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**34th WEDC International Conference, Addis Ababa, Ethiopia, 2009****WATER, SANITATION AND HYGIENE:  
SUSTAINABLE DEVELOPMENT AND MULTISECTORAL APPROACHES****The linkage between settlement profile and choice of  
sanitation system in peri-urban areas:  
A case study of Nakuru municipality***Y. Mosei, S. Kimani & B. Mutua, Kenya***REFEREED PAPER 214**

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*Presently human settlements in developing societies do not effectively address problems in urban areas including inadequate housing, unreliable energy sources, inadequate water supply, poor sanitation systems and lack of access roads in informal settlements. Recently, Nakuru town water supply has been characterized by chronic shortages and this threatens sanitation in residential and industrial functions within the Municipality. "Flying toilets" and pit latrines are conspicuous in low income high density settlements, while flush toilets, sewer systems and septic tanks are common among middle and high income low density settlements. A study was carried out to assess and map linkages between sanitation technologies and settlements profile in the municipality and examine implications of resource-oriented sanitation technologies. Results showed that sanitation situation in low income settlements and choice of sanitation technology is limited to multi-factors. 70% of respondents indicated a strain economically as a determining factor in the choice of sanitation technology. The research recommended the adoption of ecological sanitation as a paradigm shift from conventional sanitation.*

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**Introduction**

In many cities and towns in the developing world, access to basic services such as water provision, sanitation, solid waste collection and drainage is inadequate for a majority of the residents especially those living in peri-urban areas (UNCHS, 2001). Informal housing in the low income settlements faces problems such as poor planning, inadequate support infrastructure such as roads, drainage, garbage collection, water, security and electricity. This is in contrast to the high income settlements which are characterized by well laid out streets that are properly planned with support infrastructure adequately provided for the residents.

Sanitation is a basic service that when not provided for in the settlements results in diverse effects to both the livelihoods living in these areas and the environment. In the low income neighbourhoods it is common to see wastewater flowing along the roads from the households that are not connected to the sewerage system, running directly into open drains which become breeding habitats for disease vectors. Domestic sewage flow is sometimes diverted to the storm water canals which discharge into open water bodies and this is a source of pollution to the ecosystem. The peri-urban areas of most towns in Kenya do not have adequate sanitation as the sewerage network provided by the relevant local authorities does not cover these areas therefore most often than not, people living in these areas have to find alternative solutions to the problem of human excreta management.

The goal of this work was to study the existing sanitation systems that are currently in use considering their advantages, disadvantages with greater emphasis on the sustainability of these systems. This study also examined the adoptability of the ecological sanitation as a paradigm shift from the conventional practices of human excreta management.

For purposes of this study a random sample of 231 households was identified from all the four locations of Nakuru Municipality. The survey was targeted at landlords and tenants who were randomly selected in the residential areas identified. During the survey, it was realised that the sample size was large and time

constraints, financial constraints and accuracy of results could not allow for the successful coverage of the sample size initially identified and hence the sample size was reduced to 100 households to cover specific peri-urban areas in two wards within the Municipality. The two areas selected were diverse in character and would ensure comparison of the results from the elements studied.

### **Methods of human excreta disposal**

The supply of water in Nakuru town is limited and many people do not get adequate supply to the UN recommended standards of a minimum of 20litres per person per day. Water scarcity therefore means that sanitation is not prioritized as the Municipality cannot meet the water demand of the growing population and the areas outside the Municipal boundary are not connected to the sewer system which is the conventional excreta disposal method. For the sewerage system to function well there needs to be constant supply of water so that the sewage can move along the sewers to the treatment plant. This results in large quantities of potable water being used to flush the human excreta while this water could be conserved and used as clean water in the households. The sewage is channeled to the waste water treatment plant and results in high volumes of waste water (effluent) which is then directed to natural water bodies and open canals in the environment.

The sewer system is expensive to construct and maintain given the present financial difficulties faced by many local authorities presently. This coupled with increasing population and boundaries this system is hardly ever expanded to meet this demand. Peri-urban areas most of the times do not have permanent housing therefore the sewer system cannot work in these areas.

The residents living in peri-urban areas therefore have to find alternative ways of excreta disposal. Households in these areas have resorted to the use of pit latrines which do not require water, are cheap to construct and maintain. However most often than not the pit latrines often fill up quickly and new ones have to be dug to meet the needs of the residents. Areas that are characterized by high density often have their latrines filling up at a very fast rate and this is unsustainable as there is no space left to dig up more pits in the densely populated settlements once they get full. These pits are also an environmental hazard in areas where there are fault lines which allow for seepage of the liquids from the pit latrine and this results in both pollution by pathogens of the underground water and the Lake Nakuru as some of the content finds its way into the Lake.

Peri-urban areas are characterized by dense population therefore space for digging new toilets is scarce and hence the “flying toilets” come up as a result of lack of toilets to use. In areas where the ground is rocky digging of new latrines is difficult and systems for emptying the pits are not adequately put in place. Pit latrines have a high potential of groundwater pollution through the seepage of the contents into the ground especially occurring where shallow wells are dug in the vicinity of the pits. The unsustainability of these pit latrines calls for alternatives towards excreta management for the protection of the environment and improve quality of health and life.

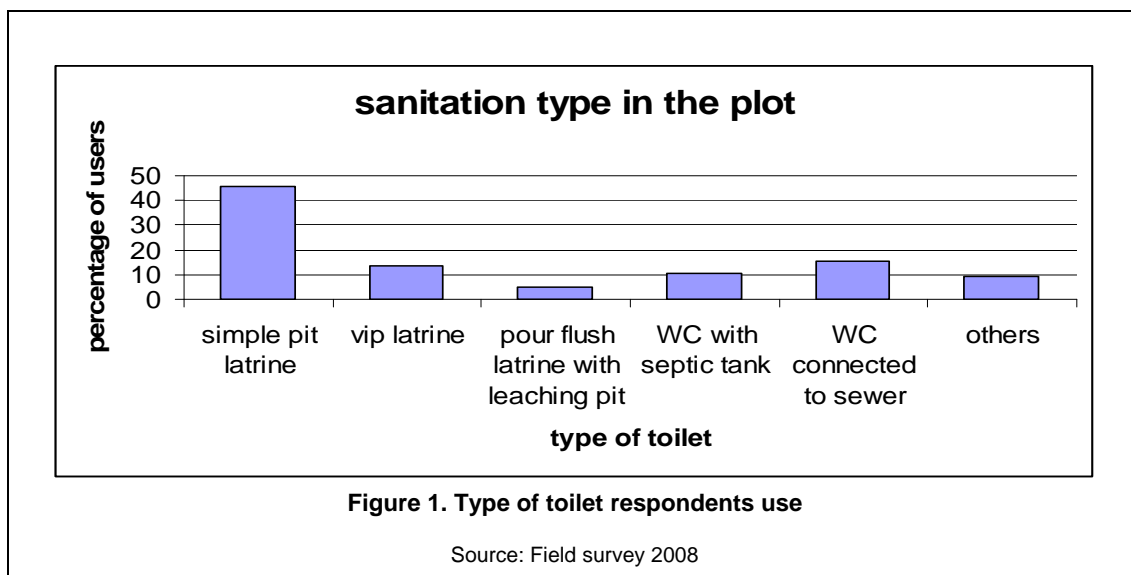
Onsite sanitation including septic tanks and cesspools are other options used especially in the middle and high income residential neighbourhoods. Once full, the collected human excreta is exhausted and the facility continues to be in use till the next emptying. These options are not viable in the low income areas as the cost of exhaustion is prohibitive and the cost of construction is also not affordable to most residents.

The paradigm shift in sanitation entails the adoption of a new system of human excreta management and this concept is the ecological sanitation technology which involves the separation of the human excreta so as to have this as a resource for reuse in agriculture which improves the yields. The concept of ecological sanitation expressly involves the construction of a urine diversion toilet which separates the solid faecal matter from the urine which is directed towards a storage tank. The solid faecal matter collects in a container positioned just below the opening on the floor of the toilet. The faecal matter is allowed to dry for a period of six months to allow for pathogen die off. The treated material can then be re-used in the farms where it is mixed with the soil as a conditioner. This acts as organic manure which improves the nutrient content of the soil and this improves production.

### ***Findings and discussion***

From the study it was established that people chose sanitation systems based on their income levels, the type of infrastructure existing within their settlement mainly the availability of sewerage services and availability of water. The type of housing that people lived in also determined the choice of sanitation used.

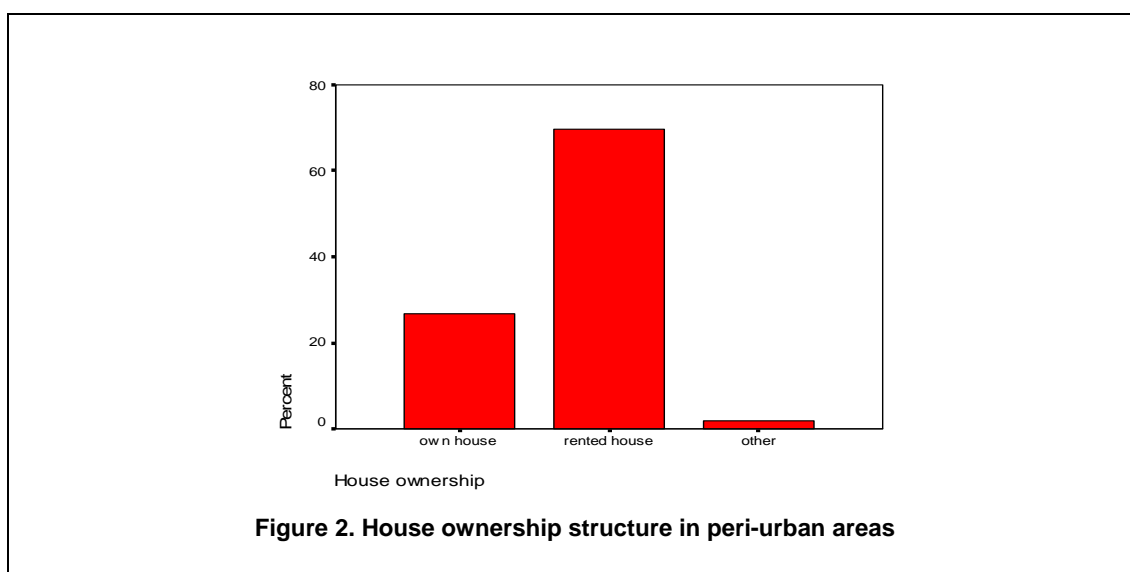
In the peri-urban areas that have no sewer connection, residents living in these areas found alternative ways of disposing off their excreta. Pit latrines were used by the majority of people notwithstanding that the disadvantages of the use of this method far outweighed the advantages in the long run. From the study it was found out that 45.9% of respondents used pit latrines as compared to 15.2 % who used water closets that were connected to the sewer and 10.8% who used water closets that were connected to septic tanks. This showed that sewerage connection or the absence of this greatly determined the mode of sanitation that was used by households. Fig. 1 below shows the methods of human excreta used by households studied.



Water supply is a major problem in Nakuru town therefore this determines the choice of sanitation to be used by the residents. This reinforced the reason why many people opted for pit latrines that helped save on quantities of water used by households on sanitation.

The income levels of the households also played a big role in determining the type of sanitation to be used. From the study the highest percentage (40.7%) of respondents were in the KShs.5,000-10,000 income bracket per month. This was low income bracket as the average person on the lower level earned approximately Ksh. 160 per day (approx 2 dollars a day, while on the higher side it is approx 5dollars a day). This amount was not able to cater for the cost of housing with adequate sanitation facilities and coupled with the increasing cost of living the respondent had to make a choice between good housing with adequate sanitation facilities provided and ability to meet the household's needs on a day to day basis. The households therefore preferred to meet the needs of the members and cope with the sanitation facilities in the plot regardless of the condition of these facilities.

Housing in peri-urban areas is mostly characterized by rows of houses with the sanitation facilities outside the houses and by the families living in the plot. The tenants, (Fig 2: 69.7% of respondents were tenants and 26.8% were landlords) living in these plots had no say in the provision of the sanitation facilities in the plot such as improving the conditions or seeking other alternatives to excreta disposal since the decision making lay with the landlord. This also influenced the initiative to improve the condition of the toilets since it was argued that the tenants could move out of the plot at any given time and any improvement was not beneficial to the household after moving to another residence.



## Conclusion and recommendations

Urban and peri-urban areas are faced with the big challenge of poor sanitation. Households that live in plots that are completely built up have problems with human excreta disposal but with the adoption of the Urine Diversion toilet, problems of toilets filling up too fast and emptying costs will be significantly reduced since the urine diversion toilet will not fill up to necessitate construction of another facility. The decision making on the incorporation of the Urine Diversion toilet and hence improved sanitary conditions in residential areas lies solely with the landlords or plot owners who need to adopt this shift in human excreta management.

The study recommended that for households living in peri-urban areas that were faced with continuous water shortages and soil structures that did not favour the construction of pit latrines, the Urine Diversion toilet was a better option towards improving sanitation. Most Municipalities are unable to expand their sewerage networks to peri-urban areas therefore alternative options have to be revolutionalised for the long term benefits of the residents.

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## Keywords

human settlements, sanitation technology, peri-urban areas, ecological sanitation.

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