환경영향평가 Vol. 24, No. 1(2015) pp.78~86 J. Environ. Impact Assess. 24(1), 78~86, 2015 ISSN 1225-7184
http://dx.doi.org/10.14249/eia.2015.24.1.78

Research Paper

Current and Future Water Demand in Communes Surrounding Kibira National Park in Burundi

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아프리카 부룬디의 Kibira 국립공원 인근 지역의 물수요 예측

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요 약 : 물은 지구상의 생물들이 살아가는데 매우 중요한 역할을 담당한다. 심각한 물 부족 현상이 가난한 지역에 사는 사람들 특히 전세계에서 가장 가난한 아프리카의 시골지역에서 사는 사람들에게 더 큰 문제라는 것을 주목할 필요가 있다. 브룬디는 바로 그런 위험 군에 속하는 나라이다. 본 연구는 아프리카 브룬디의 Kibira 국립공원 인근 7개 지역의 현재와 미래의 물 수요를 예측하였다. 잠재적인 물 수요 군을 일반가정, 가축, 농업부문 및 산업부문으로 나누어 물 수요를 예측하였는데, 이들 지역의 물 수요는 지속적으로 증가할 것으로 예측되었다. 농업생산에 필요한 물의 양은 2020년에는 연간 288,779,060m^3, 2050년에는 연간 306,018,348m^3로 증가하면서, Kibira 국립공원 인근 지역의 경우 농업부분에서 물 수요가 가장 큰 비중을 차지할 것으로 보인다. 하지만 차 재배가 주 산업인 Muruta와 Bukeye의 경우 2050년 차 산업과 관련된 물 수요가 가장 많은 것으로 나타났다. 따라서 이용 가능한 수자원의 양이 Kibira국립공원 주변 지역의 발전에 가장 큰 영향을 미치는 변수가 될 것으로 보인다. 현재의 수자원 규모는 이들 7개 지역의 미래 물 수요를 충족할 수 없는 것으로 판단되며, 수자원 확보를 위한 필요한 대책을 강구하여야 한다.

주요어 : 물 수요, 예측, 부룬디, 농업생산, 차 산업

Abstract : Water plays the fundamental role in sustaining the living system. Water scarcity is mostly experienced dramatically by people living in poverty, most of them in rural areas and often in the poorest countries. Burundi has been identified as one of those countries. This study aimed to analyze and estimate the current and future water demands in the seven communes surrounding Kibira National Park (KNP) in Burundi. Sectors such as households, livestock, agricultural production and industry as the key water users in the study area were considered. The results showed an alarming increase in future water demand. Water demand by food crops increased to 288,779,060 m^3/yr in 2020 and 306,018,348 m^3/yr in 2050. Agricultural sector will be demanding the major available water in the

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Received : 21 October, 2014. Revised : 30 January, 2015. Accepted : 6 February, 2015.

seven communes surrounding Kibira National Park except Muruta and Bukeye which showed that water demand for tea industry was the highest in 2050. The water resources could be the greatest challenges for the overall development of the communities surrounding Kibira National Park. The current water resources may not be enough and therefore may not be able to meet the needs of those seven communities around KNP.

Keywords : Water demand projection, Burundi, Agricultural Production, Tea industry

I. Introduction

Water is the most important natural resource, without which life cannot exist. Water affects the environmental quality, human life, and food and industrial production. In this respect, the United Nations has declared water as the very basic need and right for all human beings (USDA, 2006). Water stress can be qualitatively defined as the lack of sufficient fresh water for domestic, livestock, agricultural, and/or industrial needs (Alcamo and Henrichs, 2002). Water stress may result from overuse of water supplies due to population increase, industrialization, and/or lack of conservation practices, as well as from decreased rainfall due to changes in climate (UNDP, 2012). In sub-Saharan African countries, the demand for water resources is increasing. Rising water demand is mostly caused by climate change, rapid population growth, increases in economic and industrial growth rates (UNDP, 2012). Since water supply has not kept pace with water demand, present water resources have been over-utilized leading to water stress. Efficient water resource management is, therefore, an urgent issue to be addressed. Considering competing water demand by different stakeholders over the limited water supply, the availability of accurate information and knowledge on current and future water demand is a very important element in managing water resources efficiently. Like in other sub-Sahara African countries, Brundi needs better information and knowledge on current status of water resources and projections on future water demand to meet the challenges ahead that will be caused by increasing water demand as well as changing climate. Because of the fundamental role of water in sustaining life, humans also compete with other species in ecosystems for water, complicating water management issues further (Kashaigili *et al*., 2009). Among several protected areas in Burundi, Kibira National Park (KNP) and its seven surrounding administration communes were selected for this study because KNP is of considerable importance for both ecological and socio-economic aspects. KNP has the only montane rainforest in Burundi, with about 16% of the park consisting of primary montane rainforest (Nzigidahera, 2009). KNP and the surrounding local communities have their own ecological and socioeconomic characteristics to be taken into account in establishing and implementing efficient management policies of valuable water resource. Even though there have been several studies to project water demand at a national scale, no analysis of water consumption and projections of water demand have been done for the KNP area.

This study seeks to analyze and provide information and knowledge on current and future water demand by different sectors in the seven communes surrounding KNP in Burundi. Those communities have identified water as one of the limiting factors for their economic growth and livelihood. Therefore, obtaining more knowledge and information on current and future water demand would help them better manage their water

resources.

II. Materials and Methods

1. Study area

The set up for this study was developed within seven communes of four provinces surrounding KNP in Burundi (Fig. 1). KNP is of critical importance due to its location at the summit of the Congo-Nile Divide and impact on these watersheds. It stretches across northwestern Burundi, joining with the Nyungwe Forest Reserve across the border in Rwanda. The area is a typical rural society in Burundi, with high population density. Table 1 shows the demographic features of the communes surrounding KNP.

2. Data collection and estimation of water demand projection

Households, livestock, agricultural production and industry were chosen as the key water users in the study. Households use big amount of water in

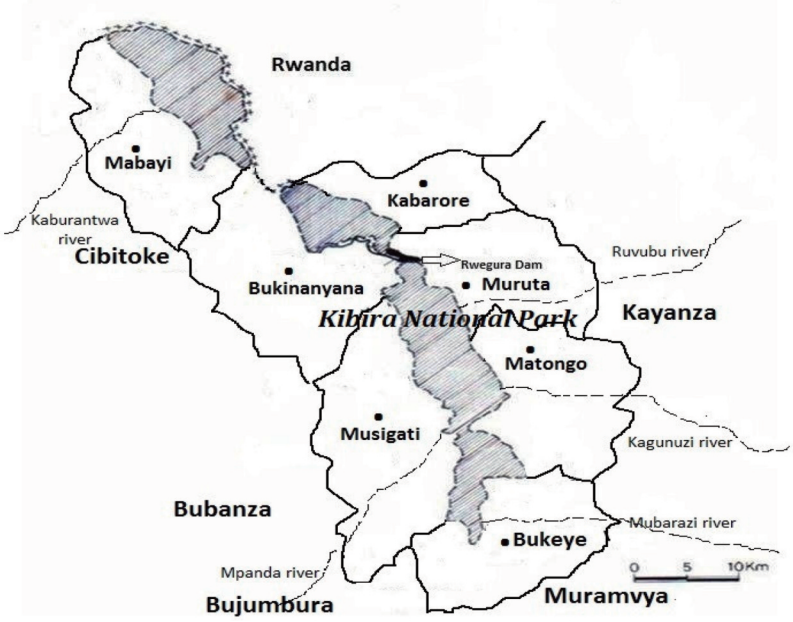


Fig. 1. Map showing Kibira national park and surrounding seven communes in Burundi.

Table 1. Population, area and density in the study area (MPD, 2006)

Provinces	Communes	Population (No.)	Area (km^2)	Density (No./km^2)	Population growth rate during 2020-2050(%)
Muramvya	Bukeye	63,235	184	347	1.31
Bubanza	Musigati	91,712	293.82	312	3.31
Kayanza	Matongo	63,208	167.80	377	1.19
	Muruta	51,234	147.08	348	1.19
	Kabarore	50,365	200.12	273	3.39
Cibitoke	Bukinanyana	82,661	344.60	231	3.96
	Mabayi	69,634	347.54	200	3.96
	Total	472,049	1684.96	280	

their daily activities and there are several large scale of agricultural farmers who are mainly producing for the Burundi and regional market and who are using large amounts of water (FAO, 2007). Besides, livestock is a very important asset for the rural population, and it necessitates much of water for healthy livestock domestication in the region. In addition to that, there is a growing tea industry in the area with extending tea plantations which have increasing water needs.

Data about household, agriculture, livestock and industry in 2005 were collected and used to project changes in population, livestock, agricultural and tea production. The population growth rate in each commune was estimated based on the population projection of 2003-2010 (MININTER, 2006). The water demand in household sector was estimated using population in communes and 20 L of daily water required for the entire household activities (FAO, 2005). The 2.9% of livestock growth rate in Burundi was suggested by FAO (2009). Drinking water requirements for livestock suggested by Aqualinc (2007) were used for water demand by livestock. Daily water demand for beef cattle (cow), sheep (ewes), goat (dry and burrowing goat), pig (dry pig), and poultry (100 birds) were 30, 3, 35, 10, and 30 L/day, respectively. The growth rate (0.198%) of food crops grown in the study area was estimated based on the 2003-2010 agricultural production (MININTER, 2006). To estimate the current and future water demand for agricultural production in the study area, average water required to produce 1 kg of crops suggested by Schlink *et al*. (2010) was applied. Those are 790, 2860, 710, 287, 287 L/kg for banana, bean, maze, sweet potato and potato, respectively.

Regarding tea complex factories located in Bukeye, Muruta and Mabayi communes, the total amount of water demand by tea industry was calculated using tea plantation area and water amount required for tea plantation (9,170 m^3/year) suggested by Chapagain and Hoekstra (2007). The tea industry in the study area was assumed to grow at a rate of 0.9%/yr that was suggested for black tea industry in the East Africa (FAO, 2008) was used to estimate water demand by the tea industry.

III. Results and Discussion

1. Current water use in seven communes surrounding KNP

Fig. 2 shows the results of water demand by households in the seven communes of the study area. The total of 3,445,958 m^3/year of water are required by households living around KNP. Musigati and Bukinanyana used 19% and 18% of total water and regarded as the communes demanding more water. This may be due to the fact that they have the biggest area and therefore contain the highest number of population.

Fig. 3(a) gives the total amount of water demanded by the livestock sector. Matongo was the most water demanding commune in the study area. 849,996 m^3/year are shown as the total amount of current

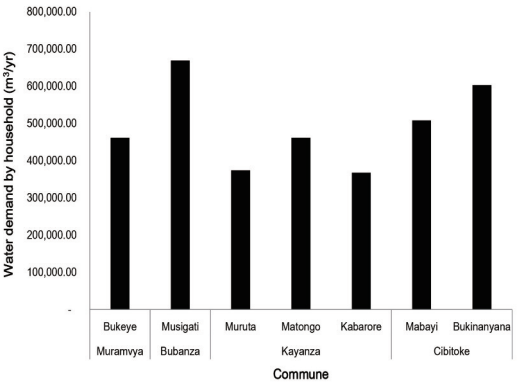
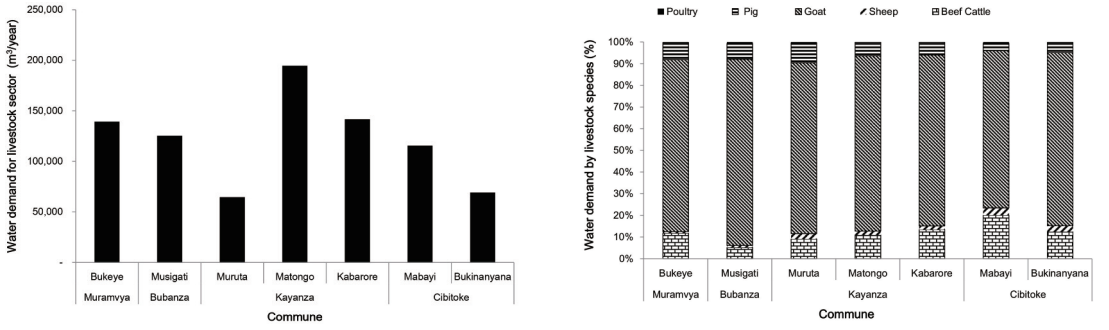
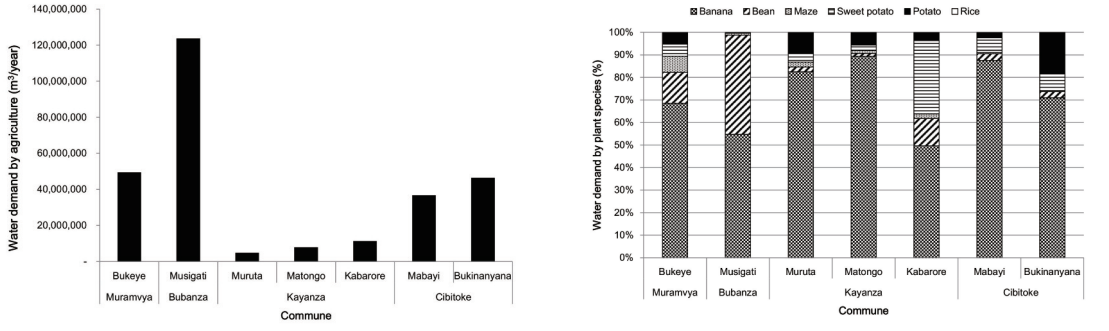


Fig. 2. Current water demand by households in the study area (2005)



(a) (b)

Fig. 3. Current water demand in seven communes surrounding KNP (a) total water demand by livestock, and (b) % water demand by livestock species.



(a) (b)

Fig. 4. Current water demand in seven communes surrounding KNP (a) total water demand by agriculture production, and (b) % water demand by plant species.

water demanded by the livestock at the current state of affairs. Fig. 3(b) shows the animal species in each commune which are likely demanding much more water than others. The results show that the goats are the ones demanding the highest overall amount of current water.

Fig. 4 shows total water demand in agricultural sector and percentage of water demand by the food crops in the region. Banana and beans in the commune of Musigati demanding the highest amount of water than other crops from the other communes. 284,951,383 m^3/year are shown as the total current water demand by the current agricultural production in the seven communes surrounding KNP.

Tea complex factories are located in Bukeye, Muruta and Mabayi communes and only three among the seven communes are growing tea plantations. The results show that 46,125,100 m^3/year are the amounts of water used by tea industry. The largest amount of water (46%) used in Muruta for tea industry among three communes (Fig. 5).

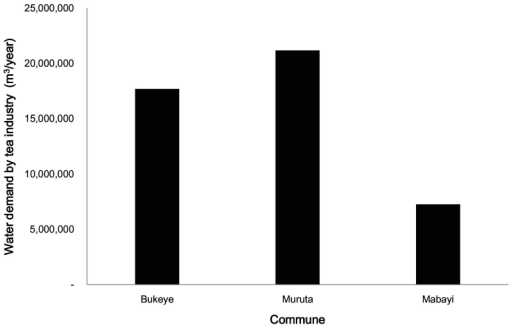
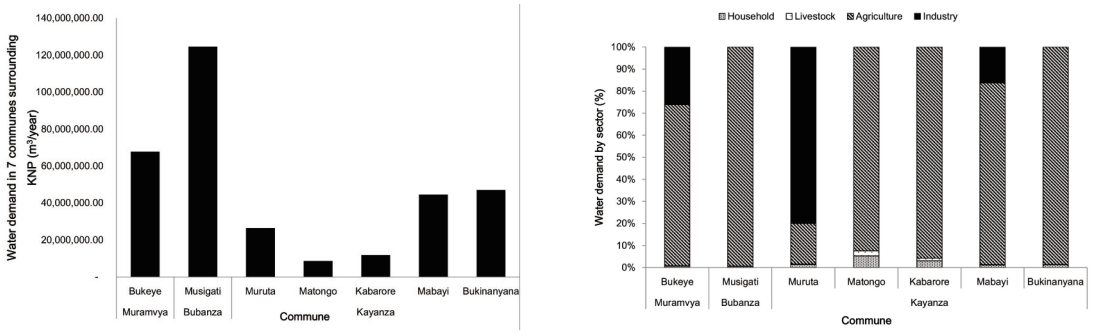


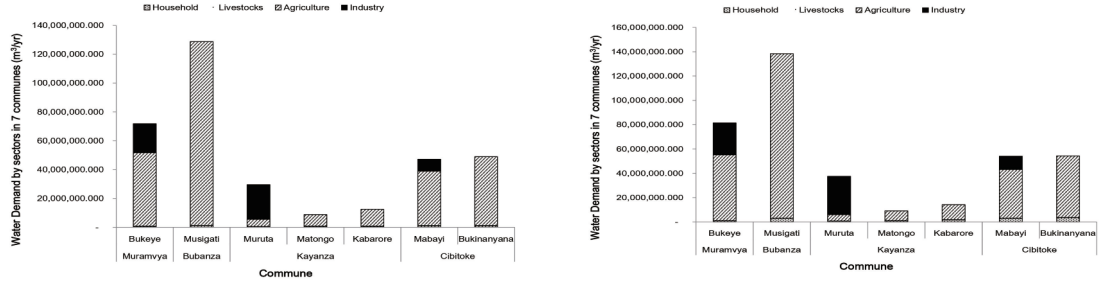
Fig. 5. Current water demand by tea industry in the study area.

Fig. 6 shows the results of the overall current water demand by the households, livestock, agricultural



(a) (b)

Fig. 6. Current water demand in seven communes surrounding KNP (a) overall water demand in seven communes, and (b) % water demand by sector.



(a) (b)

Fig. 7. Future water demand in seven communes surrounding KNP (a) 2020, and (b) 2050.

production and tea Industry in seven communes surrounding KNP. Musigati was the most water demanding commune with the agricultural sector leading its water consumption. Water demand for industry was the highest in Muruta.

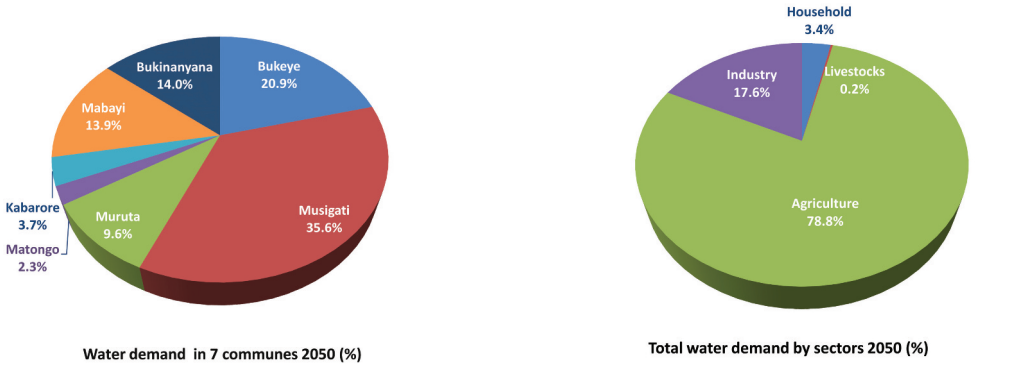
2. Future water demand in seven communes surrounding KNP (2020 and 2050)

Water demand in the KNP area was projected to grow from 330,956,976 m^3/yr in 2005 to 347, 523, 771 m3/yr in 2020, a 5% in crease, due to increases in population, number of livestock, and agricultural and industrial production (Fig. 7a). In 2050, water demand was expected to grow to 388,570,848 m^3/yr, a 17.4% increase compared to that in 2005 (Fig. 7b).

Two communes such as Musigati and Bukeye will use 56% of water that was demanded in the study area (Fig. 8a). The overall future water demand shows the agricultural sector will be demanding the major available water in the seven communes surrounding KNP. Water demand by food crops increased to 288,779,060 m^3/year in 2020 and 306,018,348 m^3/year in 2050. That means 78.8% of water will be used for agricultural production (Fig. 8b)

The results also show an increase of water demand in tea industry of about 52,289,399 in 2020 and 68,414,575 m^3/year in 2050. Muruta and Bukeye were the tea growing communes demanding more future water resources (Figs. 7 and 8a). The results from the livestock projection of the future water demand pins up Matongo and Musigati as two communes demanding more future water resources.

Results of this study suggests that the water resources could act as one of the limiting factors for the overall development of the communities surrounding KNP. The current water resources may



(a) (b)

Fig. 8. Future water demand in 2050 (a) % water demand by communes, and (b) % water demand by sectors.

not be enough to meet the future needs of those seven communities around KNP. According to studies conducted on KNP, the rise of temperature is expected to cause an increase in evaporation and evapotranspiration. Increase in precipitation may cause erosion on the hills and floods in low lands. On the agricultural level, rainy erosion might cause arable land losses due to floods, especially for the period of long rainy seasons (MLMTE, 2007). Changes in climate may exacerbate the possible water shortage that will be caused by increase in water demand projected in this study. Results of this study may provide essential information and data for the local communities in the KNP area to organize their resources to better manage life-sustaining water resources.

IV. Conclusions

The current and future water demand in the seven communes surrounding KNP in Burundi was investigated. Sectors such as households, livestock, agricultural production and industry as the key water users in the study area were considered. The results showed an alarming increase in future water demand. For the rural areas such as the seven communes surrounding KNP, the need for water is very much felt, especially when it comes to food crop production and livestock domestication. Human health issues are always linked to water usage. Livestock are valued assets for the rural and poor communities. Marketing of livestock products is a practical and effective pathway out of poverty (Lucas, 2010). The industry, especially specializing in agricultural manufacturing system is also a huge asset for the rural and low income people within the study area. However, some measures to select the priorities in the way towards efficiently managing the water resources should be put into place. The study showed that the livestock sector is the one demanding very less amount of water for the domesticated animal species to produce healthily. Results of this study indicates that the communities around KNP need to improve and upgrade the domestication of animal species and livestock production in general. In the agricultural sector which obviously takes most of the current and future available water, as it keeps booming, most efficient practice may be to decrease irrigation of feeds grown in the areas where rainfall is too low to avoid freshwater depletion, at least during certain periods of the year. The results from this paper may help the seven communes surrounding KNP to know the water challenges ahead of them. Water demands

change over time, reflecting changes in population, livestock, agriculture, industry and all economic structure. Because water demand for livestock and agriculture could depend on population growth, the control of population growth in the region could be an important strategy for future water management. Changes in demand can easily put new stress on water systems as the quantity, quality and location of water use change. Consequently, the key to effective management of water resources in water systems is the ability to allocate and reallocate water to accommodate changing demands and priorities.

In terms of policy implications and recommendation, it is evident that improving the adequacy and quality of water supplies should be a priority for rural development in Burundi. So far, the strategies of governments and international donors for tackling the problem have been supply-driven; but the fundamental importance of demand in the selection of appropriate policies has actually been virtually ignored. Based on our findings on the implications of current and future water demand for KNP and the surrounding communities, Burundi must take sufficient measures across different sectors to prevent or minimize the impacts:

- Develop and build human capacities for better management of natural resources and parks in studied area.
- Careful environmental impact assessment (EIA) has to be applied considering water resource conservation and management.
- Implement the National plan of integrated water resource management by taking into account issues related to current and future water demand especially in rural areas.
- Develop capacities and increase agricultural and livestock production by maximizing the water availability in the region. It takes a lot of water to grow food and care for animals.
- Be aware that access to quality as well as quantity water is keys to economic prosperity and better living standards especially those living in remote places. Lack of water means no economic activities will happen and the people will be in constant poverty.
- Operate a lawful and institutional reform in management of risks due to future water challenges. In this perspective, Burundi protects the people's health as the deal with water.

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