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A value proposition: Resource recovery from faecal sludge—Can it be the driver for improved sanitation?

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ABSTRACT

There is currently a lack of access to affordable sanitation in urban areas of Sub-Saharan Africa. This study evaluated the potential for resource recovery from innovative faecal sludge treatment processes to generate a profit that could help sustain the sanitation service chain. A total of 242 interviews were conducted in Accra, Ghana; Dakar, Senegal; and Kampala, Uganda to compare markets in different cultural and regional contexts. Products identified to have potential market value include dry sludge as a fuel for combustion, biogas from anaerobic digestion, protein derived from sludge processing as animal feed, sludge as a component in building materials, and sludge as a soil conditioner. The market demand and potential revenue varied from city to city based on factors such as sludge characteristics, existing markets, local and regional industrial sectors, subsidies, and locally available materials. Use as a soil conditioner, which has been the most common end use of treated sludge, was not as profitable as other end uses. These findings should help policy and decision makers of sanitation service provision to design financially viable management systems based on resource recovery options.

1. Introduction

In urban areas of Sub-Saharan Africa, 80% of existing sanitation access is met by onsite technologies, and the sludge that accumulates in these systems is referred to as "faecal sludge" (Koné, 2010). However, despite improvements in worldwide access to sanitation over the last decade, 70% of the population in Sub-Saharan Africa still lacks access to improved sanitation (UNICEF and WHO, 2012). One reason for this is the high economic burden that sanitation places on local governments and households. Although the private sector may fill a gap in service provision, such service is either barely financially viable for entrepreneurs or not affordable for the urban poor (Boot and Scott, 2009). Solving the sanitation problem will require innovative approaches in infrastructure, technology, and cost recovery. The lack of profitable or financially viable options for managing the entire sanitation service chain constitutes a major barrier hindering development. Finding innovative ways to create viable business opportunities in sanitation is considered a promising pathway for improvements in this sector (SDC 2004).

Viable business models could emerge from designing faecal sludge management systems around resource recovery, which would in turn help ensure sustainable provision of adequate sanitation (Murray and Ray, 2010). In urban areas where the sanitation problem is the worst, it has been demonstrated that faecal sludge management technologies have overall annualized capital and operating costs that are five times less expensive than conventional sewer based solutions (Dodane et al., 2012). However, households served by on-site sanitation technologies pay significantly more of their annual incomes for this service than households served by sewer based systems (Dodane et al., 2012). In Accra, Ghana, for example, the cost to poor households for emptying their latrine is ten times more than the percentage of household income that is

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considered to be equitable for sanitation services (Boot and Scott, 2009).

Faecal sludge management systems require many interactions among stakeholders (e.g. household, collection and transport company, treatment plant, enduse or disposal), in comparison to one utility managing a sewer-based system. The financial burden of sanitation on households and governments can be shifted by creating new value propositions from human waste. One way to generate additional financial flow is at the back-end of the service chain, by tapping into a customer segment interested in resource recovery from waste derived products (Murray and Ray, 2010). This new value proposition of selling end products following treatment would complement the existing value proposition, which is typically only an emptying service to the household customer group. With a multi-stakeholder approach to sanitation, it is important to develop commercially viable business models that depart from subsidy-driven approaches, with self-sustaining or, even profit-oriented business approaches, in which costs are recovered fully (Gebauer and Reynoso, 2013; London and Hart, 2010). An additional revenue stream by sale of products generated from treated waste could alter the financial flow of the service chain, and result in an offset of disposal costs. This could potentially reduce the amount paid at the household level, thereby increasing a household's ability to pay for service, which in turn improves the overall access to sanitation and impacts on hygiene, health and wellbeing.

Traditionally, the most common use of treatment end products has been in agriculture. An objective of this study was to evaluate whether more lucrative options exist, with the intention of contributing to the decision making process for sustainable faecal sludge management. However, it is difficult to calculate cost recovery from faecal sludge products because there have been so few treatment technology implementations, and as a result values are not known. This study attempted to identify innovative end products of faecal sludge management, their potential market demand, and their financial value in three Sub-Saharan African countries.

2. Materials and methods

2.1. Background

In order to make a cross-comparison of different cultural and regional contexts, the study was carried out in three cities in Sub-Saharan Africa: Dakar, Senegal; Accra, Ghana; and Kampala, Uganda (Fig. 1).

Dakar, the capital of Senegal, is located on a peninsula at the very western point of Africa. There are 2.5 million inhabitants in the greater metropolitan region of Dakar, 30% of whom are served by a centralized sewer system and wastewater treatment. Fifteen percent of the wastewater is treated using activated sludge technology, and the rest is discharged untreated to the ocean. The majority of residents (1.8 million) are served by a faecal sludge management system, including cistern/pour flush toilets connected to septic tanks on a household level (Dodane et al., 2012). The effluent of septic tanks is discharged into open drains or infiltrates into the subsurface.

Approximately 1500 m^3 of faecal sludge is collected daily by private vacuum truck companies and delivered to the Cambérène, Niayes, or Rufisque faecal sludge treatment plants where it is treated in settling/thickening tanks followed by unplanted drying beds. It is estimated that 6000 m^3 faecal sludge is produced daily, meaning the remaining 4500 m^3 of faecal sludge is disposed of directly into the environment (Bill and Melinda Gates Foundation, 2011). The total solids content of faecal sludge in Dakar is reported to be 3.5–4.5 g/l (Dème et al., 2009). Using an average value of 4 g/l

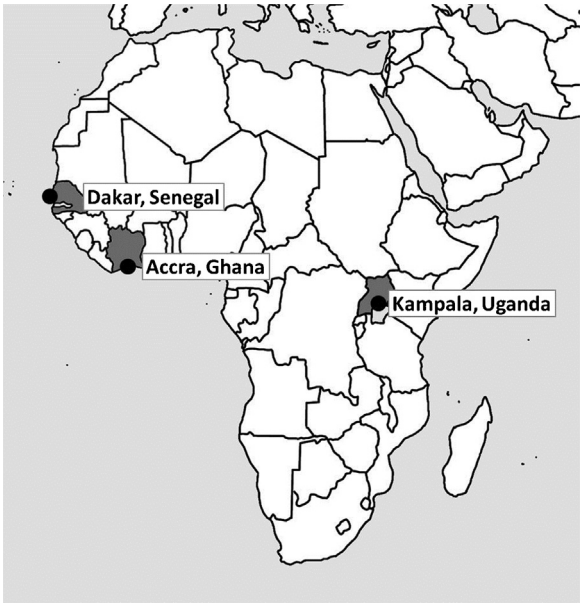

Fig. 1. Three cities in Sub-Saharan Africa where data was collected: Dakar, Senegal; Accra, Ghana; and Kampala, Uganda.

of total solids means that 6 tonnes of total solids are delivered each day to faecal sludge treatment plants, while an estimated 18 tonnes daily are dumped indiscriminately.

Accra, the capital of Ghana, is currently facing rapid population growth. In the year 2000 there were 3 million inhabitants, but by 2010 the population was estimated to be 4 million (Ghana Statistical Service, 2011). Of the metropolitan area, 15% is served by a sewer system, but with no functioning wastewater treatment plant. The majority of the population is served by onsite sanitation facilities including septic tanks, public toilets, VIP pit latrines, and bucket latrines. Sludge from onsite systems is collected and transported by private companies. Historically, there were three faecal sludge treatment plants in Accra, but none of them are currently functioning. The only current official faecal sludge dumping site is Lavender Hill at Korle-Gonno beach, which receives approximately 750 m^3/day. There is no estimate for the actual total amount of faecal sludge produced in Accra. At Lavender Hill, untreated faecal sludge is discharged directly to the ocean. The average total solids of faecal sludge in Ghana is reported to be 20–50 g/l (Cofie et al., 2009; Kuffour et al., 2009). Estimates using an average value of 35 g/l total solids results in 26 tonnes of total solids discharged daily at Lavender Hill.

Kampala, the capital of Uganda, has a population of approximately 1.7 million people, based on census data from 2002 and an average growth rate of 3.7% (Uganda Bureau of Statistics, 2006). In Kampala, 5–7% of the population is served by a centralized sewer system, and the wastewater is treated by primary clarification tanks with subsequent trickling filters. Unsewered areas of the city use onsite sanitation systems, including various types of public and private pit latrines (80%), or septic tanks (20%) (NWSC, 2004). The faecal sludge is collected and transported by various private companies and the government, operating in the city with a total of 37 trucks (Schroeder, 2011). Faecal sludge in Kampala is discharged at Bugolobi Sewage Treatment Works (BSTW). The faecal sludge is collected in a large pond intended for settling. When sludge is removed from that pond it is landfilled. The Bugolobi treatment plant receives 400 m^3/day of faecal sludge. There is no estimate for the total amount of faecal sludge produced in Kampala. The average total solids in faecal sludge of Kampala is around 50 g/l for pit latrines, and 3 g/l for septic tanks (Muspratt et al., 2014). Using these values and the distribution of different on-site systems amounts to