconomics. sixth edition. New Jersey : Pearson Education International, 2005. 716 p. ISBN 0-13-191207-0.

ROSEGRANT, Mark W. ; CAI, Ximing; CLINE, Sarah A. World Water and Food to 2025 : Dealing with Scarcity. Washington, D.C. International Water Management Institute, 2002. 322 p. ISBN 08-9629-646-6.

SCHULZ, Carl-Erik. Poverty and water : Explorations of the Reciprocal Relationship. 1st edition. New York : CROP, 2008.Water pricing, inequality and economic welfare: how can the new South African water policy support the well-being of the urban poor?, p. 210. ISBN 9781842779613Hb.

SHORDT, Kathleen, STRAVATO, Laureen; DIETVORST, Cor; . About Corruption and Transparency in the Water and Sanitation Sector [online]. Delft : International Water and Sanitation Centre, 2006. [cit. 2011-02-15]. 39 p. Thematic Overview Paper 16. Transparency International. Available at WWW: <http://www.irc.nl/page/31982>.

SINGLETARY, Loretta. Western Resource Issues : Education Series - No.7 [online]. Nevada : University of Nevada Reno, 2010. 4 p. Fact Sheet. University of Nevada Reno. Available at WWW: <http://www.unce.unr.edu/publications/files/ho/other/fs9810.pdf>.

SUMILA, Gulyani; TALUKDAR, Debabrata; KARIUKI, Mukami R. Water for the urban poor: water markets, household demand, and service preferences in Kenya [online]. Washington, D.C. : The World Bank, 2005. [cit. 2011-01-10]. 40 s. Water Supply and Sanitation Sector Board Discussion Paper Series. Available at WWW: <http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2005/04/13/000090341_20050413103808/Rendered/PDF/320290WSS1UrbanPoor.pdf>.

The relationship between water, agriculture, food security and poverty [online]. [cit. 2011-01-13]. Water at a Glance. Available at WWW: <http://www.fao.org/nr/water/docs/waterataglance.pdf>.

The United Nations World Water Development Report 3: Water in a Changing World. London : The United Nations Educational, Scientific and Cultural Organization, 2009. 318 p. ISBN 978-1-84407-839-4.

The World Bank [online]. 2011 [cit. 2011-03-20]. Renewable internal freshwater resources per capita (cubic meters) . Available at WWW: <http://data.worldbank.org/indicator/ER.H2O.INTR.PC>.

The World Bank [online]. 2011 [cit. 2011-03-20]. Improved water source, rural (% of rural population with access). Available at WWW: http://data.worldbank.org/indicator/SH.H2O.SAFE.RU.ZS>.

The World Bank [online]. 2011 [cit. 2011-03-20]. Improved water source, urban (% of urban population with access). Available at WWW: <http://data.worldbank.org/indicator/SH.H2O.SAFE.UR.ZS>.

The World Bank [online]. 2011 [cit. 2011-03-20]. GDP per capita (current US$): Available at WWW: <http://data.worldbank.org/indicator/NY.GDP.PCAP.CD>

Transparency International. Global Corruption Report 2008 : Corruption in the Water Sector. New York : Cambridge University Press, 2008. 398 p. ISBN 978-0-521-72795-2.

Transparency International [online]. 2010 [cit. 2011-03-18]. 2008 Corruption Perception Index. Available at WWW: <http://www.transparency.org/news_room/in_focus/2008/cpi2008/cpi_2008_table>.

Transparency International [online]. 2010 [cit. 2011-03-18]. CPI 2008 Table. Available at WWW: <http://www.transparency.org/news_room/in_focus/2008/cpi2008/cpi_2008_table>.

WATKIN, Kevin. Human development report 2006 : Beyond scarcity, power, poverty and the global water crises. New York : United Nations Development Program, 2006. 420 p. ISBN 0-230-50058-7.

Willing to pay but unwilling to charge : Does "willingness-to-pay" studies make a difference?. [online]. New Dehli, 2000. 8 p. scientific paper. Water and sanitation program. Available at WWW: <http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2002/05/14/000094946_02042604075127/Rendered/PDF/multi0page.pdf>.

7. Supplement

7.1. Data for sub-Saharan Africa, year 2008

Country	Improved water source, rural (% of population with access)	Improved water source, urban (% of population with access)	Improved water source, mean (% of population with access)	Renewable internal freshwater resources per capita	CPI	GDP per capita
Angola	38	60	49	8213	1,9	4671
Benin	69	84	76,5	1189	3,1	771
Botswana	90	99	94,5	1249	5,8	7050
Burkina Faso	72	95	83,5	821	3,5	528
Burundi	71	83	77	1246	1,9	145
Cameroon	51	92	71,5	14302	2,3	1243
Cape Verde	82	85	83,5	602	5,1	3071
Central A.R.	51	92	71,5	32494	2	458
Chad	44	67	55,5	1374	1,6	766
Comoros	97	91	94	1865	2,5	824
Congo,D.R..	28	80	54	14006	1,7	180
Congo, Rep.	34	95	64,5	61408	1,9	3261
Equatorial G.	42	45	43,5	39442	1,7	28103
Eritrea	57	74	65,5	568	2,6	336
Ethiopia	26	98	62	1512	2,6	321
Gabon	41	95	68	113247	3,1	10037
Gambia	86	96	91	1807	1,9	495
Ghana	74	90	82	1298	3,9	1222
Guinea	61	89	75	22984	1,6	384
Guinea-B.	51	83	67	10156	1,9	538
Kenya	52	83	67,5	534	2,1	775
Lesotho	81	97	89	2552	3,2	778
Liberia	51	79	65	52723	2,4	222
Madagascar	29	71	50	17634	3,4	495
Malawi	77	95	86	1087	2,8	288
Mali	44	81	62,5	4722	3,1	686
Mauritius	99	100	99,5	2168	5,5	7337
Mozambique	29	77	53	4481	2,6	441
Namibia	88	99	93,5	2892	4,5	4211
Niger	39	96	67,5	238	2,8	364
Nigeria	42	75	58,5	1462	2,7	1370
Rwanda	62	77	69,5	977	3	458
Sao Tome	88	89	88,5	13610	2,7	1084

Country	Improved water source, rural (% of population with access)	Improved water source, urban (% of population with access)	Improved water source, mean (% of population with access)	Renewable internal freshwater resources per capita	CPI	GDP per capita
Senegal	52	92	72	2113	3,4	1079
Sierra Leone	26	86	56	28778	1,9	352
Somalia	9	67	38	672	1	298
South Africa	78	99	88,5	918	4,9	5666
Swaziland	61	92	76,5	2261	3,6	2432
Tanzania	45	80	62,5	1977	3	503
Togo	41	87	64	1781	2,7	449
Uganda	64	91	77,5	1232	2,6	456
Zambia	46	87	66,5	6355	2,8	1165
Zimbabwe	72	99	85,5	984	1,8	313,9

Source: own processing based on World Bank and Transparency International data.