Small Scale Wastewater Treatment in Ghana (a Scenerio)

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Abstract
In Ghana, urban and rural sanitation infrastructure is poor. Only a small portion of the wastewater from the urban cities (mostly domestic) is collected for treatment. The bulk ends up in drains and nearby water bodies. Conventional treatment plants are underutilized due to poor sewage network in the cities where they are located. Any significant improvement in the network will mean demolition of several buildings to make way for pipe network construction. In many other regional capitals, treatment facilities are few and even non existent in some towns. The rural areas have no means of treating the wastewater produced. Small scale or decentralized systems of wastewater treatment is seen as an alternative to solving these problems both in the big cities and small villages in Ghana and the west African sub-region as a whole.
Analysis of information shows that implementation of conventional wastewater collection, treatment and disposal systems is not economically viable as the financial and institutional resources coupled with the efficiency required for their maintenance are beyond the means of most municipalities in Ghana. Decentralised systems will be more sustainable than the conventional methods.

Background

Ghana lies on shores of the Gulf of Guinea in West Africa. Ghana is bordered in the north by Burkina Faso, Togo to the east and Côte d'Ivoire to the west. It has a population of about 20 million, growing annually at the rate of 2.7% according to population census 2002. Almost 44% of Ghana's total population lives in urban areas. Some urban centres have annual growth rates as high as 6%, more than twice the country's average rate *(Ghana Statistical Services, 2002)*.

Wastewater collection and Treatment Methods

Collection and disposal of wastewater in Ghana is;

- Conventional sewers as can be found in Tema and parts of Accra and Kumasi.
- Septic tanks system and aqua privies. These tanks are emptied by de-slugding tankers to dumping sites when they get full and are the most used systems in Ghana.

Industrial wastewater in Ghana is generated from breweries, textile, chemical & pharmaceuticals and mining industries. Most of these industries empty their wastewater into nearby drains without treatment.
Domestic and storm water in both cities and villages are discharged into open drains which finally ends up in the sea without treatment. Wastewater form kitchen and other parts of homes are directed to nearby open drains (where drains are available) or onto the bear ground. Due to unaffordable cost of construction, most of the drains in the towns and cities are open as a result they are misused, sometimes serving as defecating sites for homes without adequate toilet facility.
About half of all wastewater treatment plants in Ghana are in and around Accra *(EPA-Ghana, 2001)*. Brong Ahafo and Upper West, though administrative regions have no

treatment plant, despite having several important cities and towns. But even where treatment plants are available, less than 25% (primarily in the Greater Accra, Ashanti and Eastern regions, and mostly small-capacity and/or privately owned plants) are functional *(F.P Huibers et al)* A few years ago, a large modern biological treatment plant started operation at Accra's Korle Lagoon; but, it handles only about 8% of Accra's inner-city wastewater from domestic and industrial sources. The system has a capacity three times greater than that it currently uses, but is constrained by the small urban sewerage network. Only about 10% of the Accra's wastewater is collected for some kind of treatment *(F.P Huibers et al)*

Decentralised Wastewater Treatment

Decentralised wastewater management may be defined as the collection, treatment, and disposal or reuse of wastewater from individual homes, clusters of homes, isolated communities, industries or industrial facilities, as well as from portions of existing communities at or near the point of waste generation *(Crites and Tchobanoglous, 1998).* There are decentralised systems that combine new technology and advanced treatment methods to treat effluent to a high standard, making wastewater acceptable for reuse in gardens, for fire fighting purposes and homes as well. The available systems can be grouped into four different categories. These are the tanks systems, the pond system and filter system; which is an improvement of the tank system and root zone system. The tank systems are made up of Septic, Imhoff and Baffled tanks. The pond system talks about the duckweed, facultative pond and waste stabilization ponds.

Tank Systems

These are the septic, imhoff and baffled tanks. These are mostly used for primary treatment purposes. Septic tanks are the most common small scale decentralized system used worldwide. This may be due to its simplicity in construction, operation and maintenance. It is basically a sedimentation plant in which settled sludge is stabilized by anaerobic digestion where dissolves and other suspended particles leave the tank untreated. *(DEWATS 2002)* It is suitable for treatment of domestic wastewater.

The imhoff tank just like the septic tank is used for primary treatment of domestic wastewater. The presence of baffle wall prevents up flow of foul sludge particles from mixing with the effluent and as a result, the effluent remains fresh and odourless.

Baffled tanks system is an improvement of the septic tank. It consists of a settling tank followed by series of up flow chambers. The process of treatment is anaerobic degradation of suspended and dissolved solids. It has a high treatment efficiency compared to septic tank. *(DEWATS 2002).* Treatment with the filter system is similar to the baffled with filter media in some of the tanks. In addition, anaerobic condition is kept throughout the system.

The Pond Systems

These consist of Anaerobic and facultative and maturation Ponds. The anaerobic pond treats the wastewater through sedimentation and anaerobic stabilization of sludge *(DEWATS 2002)*. Microorganisms which require no oxygen are used to treat the sewage. The pond systems functions just like open tank. The pond systems are simple to construct, has high pathogen removal require little maintenance and good for nutrient removal.

Root Zone System

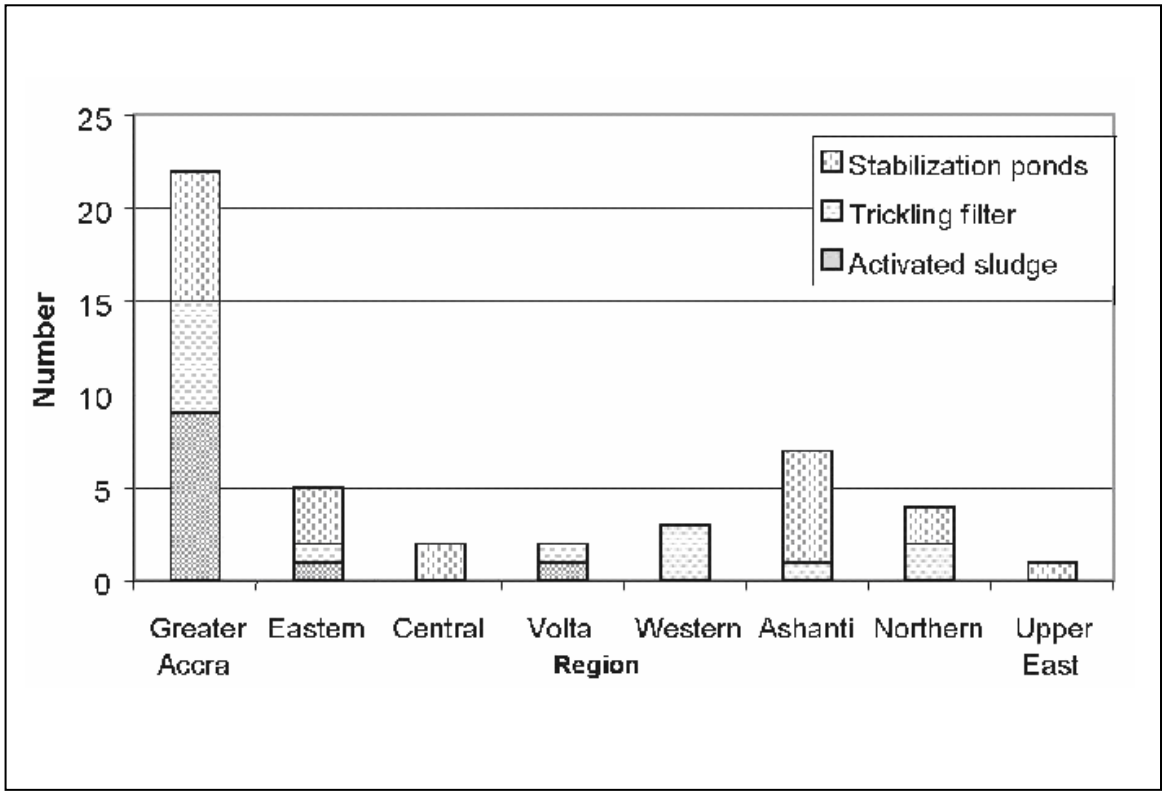
The zone system uses different species of bacteria, the root of reed plant, soil, sun, and water for treatment. It operates through horizontal flow of the waste water trough the filter, which is permanently soaked with water. The filter works partly aerobic, anoxic and anaerobic *(DEWATS 2002)*. The root zone has a high treatment efficiency and good for nutrients removal.

Sustainable Wastewater Treatment in Ghana

There are some treatment plants in Ghana at the moment. However their performances over the years and present conditions require a careful consideration. Some of the industries and abattoirs carry out some degree of preliminary treatment. There are sewerage treatment and faecal sludge treatment plants but are they able to meet the demand on them? What about maintenance? What has been the history of maintenance of the available systems? What about the construction of modern upstream anaerobic sludge blanket reactor (UASB) treatment plant (a decentralized system) on the korley lagoon? Was the construction justified, if it cannot operate at full capacity due to insufficient sewer connections?

Figures 1 and 2 shows a summary of monitoring survey carried out by the environmental protection agency (EPA), on the number, status, treatment method and distribution of both faecal sludge and sewage treatment plant in Ghana.

Figure 1: Regional Distribution and Design of waste water systems in Ghana-



Accessed from(aug.2006); http://homepage.mac.com/cityfarmer/ghana *(EPA-Ghana, 2001)*

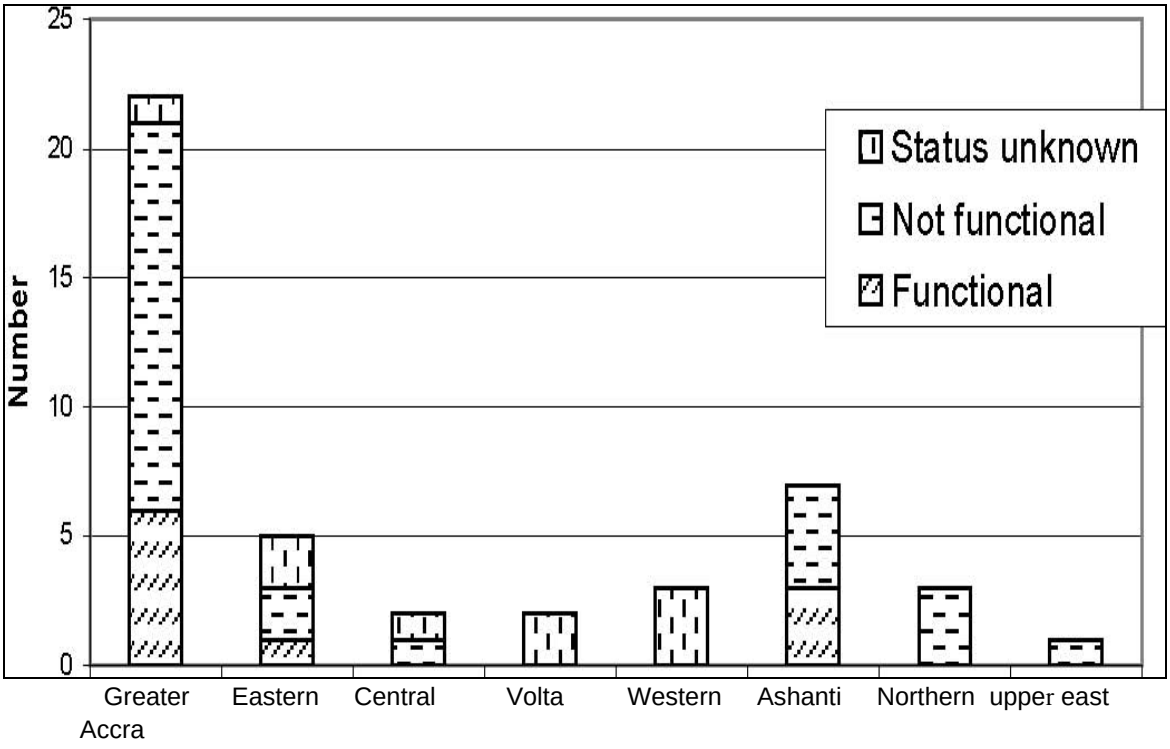


Figure 2: Regional Distribution and Design of waste water systems in Ghana-
Accessed from (aug.2006); http://homepage.mac.com/cityfarmer/ghana *(EPA-Ghana, 2001)*

Figure 1 show that there are about 23 different treatment plants in Accra alone.
Figure 2 shows that more than half of the treatment plants in Accra are not functional. Kumasi, the second largest city also has about half of its treatment plants not functional. The major treatment methods as shown in Figure 1 are:

- Stabilization Pond, located at Asafo (Kumasi), Tema community 3, Legon staff village, Achimota and Teshie Nungua, all in Accra.
- Trickling filter found at Burma camp, Nsawam prison, both in Accra and Kwame Nkrumah University of Science and Technology in Kumasi.
- Activated sludge found at La Palm, Labadi, Golden Tulip and 37 military hospital all in Accra.

The faecal treatment plants in Accra are not very good. The main plant is at Achimota with the trucks dumping at a rate of approximately 250m^3/day, follow by another one at Teshie Nungua with a dumping rate of 80m^3/day and Korley lagoon with 50m^3/day *(Sanitation and urban wastewater management-Ghana)* weather the functioning plants meet EPA effluent standard is another question. These plants cannot meet the load from the population. The situation therefore call for a more friendly, less costive, less maintenance cost, environmentally friendly but acceptable treatment efficiency.

DISCUSSION AND A SCENARIO

Efficient wastewater treatment and controlled use have proved worthwhile in reducing the health and environmental risks associated with wastewater in many developed countries. Construction and maintenance of conventional plants calls for huge investments, laying sewerage systems, especially in densely populated areas which seem economically unjustified. Urban wastewater management in Ghana is the responsibility of local municipal authorities and is mainly concerned with domestic wastewater because there are only few industrial activities and these are often along the coastline. Implementation of conventional wastewater collection, treatment and disposal systems is challenged as the financial and institutional resources coupled with the efficiency required for their maintenance are beyond the means of most municipalities in Ghana. However, the problem is more of improper sewer network construction especially in the densely populated cities.

Town and country planning departments will have to develop realistic decentralized systems in close collaboration with the private sector to research into possible implementation of decentralized systems. Special attention must be given to those currently developing suburbs around Accra, Kumasi and other regional capitals. There are opportunities to lay good and effective sewer lines for future collection of wastewater for treatment.

Baffled septic tanks system, could serve as a secondary wastewater treatment for the communities where septic tanks are already in use. Since septic tanks are used in most homes for wastewater collection, the additional components could be constructed thereby converting it to baffled tank.

The Baffled Treatment system

The baffled tank treatment system is suitable for all kinds of waste water especially for those with high level of non settleable suspended solids and low COD/BOD ratio. *(http/www.gtz.de/gate/gateid)* The system consists of several anaerobic treatment principles with at least four compartments, as shown in Figure 3.

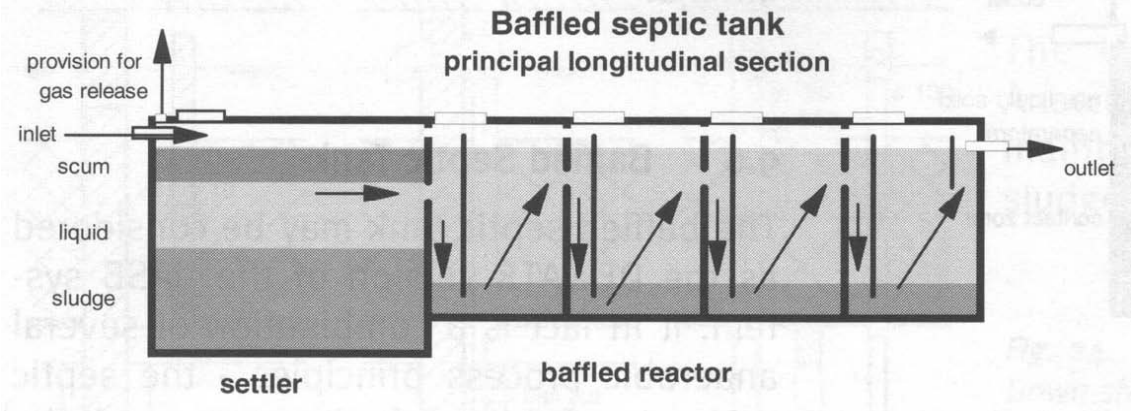


Figure 1: Schematic diagram of baffled septic tank (*Sasse, L.: DEWATS -2002)*

The first compartment is purposely for settling of larger solids and impurities. The existing septic tanks could serve the purpose of the first compartment. The first chamber is followed by series of up-flow chambers. The stream of flow from chamber to chamber is directed by baffle walls. *(http/www.gtz.de/gate/gateid).* There is intensive contact between resident sludge and fresh influent. Treatment efficiency is between 65-90% COD removal. The wastewater flows from bottom to the top so that in effect the sludge will settle against the upstream of fluid.

The baffled system is simple, durable, high treatment, relatively cheap compared to anaerobic filter and some other treatment methods *(DEWATS 2002).* The pond systems are also good but due to the odour they produce and the production mosquitoes, they may not be suitable for the climatic condition prevailing in Ghana. The Anaerobic filter is also good but due to its high cost of construction and maintenance, it will not be sustainable.
Individual house owners can build their own small baffled tanks, with the existing septic tanks serving as the first chamber to treat their sewage before they are led into receiving waters. In this way, the cost of dislodging the tanks when they are full will be saved whilst reducing the load on the few sludge treatment plants available in the country and also protecting the receiving waters from excessive pollution.
Communities such as estates and other residential areas where buildings are well laid out, one big baffled tank could be built to take care of these communities in order to save cost. In rural communities where latrines are used for sanitation purposes, these systems can be modified into baffled tanks for treatment. In the slum city areas where houses are crowded, the areas could be divided into sections where the baffled tanks could be built according to the number of sections. The baffled septic tank system is good for treatment of all kinds of wastewater (both industrial and domestic), the few industries could also treat their wastewater using the baffled system.

Conclusion

In Ghana and other low-income countries, especially in sub-Saharan Africa, efficient collection and treatment of wastewater to meet EU standard is unrealistic. Conventional waste water treatment plant cannot operate at their full capacities, due to improper sewer network to meet the plants' capacities.
Decentralised system (baffled septic tank) as described above looks more realistic as an alternative.
To make the system effective, a law has to be passed for every house owner, companies and industries to have a form of wastewater treatment. A body could be set up to over see the construction and maintenance of the systems, for them to be sustainable.
Whilst efforts are being made to control the current situation of wastewater treatment, special emphasis should be given to those currently developing suburbs around the major cities like Accra and Kumasi where there are still opportunities to lay good sewer network for future collection and treatment of waste water.

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