IOSR Journal Of Humanities And Social Science (IOSR-JHSS)
Volume 22, Issue 7, Ver. 11 (July. 2017) PP 22-29
e-ISSN: 2279-0837, p-ISSN: 2279-0845.
www.iosrjournals.org

Urban Sanitation Management Approaches in Mavoko Town of Machakos County in Kenya

Juliana Kamanthe Muia Mutua[1] Jones Agwata[2]
[1]*Centre for Advanced Studies in Environmental Law and Policy, University of Nairobi, Nairobi, Kenya*
[2]*Centre for Advanced Studies in Environmental Law and Policy, University of Nairobi, Nairobi, Kenya*
*Corresponding Author: * Juliana Kamanthe Muia Mutua*

ABSTRACT: This paper assesses the sanitation management approaches in Mavoko town. It analyses the geographical aspects and takes into account the economic considerations used in managing sanitation. The assessment reveals that the sanitation management approaches used are neither appropriate nor sustainable. The conventional sewer system serves less than 40% of the population while the septic tank is widely used in Mavoko town but compromises the environment with potential threat to the health of the population's resident in the study area due to the low infiltration capacity of the black cotton soils which are not conducive to onsite sanitation systems (OSS). The resident population is desirous of protecting the environment but is challenged by the high cost of operation and maintenance of the septic tank. Government intervention is recommended to facilitate pooling of financial resources spent on maintaining the septic tank to upgrade to a conventional sewer system which is best suited for the area.

Key words: Location, Mavoko, sanitation management approaches, sustainable development.

Date of Submission: 05 -07-2017 Date of acceptance: 20-07-2017

I. INTRODUCTION

Sanitation is a key environmental aspect and as Sigel *et al* (2012) put it a major issue related to sustainable development in many parts of the developing world. Proper management approaches are essential in the realization of protected and conserved environment for sustainable development. Global trends in proportion of population using improved sanitation indicate that India and the rest of Africa have the lowest proportion of its population using improved sanitation at less than 50 % WHO, (2013). Rapid urbanization has compounded the ability of many African governments to provide essential services like sanitation let alone the environmental degradation that has come with it.

Out of Kenya's 178 Local Government Authorities (now under County Government) only 32 have a sewerage system, Westorhof (2010) and about 5% of it is effectively treated Gakubia *et al* (2010). This is against a background of urbanization growth rates projected to reach 63% by 2030 up from 8% at independence in 1963 GoK, (2009). Relevant policies and legal frameworks existing in the Country have not provided an integrated approach to the management of the various sectors in the environment and especially in sanitation while studies illustrate that the sanitation condition is wanting in the major cities of Kenya. Sanitation studies in Kenya have concentrated on the impact it has had on public health especially in the urban areas Wright et al (2012); public health in schools Freeman, et al, (2012) Tumwine, et al, (2003), Pearson et al (2008) in Freeman, et al (2012), Mbula et al (2014); management of public toilets in Nairobi, (Water and Sanitation Program Africa-2004); and public health at the refugee camp at Dadaab, Biran et al, (2012). None has looked at the appropriateness and suitability of sanitation management approaches and their contribution to sustainable development. Hence the need to establish this contribution in an assessment of urban sanitation management approaches in Mavoko Town in Machakos County, Kenya

II. STATEMENT OF THE PROBLEM

Mavoko town (Fig 1) has the fastest urban growth rate in the Nairobi Metropolitan Region (NMR) with a population of 244259 National Population Census, (2009) projected to grow to 593,182 by 2030 GoK, (2013). This is expected to exert more pressure on the existing sanitation management system through the increase in population densities and housing developments to accommodate the growing population. Simultaneously the larger Athi Water Catchment which is supposed to provide sanitation services to a bulk of cities and towns like Nairobi, Mombasa, Machakos and Malindi is the same one that is expected to serve Mavoko town.

Under the greater Nairobi in which Mavoko falls too, the existing sewerage treatment capacity stands at 192000m3 against a required treatment sewerage capacity of 1,407,000m3 National Water Master Plan, (2012) representing a deficit of 86% in sewerage treatment capacity. Mavoko town's sewer network is over 20 years old, comprises only 31.07 km long sewer network and covers less than 1% of its 963 km^2 of its total jurisdiction.

Sanitation conditions prevailing in Mavoko town are therefore a cause for concern and the reason why the research was conducted to establish whether sanitation management approaches used in Mavoko Town were appropriate and sustainable. The paper presents research findings of a study conducted between 2015 and 2016. Location, economic considerations such as operation and maintenance costs and respondents' hygiene in sanitation management approaches were used in assessing the sanitation management approaches.

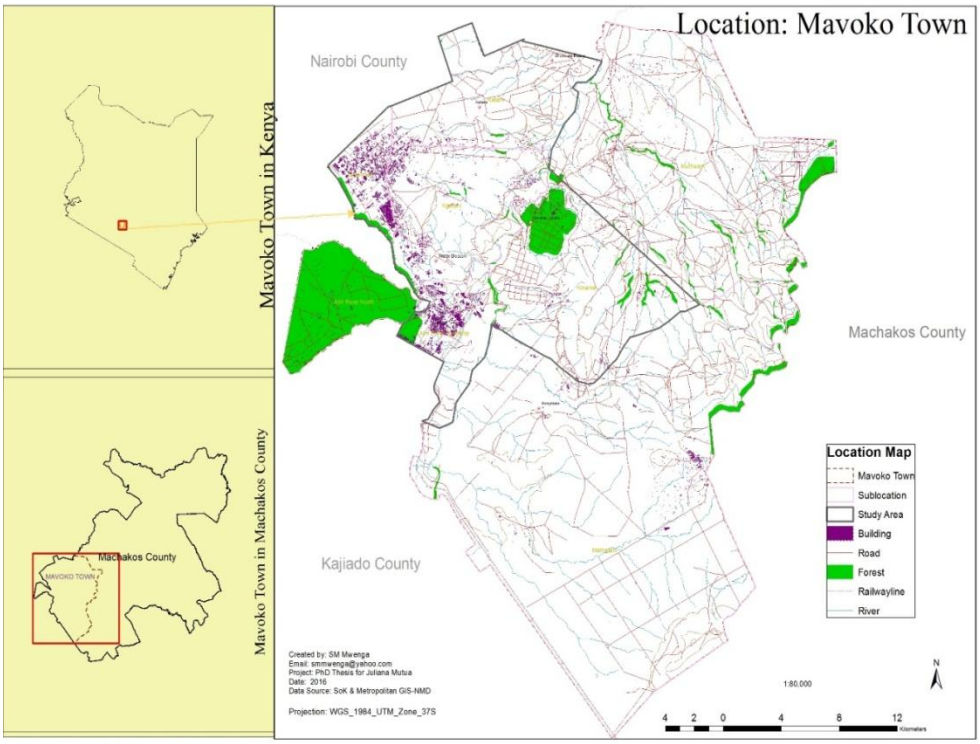

Figure: 1. Mavoko Town Study Area

Source: Nairobi Metropolitan Department, 2015

III. METHODOLOGY

A cross sectional study design as opposed to the 'before' and 'after' or the longitudinal study designs was found most appropriate with regard to time taken to conduct the research and the fact that it was best suited in establishing an overall picture of the existing situation of the study at the time Kumar (2005). A sample of 385 was arrived at using (Krecie and Morgan, 1970) guide lines for sample size questionnaire administration in the field. The populations of the four wards which make up the study area that is Athi River, Kinanie, Syokimau/Mlolongo and Katani were then used to apportion the actual questionnaires that were administered in each of the Wards. See (TABLE 1). Primary data was collected through interviews and observations through site visits. Interviewees comprised Households, Developers and County Government officials especially the Physical Planner, Environment Officer, Works Officer, Housing Officer and Public Health officer. Secondary data was obtained through analysis of records available in the form of technical reports such as the environmental impact assessment reports, building plans, institutional reports, service provision records and sectoral reports. Data was analyzed using tables, graphs, frequencies and percentages using the social statistical package for social sciences (SPSS).

Table 1 Ratio for Apportioning Questionnaire Administration

Ward	Population	Ratio (Ward Population/Total Population of Study Area)	Questionnaires for administration
Athi River	139,502	139502/244259 = 57	219
Kinanie	7,069	7069/244259 =3	12
Syokimau	42,154	42154/244259 = 17	66
Katani	55,534	55534/244259 = 23	88
Total	**244,259**	**57:3:17:23=100**	**385**

IV. RESULTS AND DISCUSSION

4.1 Sanitation Management Approach and Location

Table 2 Type of Sanitation Method Used and Location

Sanitation Method Used	% Residential Area						
	Athi River	Katani	Kinanie	Sabaki	Mlolongo	Syokimau	Total
Conventional sewer	36.5	13.1	0	8.3	4.5	10	23.9
Small bore sewer	5.4	2.4	0	0	9.1	4	4.4
Septic tank	23.6	42.9	7.1	83.3	68.2	64	36.9
Pour flush latrine	12.3	0	0	0	9.1	0	7
VIP latrine	1.5	7.1	0.0	0.0	0.0	4.0	2.9
Simple latrine	20.2	34.5	92.9	8.3	9.1	12.0	23.9
Bio digester	0	0.0	0.0	0.0	0.0	6.0	0.8
Cess pit	0.5	0.0	0.0	0.0	0.0	0.0	0.3

The sanitation management approach was assessed against location (TABLE 2). Athi River with the largest urban population had less that 40% of its population served by the conventional sewer line. Katani and Syokimau areas had less than 14% on use of the conventional sewer. Even then these areas had common user septic tanks whose residents confused with a conventional sewer system. The septic tank was in high use in the Sabaki area ranked at 83% of the population using the sanitation approach. Mlolongo and Syokimau followed at 68% and 64% respectively.

The simple latrine was in greatest use in Kinanie rated at 92%. Other sanitation management approaches in use were the pour flush latrine highly used in Athi River ward compared to other areas. However it was fourth in line among the sanitation management approaches within Athi River ward i.e. after conventional, septic tank and simple latrine at 36%, 23% and 20% respectively.

4.2 Reasons for Sanitation Management Option Used

Table 3 Reasons for Choice of Sanitation Management Approach

Sanitation Method Used	Reasons to Choice of Sanitation Management Approach							
	Availability of sewer network	Cost of sanitation	Technology available	Convenience	Preference	Environmentally safe	Found already installed	Total
Conventional sewer	55.2	2.3	1.6	2.8	4.5	0.0	62.1	23.9
Small bore sewer	1.7	2.3	10.9	5.6	4.5	0.0	1.1	4.4
Septic tank	12.1	31.8	64.1	44.4	59.1	100.0	19.5	36.9
Pour flush latrine	27.6	0.0	0.0	10.2	0.0	0.0	0.0	7
VIP latrine	0.0	6.8	4.7	2.8	9.1	0.0	0.0	2.9
Simple latrine	3.4	52.3	17.2	33.3	22.7	0.0	17.2	23.9
Bio digester	0.0	2.3	1.6	0.9	0.0	0.0	0.0	0.8
Cess pit	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.3

Respondents gave seven reasons for choice of sanitation management as demonstrated in TABLE 3. The septic tank emerged as the most preferred with reasons being advanced in the order of rank and importance as follows; environmentally safe, available technology, preference, convenience and cost of sanitation. The simple latrine and the conventional sewer tallied at 23% but differed on the reasons for choice of the same. The conventional sewer users explained that they found it existing or there was sewer infrastructure availability in

the vicinity. For the simple latrine user, cost of sanitation management was the driving factor behind its choice with 52 % of the respondents citing it. Other reasons given were convenience, preference, technology available, and existing latrine. Environmental concerns were not existent among these simple pit latrine users. There were a negligible 3% of respondents having chosen the pit latrine against availability of the conventional sewer. The small bore sewer and bio digester had very few users at less than 4% and 1 % respectively.

4.3 Operations and Costs of Sanitation Management Options Used

Table 4 Costs of Emptying Sanitation Method Used

Toilet Type	Cost of Emptying Sludge (Per Trip) from Sanitation Method Used in %								Total
	500-2000	3000-5000	6000-8000	9000-11000	12000-15000	Above 15000	I don't know	Included in rent	
Conventional sewer	0	0	0	2.8	0	0	8.5	0	3.3
Small bore sewer	0	0	5	0	0	0	14.9	0	5.3
Septic tank	83.3	57.1	70	61.1	93.8	0	40.4	50	62.9
Pour flush latrine	0	0	0	0	0	0	2.1	0	0.7
VIP latrine	0	0	15	0	0	100	2.1	0	3.3
Simple latrine	16.7	42.9	10	36.1	6.2	0.0	29.8	50	23.8
Bio digester	0	0	0	0	0	0.0	2.1	0	0.7

The costs associated with emptying various sanitation management options is shown in TABLE 4. The septic tank was the most expensive followed by the simple latrine accounting for 63% and 24% of the respondents. Amounts spent on emptying septic tanks ranged from 500/- to 15000/-. It emerged too that majority who make up 94% spent between 12000/- to 15000/- per year. This works out to kshs 1000/- to 1250/- per month. A very high 83% was recorded too amongst septic tank users spending between 500/- to 2000/- on emptying the tanks. There were other figures across the ranges of 3000/- to 5000/-, 6000/- to 8000/- and 9000/- to 11000/- indicated as 57%, 70% and 61% respectively.

Only septic tanks and simple pit latrines are emptied. Two most common methods of emptying sludge are use of the exhauster service and the pumping into the open grounds. 67% of septic tanks emptying were pumped into the surface ground while 64% were using exhauster services. The same picture is portrayed in the emptying of the simple pit latrine in which 33% pump into the surface ground while 25% use the exhauster service.

Table 5: Method of Emptying Sludge

Sanitation Method	Method Used to Empty Sludge from Toilet of Choice			
	Pumping Out Onto The Surface Ground	Exhauster Service	Does Not Require Removal	Don't Know
Conventional sewer	0.0	3.0	0.0	0.0
Small bore sewer	0.0	3.7	0.0	0.0
Septic tank	66.7	64.0	37.5	0.0
Pour flush latrine	0.0	1.2	25.0	66.7
VIP latrine	0.0	3.0	0.0	0.0
Simple latrine	33.3	25.0	25.0	33.3
Bio digester	0.0	0.0	12.5	0.0

TABLE 5 displays the various methods used to empty sludge. Most of the respondents relying on the conventional sewer and small bore sewer did not respond to the question of willingness to pay for improved services.

Table 6: Respondents Willingness to Pay for Improved Sanitation (n=385)

	% Range of payment in Kshs.

Sanitation Management Used	No response	Below 500	500-1000	1001-1500	1501-2000	Above 2000
Conventional sewer	84.8	7.6	3.3	3.3	1.1	.0
Small bore sewer	82.4	17.6	.0	.0	.0	.0
Septic tank	39.4	15.5	23.2	11.3	8.5	2.1
Pour flush latrine	66.7	14.8	14.8	3.7	.0	.0
VIP latrine	36.4	9.1	54.5	.0	.0	.0
Simple latrine	54.3	33.7	7.6	3.3	.0	1.1
Bio digester	33.3	33.3	.0	33.3	.0	.0
Cess pit	100.0	.0	.0	.0	.0	.0
Total	**57.7%**	**17.9%**	**13.8%**	**6.2%**	**3.4%**	**1.0%**

TABLE 6 shows that 85% and 82% did not give an answer. Those using the septic tank were spread out along those who did not respond and those willing to pay for improved service ranging from less than kshs 500/-, between kshs 500/- to 1000/= and kshs 1001/- to 1500/-. These were rated at 39%, 16%, 23% and 11% respectively. Simple pit latrine users had the majority 54% not responding to the question whilst 34% indicated willingness to pay for improved services but at only kshs. 500/-and below. When all the sanitation management options in use in the study area were combined, it emerged that majority 58% gave no response while 18% and 14% indicated willingness to make monthly payments ranging below kshs 500/- and kshs 500/- to 1000/- only.

Table 7 Respondents Willingness to Pay for Improved Sanitation by Location (n=385)

Location	% Range of payment in Kshs					
	No response	Below 500	500-1000	1001-1500	1501-2000	Above 2000
Athi River	62.6	15.3	11.8	6.9	2.5	1.0
Katani	60.7	17.9	19.0	1.2	1.2	.0
Kinanie	78.6	14.3	7.1	.0	.0	.0
Sabaki	41.7	25.0	8.3	8.3	16.7	.0
Mlolongo	45.5	36.4	4.5	9.1	.0	4.5
Syokimau	36.0	20.0	20.0	12.0	10.0	2.0
Total	**57.7**	**17.9%**	**13.8%**	**6.2%**	**3.4%**	**1.0%**

TABLE 7 demonstrates Respondents readiness to pay for improved sanitation management per area of residence or location where found. Apart from Mulolongo, Sabaki and Syokimau areas which registered 36%, 25% and 20% in willingness to pay for improved services respectively and at prices below kshs 500/- , other areas of Kinanie, Athi River and Katani registered 14%, 15% and 18% respectively. Syokimau respondents indicated a willingness to pay for improved services across the ranges of less than 500/-, to 2000/- with a significant population of between 20% and 10% compared to the other areas which registered below 10% in this range. This is explained by the urbanizing population in the area and reliance on the septic tank which is relatively costly compared to other sanitation options. Save for Katani and Athi River which saw a substantial 19% and 12% indicate willingness to pay in the range of kshs. 500/- to 1000/-. Sabaki area had 17% of respondents willing to pay between kshs 1501/- to 2000/-.

Table 8: Frequency in Emptying

Sanitation Method	% No of times Sanitation Method Used is Emptied per Months					
	3	6	12	24	36-60	Total
Septic Tank	18.6	20.9	45.3	5.8	9.3	86
VIP latrine	-	-	50	-	50	4

Simple latrine	9.9	12.1	45.5	18.2	15.2	33

On periodic emptying of onsite sanitation management options in the study area depicted in table 8 only septic tanks, simple and ventilated improved pit (VIP) pit latrines are emptied and mostly once a year with the frequencies ranging from 45%, 46% to 50% respectively. There are biannual and quarterly frequencies in emptying the septic tank but with minimal range differences from 21% and 19% respectively. The same scenario is seen with the simple latrine whose emptying frequencies are 12% and 10% for biannual and quarterly emptying of the toilet. This has cost implications since the fewer times the sanitation management approaches are emptied the lesser the cost of operation and maintenance of the same.

4.4 Type of sanitation method used and location

The sanitation management approach determines to a great deal location of residence. Environmental conditions of the location also determine the sanitation management approach to be adopted as shown by Anand, (2006), Tumwebaze *et al* (2011) and Zawahri *et al*, (2011). Residents would wish to live in the proximity of services like the sewer line as it would be convenient to flush away their waste. Though Athi River Township has the conventional sewer system, less that 40% of this population is served by it illustrating Okumu and Osterveer (2010) claim that Local Authorities (County Governments in the case of Kenya) are unable to put in place alternative plans that cover the entire urban population. Katani and Syokimau areas trail at less than 14% on use of the conventional sewer.

However Katani and Syokimau areas have common user septic tanks whose residents confuse with a conventional sewer system. The common user septic tanks final waste when full is channeled to Sabaki stream which leads into a wetland in the area and therefore the perception that they use a conventional sewer system since emptying of effluent does not occur. The septic tank is in high use in the Sabaki area ranked at 83%. Mulolongo and Syokimau follow at 68% and 64% respectively.

The simple latrine is in greatest use in Kinanie which is an area transiting from the rural to urban area and hence the ease in use of the pit latrine. Other sanitation management approaches in use are the 'pour flush' latrine highly used in Athi River and explained by the existing conventional sewer. In times of water shortage, the water closet is used as a 'pour flush toilet too.

These onsite sanitation (OSS) management approaches in the study area are challenged by the occurrence of black cotton and clayey soils which compromise about 80% of the study area. These soils have the characteristics of high swelling and shrinking when exposed to changes in moisture content (Gaikwad et al (2014) and may result in subsidence impacting negatively on the OSSs.

Further, for septic tanks to work efficiently they require effluent from the septic tank to be channeled to a soak pit which finally discharges into the ground where pathogens are further broken down. Tilley et al, (2014) opine that sanitation management options which use infiltration technologies must of necessity be in areas where the soil has a suitable capacity to absorb effluent.

The problem is in the discharge from the soak pit which does not infiltrate the ground but instead saturates the subsurface which leads to flooding and overflow onto the surface. There is therefore a very high likelihood that they do not perform as expected since septic tank effluent contains approximately 70% of the original pollutants. Burnham Environmental Services Ltd (2015). This alludes to Nam *et al*, (2006) study in Hanoi and the suburban area of Bangkok which found out that septic tanks used did not perform as required.

4.5 Reasons for Choice of Sanitation Method Used

Respondents in the study area were concerned about the well being of the environment as opposed to the cost of the technology in use which comes among the last of the reasons for choosing the sanitation management approach. It may be argued that cost of sanitation comes last because it is not friendly and corroborates Caincross, (2003) concern that finances are not readily available to sanitation systems users. Respondents perceptions of being able to influence environmental issues compared to the cost of technology could further inform this status.

However there is a contradiction because whereas the same Respondents concern is with the environment, the use of the septic tank which does not operate efficiently due to the soil deficiencies in absorption of effluent from soak pits is the most widely used sanitation management approach. This leads to the observation made by McConville *et al* (2010) that perception as a factor influencing and challenging sustainability of sanitation programmes is informed by behavior change processes and not technical assessments or project guidelines.

The simple latrine and the conventional sewer tallied at 24% but differed on the reasons for choice of the same. The conventional sewer users relied on the method because they either found it existing or there was sewer infrastructure in the neighbourhood. For the simple latrine user, cost of sanitation management was the driving force behind its choice with 52% of the respondents citing it.

Other reasons given were convenience, preference, technology available, and existing latrine. Environmental concerns were not existent among these simple pit latrine users for the likely reason that it was not a priority given their economic considerations. There was a negligible 3% respondent having chosen the pit latrine due to availability of the conventional sewer.

This could mean that they have channeled their pit latrine waste into the conventional sewer line in the vicinity. The small bore sewer had very few users at less than 4% while the bio digester had none most likely because the bio digester is a new entrant in the Kenyan market while the bore sewer is used to serve smaller communities in affluent areas and has not been largely adopted.

4.6 Method of transporting Sludge from the house

Two most common methods of emptying sludge are use of the exhauster service and the pumping into the open grounds. 67% of septic tanks emptying were pumped into the surface ground while 64% were using exhauster services. The same picture is portrayed in the emptying of the simple pit latrine in which 33% pump into the surface ground while 25% use the exhauster service.

This brings to the fore the question of poor sanitation management relative to its disposal method in the open field where sludge is not treated but disposed off carelessly. This presents a threat to the environment and health of the populations prevalent in the study area since as Jones *et al* (2006) submits the sanitation transactions do not result in sewage being disposed of safely. This is supported by Gunawardana *et al* (2011) who noted that that septic tanks and cess pits could not be considered as improved sanitation if the septage was not treated and disposed safely.

4.7 Cost of Emptying Sludge from the Sanitation Method Used

The cost of maintaining the sanitation management approach of choice indicated that the septic tank was the most expensive followed by the simple latrine accounting for 63% and 28% of the respondents. Amounts spent on emptying septic tanks range from 500/- to 15000/-. It emerged too that majority who make up 94% spent between 12000/- to 15000/- per year. This works out to kshs 1000/- to 1250/- per month. This amount is double that which the respondents are willing to pay towards improved sanitation services and hence does not compare favorably.

This is an area that requires Government intervention to rationalize sanitation costs to provide effective sanitation coverage. Studies by Kolsky *et al* (2010) conducted in Bangladesh, Ecuador, Maharashtra, Mozambique, Senegal and Mozambique indicate that the Asian Countries registered high sanitation coverage on moderate and reasonable costs of sanitation provided whilst Ecuador and Senegal recorded low leverage implying that the costs were a factor of importance.

Simultaneously, if these maintenance costs are spread across the total population which use the septic tank which has been seen to be leading at 37% and assuming a constant on the cost of emptying, it would mean that out of a projected population of approximately 600,000 people with 120000 households, it would be spending at least between 1.44 billion and 1.8 billion per year, money which could be pooled for a year to provide a one off conventional sewer system at about 2.1 billion going by the rates of the construction costs of the 77 kilometres of Juja-Thika South trunk sewer system, reticulation and waste water treatment plant under Government of Kenya, (2016). Better service, convenience and environment friendly sanitation options can be realized.

V. CONCLUSION

The assessment of sanitation management approaches indicates that they are neither appropriate nor sustainable. The conventional sewer system serves less than 40% of the population while the septic tank is widely used in Mavoko town but threatens the environment with potential risk to the health of the population's resident in the study area. This is as a result of the conditions of the black cotton soils which are not conducive to OSS.

It has emerged too that though the resident population is desirous of protecting the environment, it is compromised by the high cost of operation and maintenance of the septic tank. The study however notes that the situation does not have to be this way and can be salvaged through Government intervention to facilitate pooling of financial resources spent on maintaining the septic tank to upgrade to a conventional sewer system which is best suited for the area.

REFERENCES

[1]. Anand, P.B. (2006) is the Millenium Development Goal for water and Sanitation on track. Target 10 revisited. University of Bradford. *International Journal of Technology Management and Sustainable Development.* 5: 3 2006 Intellect ltd. pp 197-208

[2]. Biran A, Schmidt W P, Zeleke L, Emukule H, Khay H, Parker J and Peprah D (2012) *Tropical Medicine and International Health Vol 17 No. 9* pp1133-1141

[3]. Burnham environmental services limited (2015) waste and sewage treatment plants

[4]. Caincross, S (2003) Sanitation in the developing world: Current status and future solutions. London School of Hygiene and Tropical Medicine. *International Journal of Environmental Health Research 13,* S123-S131

[5]. Gaikwad, K.S, Mehta, K.S, Sonecha, R.J, Daxini, P.D, and Ratan, P.B (2014*) Journal of Engineering Research and Applications 4:5 pp 25-32*

[6]. Gakubia R, Pokorski U and Onyango P (2010) Upscaling Access to Sustainable Sanitation. Follow-up Conference of the International Year of Sanitation, Tokyo Japan

[7]. Government of Kenya (2016) Report on disbursements tracking.

[8]. Freeman, C M, Greene L, Dreibelblis R, Saboori S, Muga R, Brumback B and Rheingans R (2012) Assessing The Impact of A School Based Water Treatment Hygiene and Sanitation Programme On Pupil Absence in Nyanza Province, Kenya: A Cluster Randomized Trial. *Tropical Medicine and International Health 17: 3* pp 380-391 March

[9]. Gunawardana, I.P.P, L.W. Galagedara, L.W and Silva, S.D. (2011) Practical issues of partial onsite sanitation systems: Two case studies from Srilanka. *Tropical Agricultural Research 22:2pp 144-153*

[10]. Kothari, C.R. (2004) Research Methodology. Methods and techniques 2nd revised edition. Pp 1-401 New Age International P (limited) Publishers

[11]. Krejcie, R. V. and Morgan, D. W. (1970) Determining sample size for research activities. Educational and psychological measurement 30 pp. 607-610 retrieved from www.e-bookspdf.org/viewLast accessed on 29/7/15

[12]. Mbula, S.E, Mulwa, A. S., and Kyalo, D.N (2014) Access to improved sanitation: Implication for sustainable implementation of hygiene practices in secondary schools in Machakos County, Kenya. *European Scientific Journal 10:1*ISSN:1857-7881 (print) e-ISSN

[13]. McConville, J, Kain, J.H, Kvanstrom, E (2010) Perceptions of local sustainability in planning sanitation projects in West Africa in social perspectives on the sanitation challenge. DOI 10.1007/978-90-481-3721-37. Springer Science and Business media, B.V. 2010

[14]. Nam N,H, Visuanathan, C and Jegathesan, V (2006) 'Performance Evaluation of Septic Tanks as Onsite Sanitation Systems' The 4th International Symposium on Southeast Asian Water Environment, AIT

[15]. Okumu, J.O and Oosterveer, P (2010) Social perspectives on the sanitation challenge. Pp 49-66 Springer, Netherlands.

[16]. Sigel, K, Altantul, K and Basandorj (2012) *Environmental Earth Sciences 65:4* pp 1561-1566

[17]. Tilley, E, Ulrich, L, Luthi, C, Reymond, P and Zurbrugg,C (2014) Compendium of Sanitation Systems and Technologies. 2nd revised edition pp 1-180 Water Supply and Sanitation Collaborative Council, IWA AND eawag

[18]. Tumwebaze, I.K, Orach, C.G, Nakayaga, J.K, Karamagi, C, Luethi, C and Niwagaba, C (2011) Ecological Sanitation Coverage and Factors Affecting Its Uptake In Kabale Municipality, Western Uganda. *International Journal of Environmental Health Research 21: 4* pp 294-305

[19]. Tumwine, J.K, Munguti, K.K, Mujwahuzi, M, Johnstone, N and Porras, I (2003) Sanitation and Hygiene In Urban and Rural Households In East Africa. *International Journal of Environmental Health Research 13*: 107-115 Taylor and Francis Health Sciences.

[20]. Zawahri, N, Sowers, J and Weinthal Erika (2011) The Politics of Assessment: Water and sanitation MDG in the Middle East. Development and change 42:5 pp 1153-1177 International Institute of Social Studies. Blackwell

Juliana Kamanthe Muia Mutua. "Urban Sanitation Management Approaches in Mavoko Town of Machakos County in Kenya." IOSR Journal Of Humanities And Social Science (IOSR-JHSS) 22.7 (2017): 22-29.