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Full Length Research Paper

A challenge of sustaining water supply and sanitation under growing population: A case of the Gezira State, Sudan

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The challenge of securing future water supply and sanitation services for an increasing population requires continued efforts to satisfy the future needs. This paper focuses on water availability and sanitation services under growing population taking Gezira State, Sudan, as the case. Future projection of the population was predicted based on the 2.2% growth rate. Data on water sources, quantities and sanitation was collected from Gezira State Water Corporation and various health and educational reports. The results calculated that the population is increasing by 14% from 2008 to 2014. Water stands are the main source of water in Gezira and yields 84% of the available water. The current consumption rates are 22.5 and 55 Liter per capita per day for rural and urban population, respectively. There is a gab in rural water supply and is expected to increase rapidly by 2025. Sanitation coverage in the state is 80% in schools and 88% in health facilities. The study recommended construction of new water sources to satisfy the rural consumption.

Key words: Water supply, sanitation, population growth, Gezira State, Sudan.

INTRODUCTION

Continued population growth, drought and economic development, together with the expansion of irrigation has resulted in greatly increased use and need for water resources. Consequently, added to the current decline trend of / capita availability from $5.3*10^3$ m^3 / year in 1970 to the expected $1.3*10^3$ m^3 / year in 2025 (SRFAC, 2001). Sudan must develop ways and means to cope with the increasing demand for water. It has been reported that access to water and sanitation is extremely low in rural areas in Sudan (USAID, 2009). Future access to water under pressure of the increasing population is considered a big challenge, because of the competition

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between different sectors. Increasing population and subsequent increase in food (plants and animals) need careful research to put the necessary arrangements for the near and the distant future, especially for future generations. Relationships between water and other development-related sectors such as population, energy, food, and environment, and the interactions among them require analysis, as they together will determine future food security and poverty reduction (Valipour, 2015).

Comparison between available water and future increase of population is necessary for policies formulation to ensure access to water. Any shortage of water will result in deterioration in public health, especially the spread of water associated diseases. Globally, the availability of water in both quantity and quality is highly pressurized by growing population, demographic changes, particularly urbanization, agricultural and industrial expansion following changes in consumption and production patterns. As a result, some regions are now in a low safe water availability situation. Progress report on drinking water and sanitation by UNICEF and WHO (2012) explained that over 780 million people are still without access to improved sources of drinking water and 2.5 billion lack improved sanitation. It has been estimated that by 2025, the share of the world's population living in regions subject to water stress will reach 35% (Cairncross, 2003a).

Adequate water supply and sanitation protected communities from water-borne diseases and, hence, directly contribute in poverty eradication. In low income regions, only one in two people is covered by improved sanitation. WHO/UNICEF (2010) reported that about 2.6 billion people or 39% of the world's population lack access to improved facilities for the disposal of human excreta.

The World Bank estimated that rural access to safe water is as low as 14%. More than one billion people still practice open defecation. About half the world's populations live in rural locations and are typically served by small community water supplies, which are vulnerable to breakdown and contamination (WHO, 2010). Paul et al. (2010) has justified the reasons for the limited progress towards universal access to an adequate water supply, by high population growth rates in developing countries, insufficient rates of capital investment, difficulties in appropriately developing local water resources, and the ineffectiveness of institutions mandated to manage water supplies. Gezira is one of the most densely populated regions in Sudan, because of location and availability of economic activities. This makes Gezira population grow by a rate more than the normal rate of 2.2%.

Studies in developing countries have shown wide variation in the impact of improved water supply and sanitation facilities on water related diseases (Aziz et al., 1990). In Gezira, more than 70% of populations in the villages are infected by water borne diseases mainly because of the use of the polluted irrigation canal water for their domestic water needs (Henri et al., 2002). In Gezira, irrigation practices are increasing. Increasing of irrigation systems have adverse impacts on soil and quality of water resources (Valipour, 2014). Inadequacies in water supply affect health adversely both directly and indirectly (Paul et al., 2010). Lack of access to water is the main factor of displacement because of insufficient amount of water resources to produce food for subsistence.

Shortage of water causes absence of basic sanitation associated with unhygienic practices. Lack of water directly influence education because no schooling especially for children involved in fetching remotely available water. Mortality among children below 5 years of age is expected because of diarrheas associated with contaminated and polluted water. Examining future water supply and sanitation under dramatic growing population is of a vital importance, particularly for rural people in low income countries.

METHODOLOGY

The Gezira State lies between the Blue Nile and the White Nile in the east-central region of the country. It lies between 13° 30´, and 15° 35´N and 32° 15´, and 34° E (Figure 1). Gezira has an area of 23.3 thousands km^2. The majority of the population depends on irrigated agriculture, animal husbandry and trade. Only fewer are urban population. The average rainfall in the region during the last 30 years is estimated between 250 to 300 mm per year. The mean monthly temperature is about 22°C in January and 34°C in May. Humidity is generally low (minimum in April and maximum in August). Humidity varies from 13% in the north to more than 60% in the southern part of the State.

Data collection and analysis

The data used in this paper was collected from the Gezira State Water Corporation (GWC) and other various sources as classified in Table 1. Water supply component includes improved and adequate domestic water supply for human consumption. The sanitation component includes improved and adequate sanitary facilities for households, schools and health facilities. Population data was collected from Sudan censuses of 2008 and 2010. Population projections from 2010 to 2025 were calculated by the authors based on the following population growth equation using 2.2 growth rate:

$$N = N_o e^{rt}$$

Where, N: final population; N_0: initial population; e: exponential; r: the rate of growth and t: time in year. The purpose of the following analysis is to demonstrate the impacts of an increase in population growth on water supply and sanitation and to highlight the efforts need to be exerted in water supply and sanitation sectors against static population growth. Population growth model was used to predict future population up to 2025 and then increasing population growth rate was determined (Figure 2). Available water was allotted against population to determine current and future per capita water consumption for both rural and urban population. Sanitation coverage in education and health facilities was estimated and compared with national and regional levels.

Figure 1. Gezira State location in Sudan.

Table 1. Data classification and sources.

Data type	Data package	Sources
Population in Gezira	Rural population Urban population Migrant population	Sudan population census (2008&2010) Gezira population statistical office
Population projection	Population growth $N = N_o e^{rt}$	Population growth equation
Water sources and quantities	Water stands Treatment plants Hand pumps Slow sand filters	Gezira Water Corporation data sets Gezira strategic plan NGOs (UNICEF, WHO, USAID) reports
Sanitation	Latrines in schools and health facilities	Gezira water corporation, UNICEF project Health and education reports NGOs (UNICEF, WHO, USAID) reports

RESULTS

Recent and projected population of the Gezira (2008-2025)

In 2008, the population was 3.57 million persons and expected to reach 5.2 million by 2025 based on the annual growth rate of 2.2% (Table 2). The majority (81%) of the State population are rural (3.3 million). Currently the population is increasing by 14% from 2008 to 2014 and expected to increase by 27% between 2008 to 2025.

Water availability and per capita consumption in Gezira

The results show that water stands constitute the main source of water for rural (88.4%) and urban (73%)

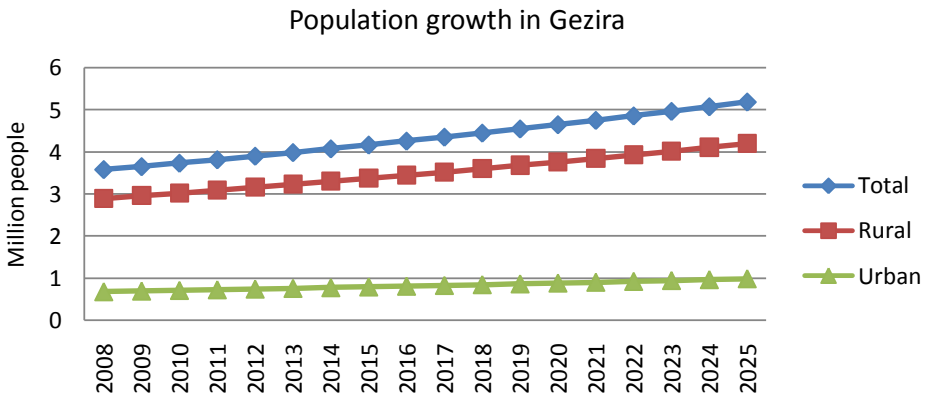

Figure 2. Gezira Urban and Rural Population for the period 2008 – 2025.

Table 2. Recent and projected percent population growth in the Gezira.

Year	Rural	Urban	Total
2008	2.90	0.68	3.58
2010	3.10	0.71	3.81
2012	3.20	0.75	3.95
2014	3.30	0.78	4.08
Growth (2014-2008)	0.40	0.1	0.5
Growth %	14	14	14
2014	3.30	0.78	4.08
2015	3.37	0.80	4.17
2020	3.77	0.88	4.65
2025	4.20	0.99	5.19
Growth (2025-2014)	0.90	0.21	1.11
Growth %	27	27	27

population (Table 3). Water stands yield 67.4 and 32.4 thousands m^3/day for rural and urban needs, respectively. The hand pumps were used only in rural areas where groundwater is scare. These pumps produce 3% of the total water production. The functioning slow sand filters exist in rural areas and produce 7% of the consumed water. The water purification plants produce the remaining 26.3% for urban areas Form Table 2, it is calculated that rural water supply consumption was estimated at 76.21 thousands m^3/day, making an average consumption rate of 22.5 L per capita per day. Water supply consumption for urban centers was estimated at 43.9 thousands m^3 per day, making an average consumption rate of 55 L per capita per day. The study estimated that the current gab in rural water supply is 92.5 m^3 per day. This gab is expected to increase to 112 m^3 per day and to 134 m^3 per day in 2020 and 2025, respectively (Figure 3).

Sanitation coverage in the Gezira

Sanitation coverage in the Gezira State has been improved from 32% in 1990s to 42% in 2010 (Figure 4). Compared to national scale, the Gezira State is faster in sanitation coverage. The results show increasing trend in sanitation coverage in the Gezira and Sudan compared to the decreasing trend in sanitation coverage in Africa. This result is in agreement with (Cairncross, 2003) who stated that Africa in sanitation coverage has actually decreased slightly during the last decade. Sanitation coverage in schools has increased from 60% in 2010 to 88% in 2014, with increasing rate of 7% (Figure 5). In heath facilities, sanitation coverage has increased from 39 to 79%, in four years, from 2010 to 2014 by 10% increasing rate. Still the coverage is insufficient to keep pace with population growth leaving a widening gap in the number of unsaved households.

DISCUSSION

The main water resources in the Gezira are the Blue Nile River, Eldinder and Elrahad rivers and their tributaries in addition to the rainfall and huge groundwater resources.

Table 3. Water availability in the Gezira.

Water source	Rural water availability			Urban water availability		
	Number	Production (m^3 per day)	% of total	Number	Production (m^3 per day)	% of total
Water stands	1835	67440	88.4	26	32353	73.6
Hand pumps	594	2376	3	0	0	0.00
Slow sand filters	111	5136	7	4	0	0.00
Water treatment plants	18	1296	1.7	4	11580	26.3
Total		76248	100		43933	100
Population (2015)		3376435			796644	
Liter per capita per day		22.5			55.1	

The average rainfall during the last 30 years is estimated within the range of 250 to 300 mm/year. Groundwater generally occurs in the Gezira Nubian and basement aquifers. Ahmed (2004) indicated that 90% of Gezira water supply from the Gezira aquifer, while about 10% is from Nubian sandstone aquifers. The groundwater is mainly recharged from the Blue Nile. Literature confirmed that groundwater quality recorded over the past indicates a good quality, except in some locations and pockets. Sudan is rich of water resources, however, greater multiple efforts are needed to make these resources available to use.

The results show that population in Gezira is expected to increase by 27% between 2008 to 2025. This indicates that the Gezira State will be one of the most densely populated states in the country. This is attributed to the availability of economic activities and natural resources, such as water resources and fertile soil, as well as health and education services. The State is characterized by an enabling and attractive environment, due to its strategic location and large scale agricultural schemes e.g. Gezira scheme (0.88 million hectare) and Rahad agricultural Corporation (0.35 million hectare).

The analysis indicates that, the gab in rural water supply in Gezira is far below what was stated by Pual et al. (2010) of at least 50 L per person per day is needed to ensure all personal hygiene, food hygiene domestic cleaning, and laundry needs. With continuing trend of population growth in the Gezira State, the gab in rural water supply will remain unacceptably high in 2025. According to these results, new water sources should be constructed to fulfill the future needs, particularly for rural community. The gab in water supply for rural people in the Gezira might lead to child mortality, diarrhoea, malaria and bilharzias, which are the most common diseases in the State. These diseases are also seriously creating socio-economic problems with adverse effects on agricultural output, school attendance etc. Some places in the State are currently facing shortage of safe water supply because of saline water like Managil region.

Public house connection and tap/stand-pipe are the main source of drinking water in urban and pre-urban areas, while protected wells are wildly used in rural areas and urban centers.

Hand pumps are very popular in areas where ground water is not enough, especially in basement complex areas in the West and East Gezira. Groundwater aquifers in these areas are not rich and communities depend mainly on surface water, which is liable to contamination. Slow sand filters are useful in improving surface water quality. Haffirs (are rectangular or semi-circular impoundments that store rainwater to be used by both human and livestock population during the dry season). Haffir is considered an important water source for livestock and, therefore, it is excluded in this Gezira case. Sustainability of these water sources in the Gezira is a problem as Paul et al. (2010) justified that it is relatively easy to increase coverage through construction of water supply systems, but it is much more difficult to ensure that such systems continue to provide service over the long-term.

In Sub-Saharan Africa (SSA) coverage is just 31%. Sanitation coverage in SSA has not kept pace with population increase, but has dropped from 60% in 1990, to 47% in 2000 (Waterkeyn and Cairncross, 2005).

The present study showed that there is a slight improvement in sanitation coverage in the Gezira State. It has been found that the per capita water rate for rural people in Gezira is around 20 L per day and this may cause poor sanitation.

Poor access to water and sanitation at the home, and at health facilities may be associated

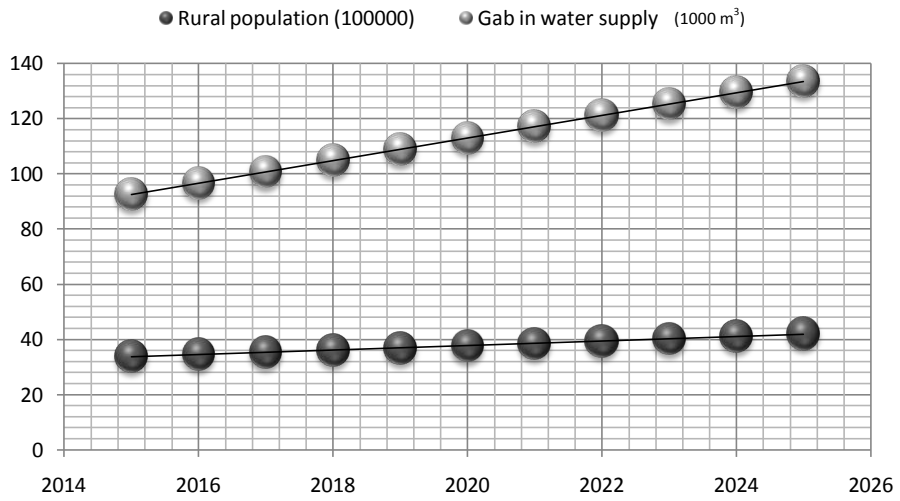

Figure 3. The gab in rural water supply.

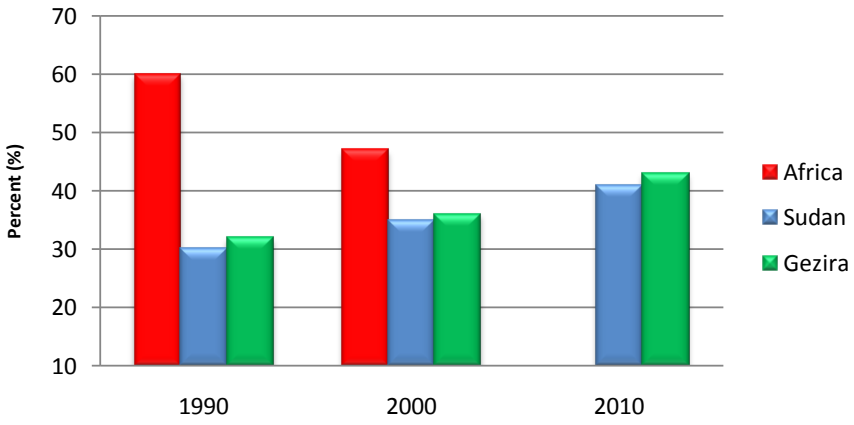

Figure 4. Change in sanitation coverage.

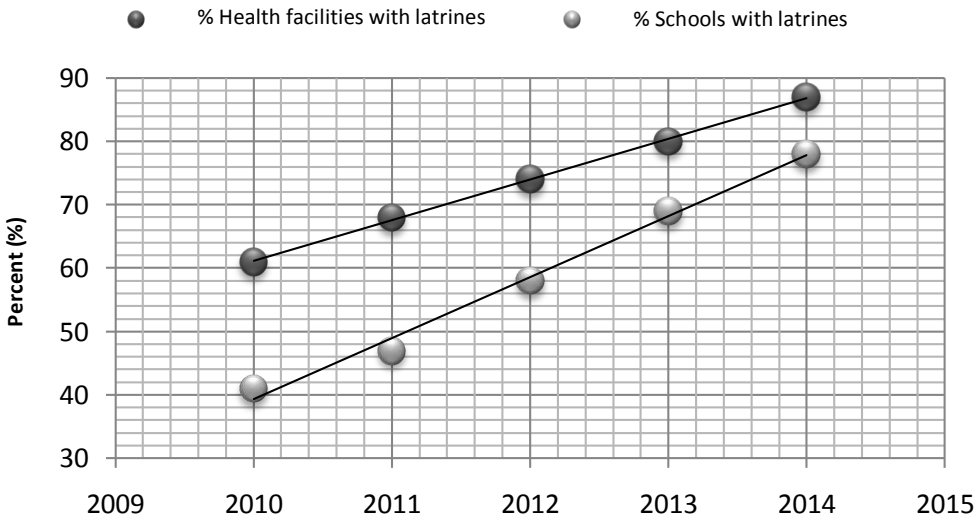

Figure 5. Primary schools and health facilities coverage.

with higher maternal mortality. It has been observed that there is an increasing number of latrines in the State. This may reduces environmental contamination and rate of disease transmission, however, Asaolu and Ofoezie (2003) stated that latrine facilities does not always imply they are used, and even where they are used, they might not be used properly. The state includes settlements around Gezira scheme canals where population from different places and ethnic groups come to work in farming at the scheme. Most of these inhabitants have neither latrines nor do they have access to safe water supply and their only source of drinking water is directly from the irrigation canals; while some of them had water hand pumps.

A slight improvement in sanitation coverage might be ascribed to the improvement of economic situation in general, which resulted from oil extraction before the secession of South Sudan. Moreover, in 2010, opportunities of gold exploration has just begun, which constituted a great wealth for rural people. These economic developments have resulted in rehabilitation and construction of houses, health and schools with good sanitation facilities. MDG target in water supply and sanitation might not have been met in Gezira, however, slight improvements have been achieved in the Gezira State.

Conclusion

Population growth is the key factor that influences water supply and sanitation. Growing population is increasingly creating gab in water supply and sanitation in both quantity and quality, particularly for rural people. Under dramatic increasing population, compared with stable or deteriorating water sources, access to water and sanitation will be decreasing with time. Associated water stress and health problems are highly expected, particularly among rural communities in the Gezira. Under scarce technical and financial resources in low income countries, development of water supply and sanitation services with a rate similar to increasing rate of population constitutes big challenge.

Conflict of Interest

The authors have not declared any conflict of interest.

REFERENCES

Ahmed MI (2004) A hydrological study of the area around the blue Nile between Kamilin and Wad Medani. M.Sc. thesis, department of civil engineering, Sudan University of Science and Technology, Khartoum, Sudan.

Asaolu SO, Ofoezie IE (2003). The role of health education and sanitation in the control of helminth infections. Acta Tropica 86:283/294.

Azizi K, Bilqis M, Hopue A, Hasan Kh, Patwary MY, Sharon RA, Huttl MM (1990). Reduction in diarrheal diseases in children in rural Bangladesh by environmental and behavioral modifications. Transactions of the Royal Society of Tropical Medicine and Hygiene 84:433-438.

Cairncross S (2003a). Sanitation in the Developing World: Current Status and Future Solutions. Int. J. Environ. Health Res. 13:S123 – S131

Cairncross S (2003b). Water supply and sanitation: Some misconceptions. Trop.Med. Int. Health 8(3):193-195

Henri S, Chevillard C, Mirgani A, Paris P, Gaudart J, Camilla C, Dessien H, Montero F, Elwali NM, Saeed OK, Magzoub M, Dessien AJ (2002). 'Cytokine regulation of /iportal fibrosis in humans infected with Schistosoma mansoni', The J. Immunol. 169(2):929-36.

Paul R, Alan M, Richard C (2010). Water supply and health. PLoS Medicine. 7(11).

UNICEF WHO (2012). Progress report on drinking water and sanitation. Available online http://www.unicef.org/media/files/JMPreport2012.pdf

USAID (2009). Sudan Water and Sanitation Profile. Available online http://www.usaid.gov/pdf.docs/PNADO924.pdf

Valipour M (2014) Drainage, water logging, and salinity. Arch. Agron. Soil Sci. 60(12):1625-1640.

Valipour M (2015) Assessment of Important Factors for Water Resources Management in European Agriculture. J. Water Resour.and Hydraulic Eng. 4 (2):171-180.

Waterkeyn J, Cairncross S (2005). Creating demand for sanitation and hygiene through Community Health Clubs: A cost-effective intervention in two districts in Zimbabwe. Social Science & Medicine 61:1958-1970.

WHO (2010). Small and safe: Investing in small community water supplies will reduce waterborne disease outbreaks and overall costs. World water day 2010. Available online at http://www.who.int/water_sanitation_health/WHS_WWD2010_small_systems_2010_4_en.pdf

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