

Assessment of Post Expansion Impacts of Maruba Dam in Machakos County; A Case Study of Miwani Estate in Machakos Town

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Abstract: Many small and medium dams have been constructed in Machakos County by various agencies. The objective of this study was to determine the economic, environmental and social impacts within Miwani estate in Machakos town, which resulted from the expansion of Maruba dam. Data was collected using; semi structured household survey questionnaires, key informant interview guides, focus group discussion guides, physical observations and desk review of secondary data. The findings show that 100% and 98% of the respondents agreed that there was an upsurge in construction of new rental houses and rejuvenation of businesses after the expansion of Maruba dam which point to positive economic impacts. 93% of the respondents were positive that the environment relating to trees and flowers improved. However, they were uncomfortable with wastewater and solid waste disposal. The estate is not sewered and therefore onsite technology of wastewater disposal is practiced. 100% of the respondents agreed that the expansion of the dam enhanced access to clean and reliable water. Establishment of recreation facilities has also contributed positively to the social aspects.

The study also looked at the economic impacts to the Water Service Provider. Water coverage increased from 20% before the expansion of the dam to approximately 70% after the dam's expansion. The revenue collection rose from an average of Kshs 101,231 per month before expansion of the dam to an average of Kshs 859,393 after the expansion.

Keywords: Maruba dam, Assessment, Economic, Environmental and Social impacts

1. INTRODUCTION

1.1 Background

Throughout history and the world over, man has been dependent on adequate water supply for his food security, socio economic development and general wellbeing. Water is a universal need and is considered the principle limiting factor for human life. Likewise, the general ecosystem is also dependent on adequate water supply for its survival. Of the total earth's surface, seventy percent is covered by water, where only one percent of this can be utilized as a source of potable water [1]. Sources of potable water in the world include rivers, springs, lakes, dams, boreholes, wells among others [2].

Lack of adequate basic infrastructure is a major challenge facing the urbanization process in Africa. Actualizing the dream of water for all is one of the hindrances for urban water and sanitation managers in the 21st century. It is predicted that in the next 30 years in Africa, most urban growth will take place in the fast growing small towns. Another challenge facing the emerging urban areas is lack of mature infrastructure and governance structures. Similarly, such areas are devoid of urban planning. These factors may post real opportunities to implement innovative solutions based on the principles of integrated urban water management (IUWM) [7].

A complex set of social and technical factors is posing a challenge to the actualization of IUWM strategies in Africa. In addition to the above, there are a myriad of other factors that include; stringent regulatory framework, institutional fragmentation, lack of suitable financial and economic models which are required so as to provide a platform of incentives for efficient and safe reuse. Many of the IUWM projects in Africa are of uncertain suitability and mainly are at piloting stage [7].

In Kenya, the arid and semi-arid land (ASAL) covers about 80% of the total land. Immigration of people from the high potential areas to the ASAL areas has resulted to a rapid increase in population in such areas. Machakos County is one of the areas affected by such immigration. Immense pressure has been exerted on the limited natural resources including the few surface water sources available. The growth in domestic and industrial water demand, has put immense pressure on the capacity of water schemes to supply the commodity in the required quality and quantity. Management of the resulting volumes of effluents and associated sludge is also wanting. The changing urban landscapes such as pavements and roofs are impacting on the environment by reducing natural infiltration, resulting to inadequate percolation and rapid peak runoff flows [7].

Water is a right to every Kenyan citizen according to the Constitution of Kenya [5]. Through the enactment of the Water Act, 2002, enhanced access to water has been realized across the country. Despite the positive development, millions of Kenyan citizens have no access to safe water or are forced to walk for long distances in search of the valuable commodity.

In response to water needs, the Kenya government and other agencies including Non-Governmental Organizations (NGOs) have engaged in construction of water harvesting structures (dams) to increase water availability. The main objective of the projects is to avail the resource within minimum distances of travel and in reliable quantities. Expansion of Maruba dam which is the major source of water for Machakos town is one of the projects implemented by the government in its effort to address the water shortage.

Water reservoirs have the potential to impact positively or negatively on the people and the surrounding environment. Each of the two categories of impacts can further be broken into three major items. These are; economic, environmental and social impacts.

1.2 Problem Statement

National Water Harvesting and Storage Authority (NWHSA) formerly National Water Conservation and Pipeline Corporation (NWPC), constructed over 200 dams, according to end of financial year 2014-2015 projects report by NWPC [10], over a period of ten years from 2005 to 2015 in Machakos County. The Authority has not been able to come up with a study on the post construction or post expansion impacts of these dams and others that it has been implementing throughout the country. Some of the projects have had enormous positive and negative impacts to the environment and the beneficiaries, which have not been documented. There was therefore need to assess the post construction or post expansion impacts of the implemented dams which would offer a platform for any appropriate measure that may be required. Similarly, there was also need to establish whether the recommendations in the Environmental Management Plan (EMP) are being adhered to.

In order to carry out a thorough study, Maruba dam which is the main source of water for Machakos town and its environs was purposively selected for the study. The dam was constructed in the late 1950s during colonial times and was rehabilitated and expanded by NWHSA during the period 2008 to 2010.

1.3 Objectives of the Study

The overall objective of this study was to assess the post expansion impacts of Maruba dam, within Miwani estate and its environs in Machakos town. The specific objectives were to determine the economic, environmental and social impacts, within Miwani estate and its environs that resulted due to the expansion of Maruba dam. The economic impacts to the local water service provider, were also part of the study.

2. MATERIALS AND METHODS

2.1 Scope of the Study

The scope of the study was limited to Miwani estate and its environs in Machakos town. The research was limited to the residents who depend on the water supply from Machakos Water and Sewerage Company (MAWASCO). The estate was purposefully selected because it used to suffer from acute water shortage before the expansion of the dam and that it also forms part of the catchment of Maruba dam. Water coverage in the estate was approximately 20% and water rationing was the order of the day before the expansion of the dam [11]. Currently, the water coverage in the estate is approximately 70% [9].

The parameters that the study explored in the estate are; economic, social and environmental impacts which emanated in the estate and environs as a result of expansion of Maruba dam. These impacts are deemed to be as a result of both internal and external factors. The internal factors are considered as those that resulted from the intensified activities by the initial residents of the estate. The external factors are considered as the activities by the influx of the new population, whose activities loaded into the already existing ones.

Availability of clean water catalysed the existing population hence some of the activities that require adequate water to operate were bound to be revived and new activities sprang up. The activities like hotel businesses, tree/flower nurseries, kitchen gardens, car washes, tyre repairs, ease of construction among others were revived due to enhanced water availability. Similarly, enhanced water availability led to the springing up of small scale industries, garages and other commercial activities. The enhanced and the new activities produced by-products, some of which pose a challenge to the environment. These include; increased waste water, solid wastes, oils and smoke among others. Enhanced water availability also caused migration of people into the estate due to the perceived new opportunities within Machakos town and in the estate. The new entrants in the estate required additional housing, transport and other social amenities. Some people established businesses whose supplies come from outside the estate. This resulted into activities that have an impact on the economic, environmental and social aspects.

2.2 Data Collection Techniques

Data was collected using; semi structured household survey questionnaires, Key informant interview guides, Focus group discussion guides, physical observations, Camera and desk review of secondary data.

The semi structured questionnaires were administered randomly to the residents of Miwani estate by research assistants, through the support of some staff from the Water Service Provider who man water infrastructure within the estate. Focus group discussion guides were administered to the top management of the Water Service Provider by the researcher. The Key informant interview guide was also administered to the water vendors and the area local administration by the researcher.

The institutions that were cited in the Environmental Management Plan to take lead in monitoring respective parameters were visited for confirmation whether the same has been happening. These institutions are; NWCPC, National Environment Management Authority (NEMA), Tanathi Water Services Board (Tanathi WSB) and Water Resources Authority (WRA).

2.3 Sample Selection

Purposive sampling was used which enabled the researcher to interview respondents that had the right information in relation to the objectives of the study. The people interviewed were adults who are beneficiaries of the water from the Water Service Provider and who were living in the area prior to the expansion of the dam.

The target population was estimated at 10,000 persons. This is the number of people estimated to be benefiting directly within Miwani estate and environs from the water provided by the Water Service Provider. The residents of this estate are supplied with water from Maruba dam and their activities have a bearing on the objectives of the study. Cochran [3] formula was used to obtain the sample size needed for the field data collection as shown below.

$$n = \frac{p \cdot q \cdot z^2}{d^2} \quad (1)$$

Where n = desired sample size

p = Expected proportion in population estimated to have the characteristics being measured

z = standard normal deviate at the required confidence level

q = 1 - p

d = the level of precision or accuracy set

In this case the level of accuracy will be set at 0.05, p as 50% and z as 1.96

Applying the above formula, the sample size was thus calculated to be 385. In this study, 397 persons were interviewed. The additional people interviewed are; five staff of Machakos Water and Sewerage Company who man the estate, one area administrator, two water vendors, the officer responsible for following up on EMP from NEMA, the heads of environment in NWCPC, Tanathi WSB and WRA Machakos regional office.

2.4 Data Analysis

Data collected was scrutinized and relevant information to the research was identified. Coding was done for ease of analysis and for purposes of ensuring accuracy. Sorting of data into categories and examination of each, was then done in relation to the set objectives. Microsoft Excel software was employed during the data analysis. Microsoft Office Word 2010 was used in compiling the report. A summary report was then developed.

3. RESULTS AND DISCUSSIONS

3.1 Water Sources

All the respondents interviewed depend on water from the Machakos Water and Sewerage Company (MAWASCO). This is the local Water Service Provider charged with supply and management of water and sewerage services in Machakos town and its environs. The Company does not have any other source of water for Miwani and its environs apart from Maruba dam. However, there is a borehole that was supplying water to the former office of Machakos County Governor, which MAWASCO is pursuing with the county government so that it can be used to supplement supply of water from the dam.

3.2 Economic Impacts

3.2.1 Economic benefits

Water is one of the development enablers across the world over. It is considered as the principle limiting factor for life and the ecosystem. As stated earlier, the primary objective of expanding Maruba dam was to increase water storage in the dam and to increase water coverage within Machakos town and its environs. However, the improved water supply brought about complex direct and indirect secondary impacts that affected the economic activities in Miwani and its environs [6]. Figure 1 shows the views of the respondents on some of the economic benefits that resulted from the increased water supply after the rehabilitation/expansion of Maruba dam.

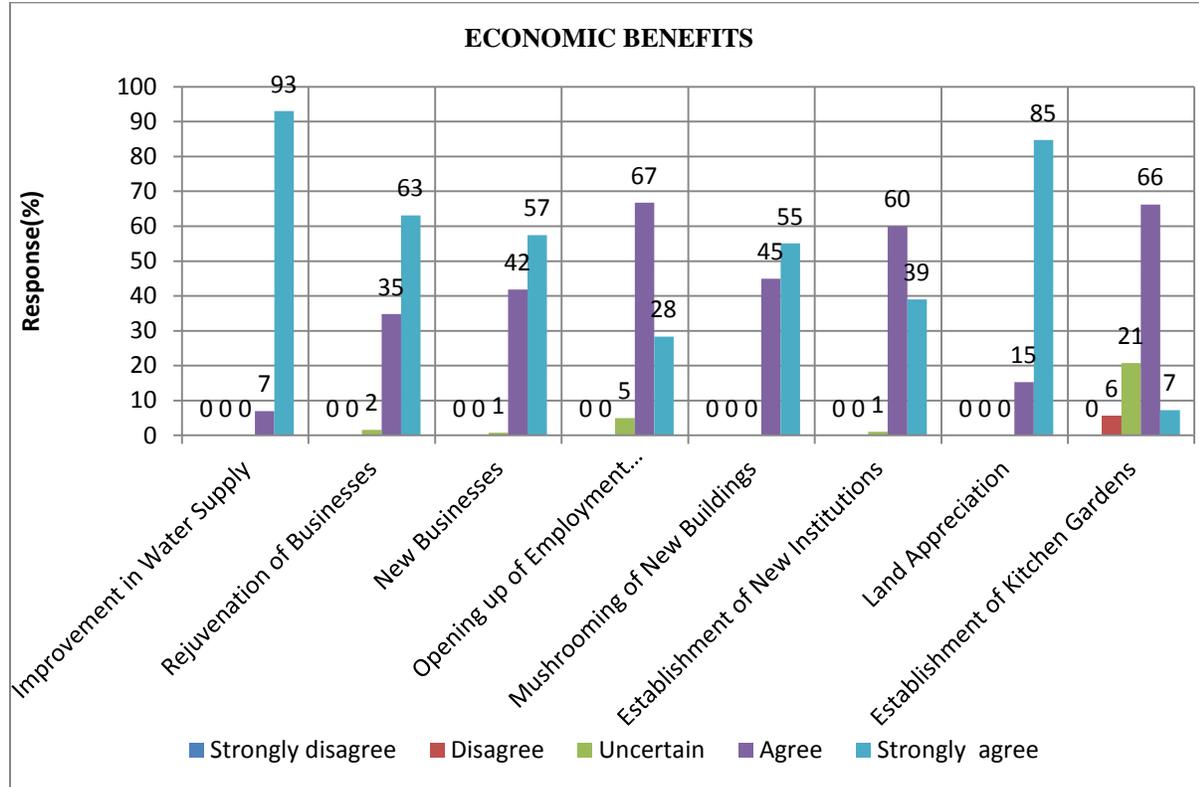


Figure 1: Economic benefits

Majority of the respondents agreed or strongly agreed that the rehabilitation/expansion of the dam contributed positively to the economy of the estate as depicted by the percentages for various economic growth indicators sampled as shown in Figure 1.

Some investors identified gaps in services required by the increased population in the estate and took advantage of them. Businesses that are thriving in the estate and its environs are; Hotels, petrol stations, supermarkets, car washes, food kiosks, grocery shops, retail shops, transport, tree nurseries, fabrication workshops, carpentry shops, rental houses, funeral homes and recreation facilities among others. Some residents practice kitchen gardens which help save expenditure on some of the vegetables and fruits.

The west of Machakos, where Miwani estate is located, is among the fastest growing areas of Machakos town. It was deduced that time and money that used to be allocated in search and purchase of water was currently being used for other beneficial activities. It was also deduced that besides the direct economic benefits, the multiplier effect resulted to other intangible benefits. These include; better health, improved sense of well-being, lower medical expenditure and family health costs on water related diseases among others. Thus the economic performance and productivity of the residents increased. An economically empowered community is able to pay for the water bills which in turn translate to supporting the sustainability of the water supply.

Machakos people's park which is supported with water from Maruba dam is within the vicinity of the estate. The park attracts tourists from within and without Machakos town. It is designed to host a myriad of activities and besides being a recreation facility, is a source of revenue for Machakos County Government. Some of the visitors purchase their supplies within the estate and its environs thus boosting its economy.

The staff of MAWASCO interviewed reported that the water reticulation system in the estate was expanded so as to supply the newly built up areas. Some sections of the existing water infrastructure were also rehabilitated thus checking on the unaccounted for water. A 150m³ elevated steel tank was erected within the estate which initially gave the residents the comfort of both reliable and adequate water supply at their taps. Water coverage in Miwani estate before the expansion of Maruba dam was 20%. The estate could remain without water for days since priority used to be given to the CBD and Government Institutions. According to a report by MAWASCO [8], complains from the consumers were the order of the day. The supply was not consistent and would cease during times of drought. Water could only be supplied for at most 3 days per week (120 m³/day) during peak volumes in the reservoir. This was hardly enough to meet the demand. However, the coverage increased to approximately 70% after the expansion of the dam with a daily regular supply of approximately 958m³/day.

Machakos Water Supply is a metered scheme. However, the Water Provider instituted additional measures that increased the efficiency of water distribution and also checked on the unaccounted for water. These include; zonal metering, regular patrols, deploying regional supervisors on rotational basis, improved efficiency in billing system and prompt repairs to bursts. The number of water connections was 80 before the expansion of the dam as compared to the current number of 359 active connections. Before the expansion of the dam, the average revenue collection per month was at Kshs 101,231 as compared to the current collection of average Kshs 859,393. Besides the continuing increase in water demand due to population increase in the estate, the primary objective of increased water coverage and increase in water revenue collection by MAWASCO was achieved.

3.2.2 Economic costs

A revitalized economic environment spelt doom for some of the ventures that resisted change in a fair competition. Some businesses bore the brunt of the side effects of the increased water coverage in Miwani estate and its environs. Some of the respondents interviewed disclosed that there are businesses that closed down due to heightened competition from new ones. This translated to economic losses to the affected business owners and their employees.

Settlements spread to areas that had no water infrastructure. Extension of water infrastructure was done so as to serve some of the new settlements while others remain without water infrastructure to date. Areas without water infrastructure depend on water tankering from private boreholes.

3.3 Environmental Impacts

3.3.1 Environmental benefits

The environment is usually a key beneficiary from the ripple effects of a well planned and well executed water project. People require extensive infrastructure so as to sustain their lives. During construction of infrastructure environmental problems will arise. Therefore, adopting best practices that are friendly to the environment during and after construction will mean a better world for the future generation.

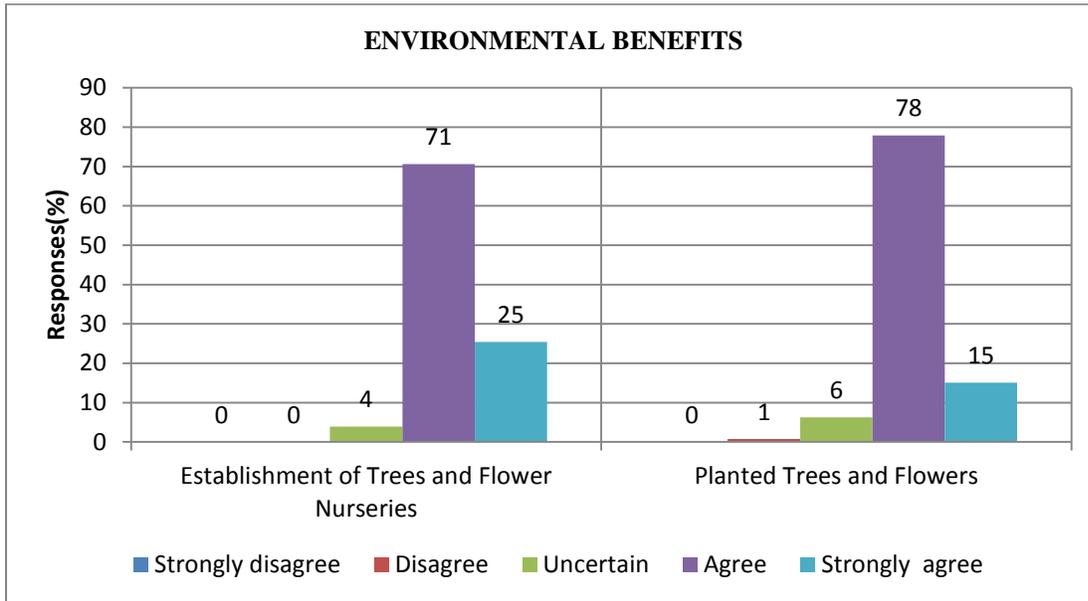


Figure 2: Environmental benefits

Figure 2 shows that tree and flower nurseries have been embraced in Miwani estate and its environs. 96% of the respondents were aware of the tree and flower nurseries. 93% of the respondents were cognizant of the planted trees and flowers. The nursery owners interviewed reported that the thriving of the venture was due to guaranteed water during the dry season and also availability of market for the plants. The planting of trees and flowers by some of the residents has impacted positively to the environment. The activity doubles both as an economic and an environmentally friendly venture. Flower gardens are evident in the estate and along the Machakos-Nairobi road. Trees have been planted on some parts of the riparian land along the river draining into Maruba dam and even in the habited parts of the estate. They help in holding soil, curb erosion and also cool the environment.

3.3.2 Environmental costs

Sometimes, the gains realized from a successfully implemented water project may be undermined by some of the negative impacts which result from the secondary by products. Miwani estate and its environs are not served with a conventional sewerage system and therefore onsite sanitation technology consisting mainly of pit latrines, soak pits, pour flush toilets, holding tanks and septic tanks is practiced. With the rejuvenated economic environment and increase in population, waste water and solid wastes were bound to increase. Figure 3 shows the opinions of the respondents pertaining to waste water and solid waste management in the estate.

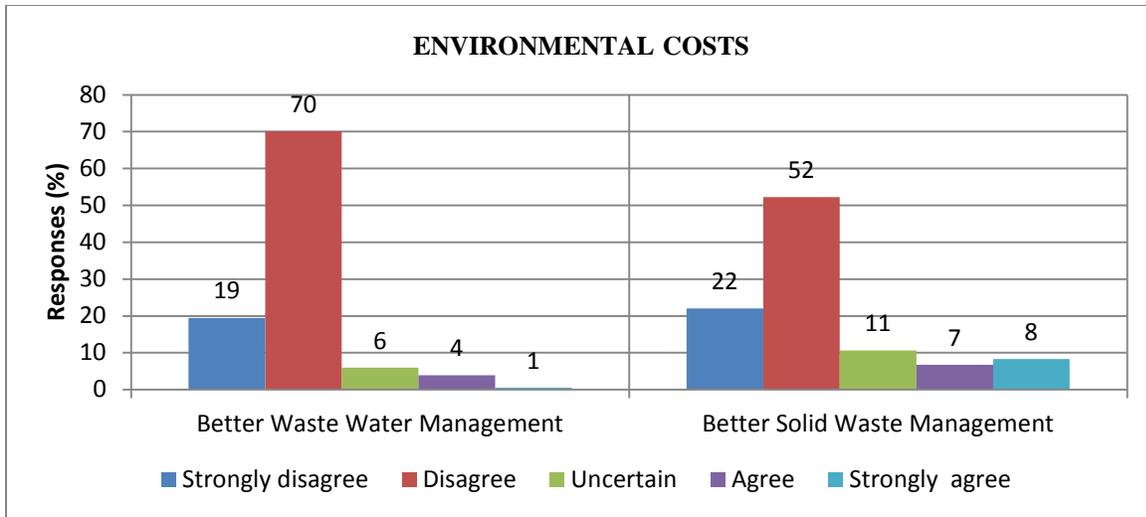


Figure 3: Environmental costs

89% of the respondents (19% strongly disagree and 70% disagree) were of the opinion that waste water management is poor in the estate. 74% of the respondents (22% strongly disagree and 52% disagree) were of the opinion that solid waste management is still a menace in the estate. As stated earlier, the estate is not connected to the sewer system and therefore it is onsite technology of waste water disposal that is used. Infiltration of waste water into the ground has a high likelihood of polluting ground water and the soil in a given area [4]. This puts the private boreholes into a risk of contamination. The researcher observed that the spillovers from the sanitation facilities, car washes and effluents from garages find their way into the available natural and man-made channels which act as the alternative for wastewater ways. These finally find their way into the river draining into Maruba dam. Oils, grease and other petroleum products from garages and car washes were also cited to be a source of environmental cost in the estate. Figure 4 shows the main modes of waste water disposal from the residential and commercial buildings.

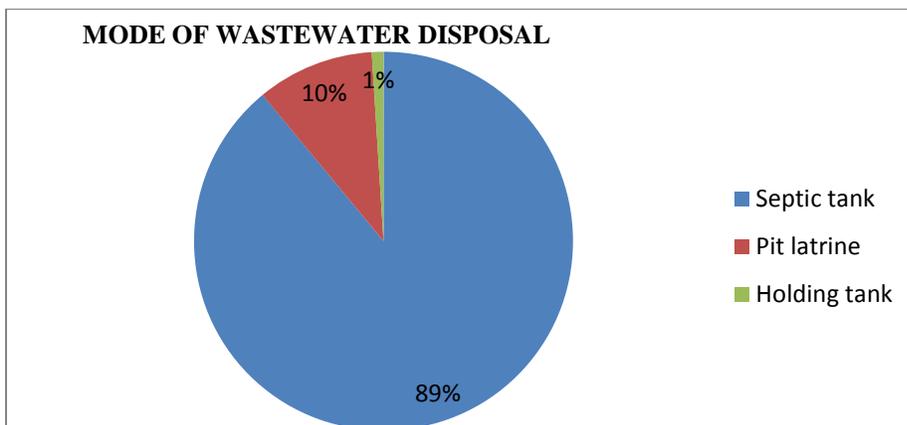


Figure 4: Mode of Wastewater Disposal in Miwani Estate

With the increased population in the estate and environs, solid waste disposal is also a menace in the estate. All the respondents interviewed depend on the County Government for their solid waste disposal. The efficiency in garbage collection is low. The designated garbage collection point is a distance from most of the residents and therefore there are incidences where you find garbage thrown in the available open spaces. During the rainy season some of the solid wastes are dissolved by rain water while others are washed into the available drainage system which in turn drains into the river and eventually draining into Maruba dam affecting the water quality. Poor water quality will translate to increased cost for the water treatment.

It is evident that the component of waste water disposal was not given priority during the project planning. Likewise, management of solid waste emanating from the increased population was also not well planned for. These two components if not checked will undermine the gains realized from the project. The respondents interviewed pointed that indigenous trees are in danger of depletion in the built up areas. This is one of the side effects to the environment which is a product of creating room for buildings. This spells the need to put in place environment related adaptation measures and involvement of all relevant stakeholders during project planning as opposed to the discrete manner in which projects are planned.

3.4 Social Impacts

3.4.1 Social benefits

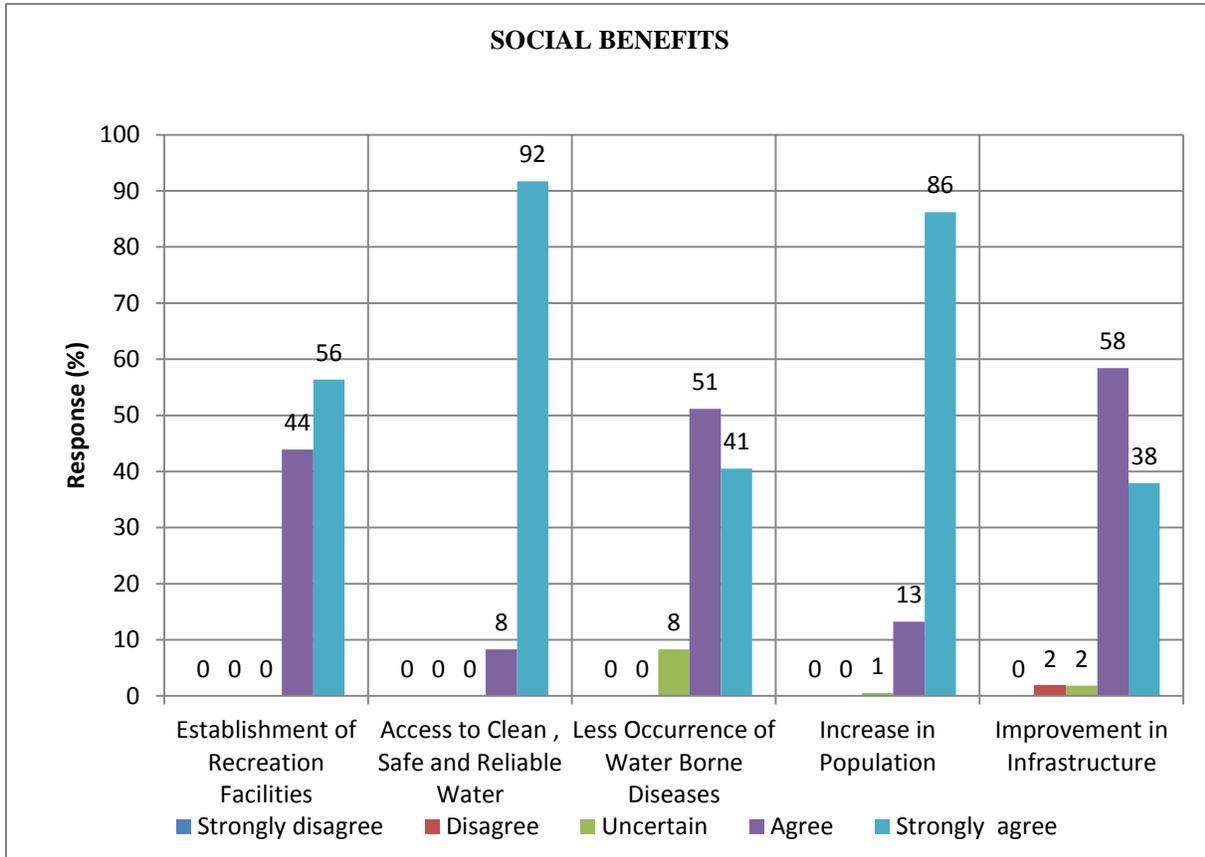


Figure 5: Social benefits

Among the three main pillars that play a key role in the sustainability of a project (Economic, environmental and social), social benefits have been receiving less consideration in the past unlike today. This is because this concept is typically difficult to define and quantify.

Majority of the respondents were of the view that the rehabilitation/expansion of Maruba dam brought about numerous social benefits.

Figure 5 displays the views of the respondents on some of the social benefits anticipated. The views are summarized as below;

- 100% of the respondents (44% agree and 56% strongly agree) observed that public and private recreation facilities were developed focusing on the reliability of water from the dam. Key among them is the spectacular Machakos People's Park.

- 100% of the respondents (8% agree and 92% strongly agree) opined that the rehabilitation/expansion of the dam increased access to safe, clean and reliable water in the estate and its environs.
- 92% of the respondents (41% agree and 51% strongly agree) were positive that there was less occurrence of water borne diseases due to increased access to clean water.
- 99% of the respondents (13% agree and 86% strongly agree) were of the view that the rehabilitation of the dam and the subsequent improvement in water supply was one of the drivers of increase in population.
- 96% of the respondents (58% agree and 38% strongly agree) recognized improvement in infrastructure which include roads, water reticulation system, electricity connectivity among others.

Besides access to clean, safe and reliable water supply which was one of the primary objectives for expansion of Maruba dam, all the other benefits were as a result of the multiplier effects of a well executed water project. Majority of the respondents affirmed that Maruba dam played an important role in light of the fact that a reliable source of potable water especially in urban set ups translates to a growing population.

Social amenities have been given attention by the respective stakeholders. Roads have been improved and extended to reach newly habited areas. Road maintenance is carried out regularly and also some roads have been upgraded to bituminous standards. Electricity connectivity has also been enhanced in the area and has been extended to newly built up areas. This has revitalized business activities such as welding and movie shops. Water infrastructure was also rehabilitated and extended to some of the areas that did not have access to the commodity before expansion of the dam.

3.4.2 Social costs

Where social and economic benefits are found, social costs must be behind the scenes. Figure 6 demonstrates the views of the respondents in regard to some of the social costs that emanated from the rehabilitation/expansion of Maruba dam.

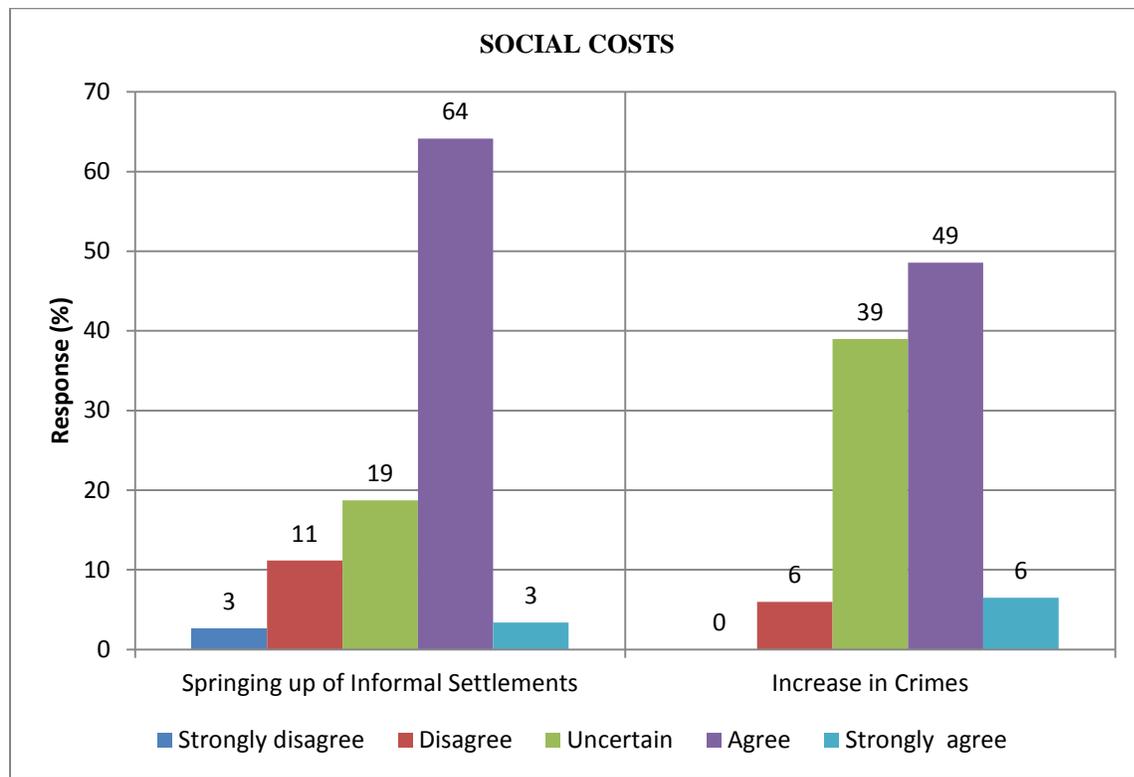


Figure 6: Social costs

Majority of the respondents were aware that some informal settlements had sprang up and also insecurity had deteriorated. According to the respondents, land fragmentation due to increased demand for housing resulted into agricultural land being converted to plots. Some of the households sold all the land they had and mismanaged the dues. Such households are part of those living in informal settlements. Some of the respondents interviewed opined that insecurity increased in the estate due to unmet expectations by some of the people who migrated to the estate with an expectation of a greener pasture. When their expectations turned into an illusion, they turned into becoming petty thieves thus occasionally terrorizing residents during the night and also breaking into houses. This has called for regular police patrols especially during the night.

3.5 Implementation Status of Environmental Management Plan (EMP)

Table 1 below shows the implementation status of the EMP as recommended in the Environmental Impact Assessment report.

Table 1: Implementation Status of Environmental Management Plan

Parameter	Responsible Intervention/ Monitoring for	Method/ Activity needed	Frequency	Findings
Dam siltation	NWCPC	-Sediment load survey -Construction of silt traps	-Twice per year -Once	Has never been executed
Sludge from the treatment works	NWCPC/NEMA	Provide sludge drying beds and replant with suitable weed	Once	Not done
Risk of eutrophication / growth of invasive species	Tanathi WSB/NEMA	Ecological surveys	Twice a year	Has never been executed
River flow obstruction during river filling	Tanathi WSB/WRA	Provide suitable flow release mechanism	During operation	Not usually done
Changes in downstream ecology	NEMA	Ecological surveys	Yearly	Has never been executed
Creation of favourable habitats for disease vectors	Public health department/NEMA	Epidemiological surveys	Twice a year	Has never been executed
Enhanced erosion and changes in topography due to excavation	Tanathi WSB/NEMA	Backfill borrow pit areas and plant vegetation	Yearly	Was not executed
Risk of accidental drowning	Tanathi WSB	Fencing and appropriate dam management	Continuous	There is no fence around the dam

The findings show that the Environmental Management Plan has never been implemented. The key challenge cited by the stakeholders interviewed was that confusion engulfed the process after devolution came into being in 2013.

There were different schools of thought as to who was to provide the budget to implement the activities recommended in the EMP. The county government was of the opinion that it was its mandate while the national institutions had a contrary opinion. Since the activities of the EMP required a budget and the good will of the county government, the EMP became no one's business and has never been implemented to date. However, the recommendations in the EMP are important and require to be implemented as appropriate.

4. CONCLUSION AND RECOMMENDATIONS

4.1 Conclusion

Based on the research findings, improved water supply to Miwani estate and environs as a result of expansion of Maruba dam was cited by the majority of the respondents interviewed as one of the key factors that contributed to the positive economic, social and environmental well-being of the estate. Most of the respondents interviewed had experienced the days when the estate would go without water for months and the current status where besides water rationing, they are guaranteed of getting it throughout the week. The population of the estate has increased thus giving birth to new and expanded business ventures. The economic, environmental and social benefits outweigh their corresponding costs. The County Government has improved the road infrastructure, garbage collection, boda-boda shades and many other social facilities. The combination of the above factors among others gives the assurance that the gains realized in Miwani estate and its environs from improved water supply are contributing positively towards the sustainability of Maruba dam.

However, wastewater and solid waste disposal are still a challenge in the estate. They are a major source of environmental pollution in the estate. Maruba dam is in danger of increased pollution from domestic, industrial and agricultural sources from Miwani estate and environs and measures require to be put in place so as to minimize the effluents draining into the river flowing to the dam both during the dry and wet seasons.

4.2 Recommendations

The following is the list of recommendations that if implemented, will help mitigate on the negative impacts to the gains achieved through the expansion of Maruba dam within Miwani estate and its environs.

1. Miwani estate and environs be sewerage and be connected to the sewerage system of Machakos town. This will help check on probable pollution of the ground water, the river draining into Maruba dam and the general environment.
2. There is need to improve on solid waste management in Miwani estate as this is another source of environmental pollution.
3. The local Water Service Provider and Machakos County Government should put measures in place for sensitizing business people involved in sewerage and wastewater exhausting business on the best practices.
4. Continual sensitization of car wash owners on best practices of wastewater disposal instead of letting the water flow directly into the river channel.
5. Enforcement of the building act on all the developers putting up infrastructure in Miwani estate and its environs. This is because some developers disregard the impact of their actions to the surroundings.
6. There is need for sensitization of the people practicing farming in the estate and its upstream on best farming practices.

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