Assessing public perception of odours in a community: case of Ayigya Zongo, an urban poor community in Ghana
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ABSTRACT

Malodour has been identified as a barrier to utilization of sanitation facilities. It is generally recognized that for effective odour control measures to be implemented, the problem must first be quantified. With today’s increasing levels of development, odour nuisance has become a major environmental issue. Citizen complaints about and reaction to odours caused by landfills (including refuse dump sites), waste water treatment plants (most of which are non-functional), public (communal) toilets, industrial processes, and other sources have made it difficult to secure sites for such facilities. Current trends show a community impact approach based on citizen involvement. This paper discusses a rapid baseline survey carried out as part of a community odour annoyance study conducted in Ayigya Zongo, an urban poor community in the Kumasi Metropolis in Ghana. The study quantified the public perception (impact) of all odours in the community through a face-to-face interview survey utilizing a structured questionnaire protocol. Responses from the survey were analysed with SPSS software program (version 20.0). Methods, results, and conclusions of the study are each discussed.

Key words | community survey, odour, odour annoyance

INTRODUCTION

The power of odours to modify human approach and avoidance behaviour is well known. For example, the perception of a malodour can rapidly render most environments undesirable just as the perception of an unfamiliar odour can elicit rejection and withdrawal. In a study employing six different racial and ethnic groups to determine the universality of any malodour, the smell of human faecal matter was consistently rated as the most intense, the most unpleasant and the most dangerous by all groups (Dalton 1999).

Although the odour from faeces per se cannot transmit disease (through the discredited miasma theory), the association between an odour and potential adverse consequences is an extremely powerful motivator of behaviour. Thus, malodour from human faeces and urine can serve as a barrier to the utilization of sanitation facilities in many communities and when replaced by open defecation can render the community at large at greater risk from disease. Gaseous wastes, leading to air pollution in the form of odours, can have the greatest impact on the population in the vicinity of the facility. Odour emissions affect quality of life (Brennan 1993) leading to psychological stress and symptoms such as insomnia, loss of appetite and irrational behaviour (Wilson et al. 1980; Brennan 1993).

Globally, people have become more environmentally aware over the past few years. With this awareness, individuals create stronger personal definitions of the type of environment in which they wish to live. For instance, recently in Kwabenya, a suburb in Accra, the capital of Ghana, residents vehemently resisted the siting of a landfill in the area because of their anticipation of the odour nuisance that the facility could cause. Citizens now know that they want clean air, clean water, no noise, and no objectionable odours.

Increased community concerns and involvement have forced governments and facility owners/operators to take a more serious approach to the odour nuisance issue. One
method of creating community involvement is through a citizen survey.

The community survey was used to identify the sources of odours. It identified sources specific to both environmental sanitation facilities and those from other facilities in the neighbourhood. This allows planners to identify facilities and processes that are affecting the community most and help prevent them from receiving the blame for odours produced by another facility. These results are not concrete since characterization of odours is dependent on the vocabulary of descriptors used; however, in extreme cases it could prove to be very effective (McGinley 1995). Further, the survey helped to determine if the odour impact is widespread over many sections, scattered between a few sections, or limited to a small area of the neighbourhood. The survey can also help identify regions around the facility that are heavily impacted by odours but may not have produced any complaints.

**Odour perception**

A simple model of odour perception is provided by Frenchen (1994). The process is visualized in two steps, physiological reception and psychological interpretation. The end result is a mental impression of the odour.

The sensitivity of physiological reception of odours differs from person to person. Although a random variation in sensitivity is inevitable, some general influences on odour sensitivity have been identified. Sensitivity to odours declines with age (Patterson et al. 1993; Cain et al. 1995; Griep et al. 1995, 1997; Bliss et al. 1996; Fortier et al. 2007) and is also worse for subjects who smoke or have poor health or dental state (Griep et al. 1995, 1997; Fortier et al. 2007). The effects of gender on odour sensitivity have also been investigated, and although differences were found in some studies, they were not statistically significant (Cain et al. 1995; Griep et al. 1995, 1997; Bliss et al. 1996; Fortier et al. 2007).

An additional influence on sensitivity is prior exposure to an odour. This has two conflicting effects. The first is that, under continuing exposure to an odour, the sensitivity to that odour decreases. This is termed adaptation or olfactory fatigue (Dravnieks & Jarke 1980). A conflicting effect is apparent under repeated (not continuous) exposure to an odour in which case sensitivity is found to increase (Cain 1980; Leonards 1980; Laska & Hudson 1991). This is most likely due to familiarity with the particular odour and subsequent increased skill in identifying it.

The psychological interpretation of odours leads to judgements about how strong an odour is, whether it is pleasant or unpleasant, and also an impression of what the odour may be associated with. Unpleasant odours are usually associated with unpleasant things. The odours emanating from a sewage treatment works are generally associated with biological decay of organic material. Although the odours themselves may not be toxic, their association with decaying material indicates something that is best avoided as the decaying material itself can represent a health risk. The odours are perceived as unpleasant as a warning signal to avoid their source.

**The mechanism leading from smell to odour nuisance**

Pro-poor sanitation facility providers have a responsibility to minimize the negative impact of operations in the vicinity of these facilities. Odours are probably the predominant nuisance issue for onsite sanitation systems, with the potential to reach well beyond the boundaries of these facilities. Odour nuisance can develop after long-term intermittent exposure to odours that cause a negative appraisal in the individual concerned. It has to do directly with the way we value our environment. It is not a straightforward process. Our attitudes towards the source, the inevitability of the exposure and the aesthetic expectations regarding our residential environment are some of the less tangible factors that are relevant to the probability of experiencing nuisance. Once the balance tips and an environmental stressor, such as odour from human faeces, becomes a nuisance to an individual, it is very difficult to reverse the process.

The mechanism that leads from an emission of odour to the atmosphere to actual odour nuisance is quite complex as shown in Figure 1. It involves the following main factors

- the characteristics of the odour that is released (detectability, intensity, hedonic tone, annoyance potential);
- variable dilution in the atmosphere through turbulent dispersion (turbulence or stability of the boundary layer, wind direction, wind speed, etc.);
• exposure of the receptors in the population (location of residence, movement of people, time spent outdoors, etc.);
• context of perception (i.e. other odours, background of odours, activity and state of mind within the perception context);
• receptor characteristics (exposure history, association with risks, activity during exposure episodes, psychological factors such as coping behaviour, perceived health and perceived threats to health).

MATERIALS AND METHODS

Description of study area

The study was conducted in Ayigya Zongo, an urban poor community (slum). Ayigya is a suburb in the Oforikrom Sub-metro of Kumasi Metropolis. It is located in the eastern part of Kumasi along the 24th February Road (Kumasi–Accra road) and shares boundaries with Kwame Nkrumah University of Science and Technology (KNUST) to the south, Susanso to the west, Kentinkrono to the east and Asokore Mampong to the north. In 2000 the population stood at 30,283, increasing to 40,548 in 2010, representing an intercensal growth rate of about 3.0%.

Most residents do not have household toilet facilities and as such patronize the public toilet facilities. This puts excessive pressure on the existing public toilet facilities. According to KMA (2011), there are a total of 11 public toilets in Ayigya. However, this study considered four public toilets (as shown in Figure 2) due to their location with respect to the objective of the study: odour nuisance from public toilet facilities. Of those respondents who use the available public toilets 69.7% indicated that they were in bad condition with cracked walls, holes blocked with faeces, and no proper cleaning of the place (Dinye & Acheampong 2013). This makes it uncomfortable to use the facility but that was the only option for them. Waiting in queues to access the public toilets was a common feature at all the toilets. This was particularly evident during the early mornings between the hours of 5.30–7.30 GMT and in the evenings between 18.00 and 19.30 GMT. On average there is a user rate of 56 persons per day per squat hole which is more than twice the design standard of 25 persons per day per squat hole.

Regarding liquid waste disposal, two-thirds (66.7%) of the respondents disposed of their liquid waste in drains outside the house while nearly one-third (29.3%) disposed of their liquid waste in drains inside the house (Dinye & Acheampong 2013). These drains are in poor condition and choked with solid waste. As a result, flow of wastewater (mainly grey water) through the drains is stagnant, serving as breeding grounds for mosquitoes and other disease-causing organisms. Furthermore, there is foul smell that emanates from these drains.

Community survey

Purpose of survey

Currently, there are three main methods used by facility operators to determine the impact of their odours on the surrounding community (McGinley 1995). These include: odour dispersion modelling, neighbourhood ‘drive through’ by

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**Figure 1 |** Mechanism leading from emission of odour to complaint. Source: adapted from Environmental Research (2001).
facility operators, and community complaints (McGinley 1995). Community surveys can also benefit a facility when used in conjunction with and/or instead of the other previously mentioned methods. First, the survey can be used to validate dispersion modelling. The survey can give testimony for or against a model’s predictions of the odour impacts on a community. This would give a certain confidence level in the model data and allow the facility to make better decisions about which model scenarios to follow in order to reduce their odour impact (McGinley 1995). Second, the survey can be used to identify the sources of odours. It could identify sources both specific to the facility and those from other facilities in the neighbourhood. This would allow the facility operator to identify the processes which are affecting the community most and help prevent them from receiving the blame for odours produced by another facility. These results are not concrete since characterization of odours is dependent on the vocabulary of descriptors used; however, in extreme cases it could prove to be very effective (McGinley 1995).

This survey was, however, carried out to establish that there is odour nuisance in the community and identify other sources of odour.

The survey

The survey was carried out over a period of 1 week in October 2013. The survey was conducted taking the whole community as the sampling area because of the even spread of the public toilets. Only adult respondents (18+) were considered.

Through census data, the population of residents within this area was estimated. The sample size was determined by using the mathematical formula, \( n = N/[1 + N(\alpha)^2] \), where \( n \) is the sample size, \( N \) is the sample frame, \( \alpha \) is the margin of error and 1, a constant. The population size of the

Figure 2 | Spatial map of Ayigya Zongo showing area considered for studies.
community was projected from the 2010 population and housing census results for a more representative size. Using the regional intercensal growth rate of 3.0%, the population was projected using the compound growth rate formula 

\[ P_t = P_0(1 + r)^t, \]

where \( P_t \) is the projected population after time, \( t \), \( P_0 \) is the current population, \( r \) is the population growth rate, and \( t \) is the time in years between the last known population figure and the year for which the projection is being estimated. The sample size estimation is presented in Table 1.

Enumerators who could interpret the survey questions in the local language were recruited and trained. Structured questionnaires were prepared and pre-tested. Respondents were selected by simple random sampling. To solicit responses from individuals, they were first asked if they were above or below 18. Only those above 18 were considered and a brief explanation of the survey was given. If the individual volunteered for the survey, then the enumerator would first record referencing data for the individual on a data sheet. The referencing data included was narrowed to the house number of the respondent. The enumerator then investigated the individual’s awareness of odours in the community. The questions asked were created to investigate the community’s awareness of and annoyance about odours in their neighbourhood without taking up a great amount of time.

If residents were able to name or describe the odour source (e.g. drain, public toilet, refuse dump in the neighbourhood) and/or describe the odour quality correctly (such as offensive, chemical, fishy, etc.), they were counted as being exposed and their odour annoyance was taken into account.

However, the studies did not include data collection for spatial analysis.

Data analysis

Data from the questionnaires were entered into the SPSS software program (version 20.0) and descriptive analysis computed.

Differences between responses in terms of the distribution of age and gender were tested by means of chi-square (\( \chi^2 \)).

RESULTS AND DISCUSSION

Respondent characteristics

Characteristics of respondents with respect to age group and sex are shown in Table 2. As stated above, the survey targeted adults (individuals aged 18 years and above). Though respondents were picked randomly, the results show a fairly even spread across the various age brackets. The results further show that the 18–50 years age group forms the majority of respondents [90.7% (729)] of which the 31–40 years age group is the largest [42.2% (339)]. This confirms the fact that urban poor communities have a higher percentage of the population in the working age group, which is 15–59 (Ghana Statistical Service).

Odour exposure

Percentage distribution of response to notice of odour is presented in Figure 3. Results of the statistically significant

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010 population of Ayigya</td>
<td>40,548</td>
</tr>
<tr>
<td>Regional intercensal growth rate (2000–2010)</td>
<td>3.0%</td>
</tr>
<tr>
<td>Projected population to 2013</td>
<td>44,308</td>
</tr>
<tr>
<td>National percentage of adult population (above 18 years)</td>
<td>55.2%</td>
</tr>
<tr>
<td>Estimated adult population of Ayigya</td>
<td>24,458</td>
</tr>
<tr>
<td>Sample size</td>
<td>804</td>
</tr>
<tr>
<td>Confidence level (margin of error)</td>
<td>96.5% (0.035)</td>
</tr>
</tbody>
</table>

Table 2 | Sex and age group of respondents

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Male, % (n)</th>
<th>Female, % (n)</th>
<th>Total, % (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>18–30</td>
<td>12.2 (98)</td>
<td>17.5 (141)</td>
<td>29.7 (239)</td>
</tr>
<tr>
<td>31–40</td>
<td>18.8 (151)</td>
<td>23.4 (188)</td>
<td>42.2 (339)</td>
</tr>
<tr>
<td>41–50</td>
<td>8.0 (64)</td>
<td>10.8 (87)</td>
<td>18.8 (151)</td>
</tr>
<tr>
<td>51–60</td>
<td>3.7 (30)</td>
<td>5.5 (44)</td>
<td>9.2 (74)</td>
</tr>
<tr>
<td>&gt; 60</td>
<td>0.1 (1)</td>
<td>–</td>
<td>0.1 (1)</td>
</tr>
<tr>
<td>Total</td>
<td>42.8 (344)</td>
<td>57.2 (460)</td>
<td>100.0 (804)</td>
</tr>
</tbody>
</table>

Mean – 34 years; standard deviation – ±0.963.
difference test carried out are shown in Table 3. With the probability levels (P value) of both hypotheses greater than 0.05, neither hypothesis can be rejected. In other words, there is no statistically significant difference between notice of odour and sex and age of residents.

**Source of odour and annoyance**

Odour annoyance levels were reported by 677 respondents from various sources. Figure 4 shows the various sources of odour and their related annoyance levels. Other sources of odour reported include crude small-scale activities such as corn mills, manufacturing of insecticides, livestock rearing (sheep and poultry) and brewing of local drinks (popularly called ‘pito’).

It is evident from the results that a high proportion of odour annoyance is caused by environmental sanitation-related facilities (drains, communal toilets, refuse dumps), contributing about 94% of complaints. Odours from drains are greatest among these facilities due to the direct disposal of human excreta, solid waste, grey water and urine into these drains. The biological decomposition of all these waste streams produces odorous gases. Drains (both lined and unlined) cover a relatively large surface area of the community, hence contributing to the largest source of odour complaint. Covered drains could be considered over open drains to prevent the

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**Table 3 | Statistically significant difference test**

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Df*</th>
<th>Chi-square</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Notice of odour is independent of sex of</td>
<td>1</td>
<td>1.067</td>
<td>0.303</td>
</tr>
<tr>
<td>respondents</td>
<td></td>
<td></td>
<td>(P &gt; 0.05)</td>
</tr>
<tr>
<td>Notice of odour is independent of age of</td>
<td>4</td>
<td>2.263</td>
<td>0.687</td>
</tr>
<tr>
<td>respondents</td>
<td></td>
<td></td>
<td>(P &gt; 0.05)</td>
</tr>
</tbody>
</table>

*Degree of freedom.

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**Figure 4 | Reported sources of odour and their related annoyance level.**

<table>
<thead>
<tr>
<th>Source</th>
<th>Extremely Annoying</th>
<th>Very Annoying</th>
<th>Annoying</th>
<th>Some annoyance</th>
<th>Definitely Not Annoying</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communal Toilet</td>
<td>69</td>
<td>55</td>
<td>30</td>
<td>18</td>
<td>1</td>
</tr>
<tr>
<td>Drains</td>
<td>117</td>
<td>141</td>
<td>91</td>
<td>55</td>
<td>4</td>
</tr>
<tr>
<td>Others</td>
<td>9</td>
<td>19</td>
<td>3</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Refuse Dump</td>
<td>22</td>
<td>23</td>
<td>6</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Urine</td>
<td>2</td>
<td>7</td>
<td>3</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>
direct disposal of other waste streams such as human excreta and solid waste. Furthermore, odorous gases which are produced as a result of biological decomposition will be largely contained and can escape into the environment at the final point of discharge. Owing to the localized nature of this point, odour abatement methods can be applied with relative ease.

Communal toilets and refuse containers are placed at designated sites (so called sanitary sites); hence respondents who live within a certain radius of these sites complain of odour from them. Further analysis shows that of the odour annoyance responses for each source, 40% of respondents who traced their source of odour to a communal toilet perceive the odour as extremely annoying (36%, 29% and 26% for refuse containers, drains and other sources, respectively). This result confirms the conclusion of Dalton (1999) that the smell of human faecal matter is rated as the most intense and most unpleasant.

**Frequency of odour exposure**

Responses on odour annoyance levels show that ‘extremely annoying’ and ‘very annoying’ have the highest frequency: 221 and 249 times, respectively (total of 470 out of 710 responses), as shown in Figure 5. Results also show that a higher proportion of the ‘very annoying’ and ‘extremely annoying’ odour perceptions occur ‘all the time’. The ‘definitely not annoying’ response accounted for only about 1.1% of responses.

**Odour description**

Responses obtained for odour description include ‘offensive’ (94.5%), ‘vegetable’ (2.5%), ‘chemical’ (1.6%) and ‘fishy’ (1.4%) as presented in Figure 6. The high response of offensive is consistent with the earlier assertion that environmental sanitation facilities are the major sources of odour in the community. Offensive odours include fecal (possibly from communal toilets), urine, sewer, septic (possibly from indiscriminate disposal of human excreta, grey water and urinating into drains) and landfill leachate (possibly from refuse dumps) odours.

**CONCLUSION**

The results of this study show that a community survey can be used to establish odour nuisance in a community and also to identify other sources of odour and activities which
hitherto were not known. Through this study, local authorities have found out that there is small-scale manufacturing of chemicals within the locality. Also, the survey has confirmed the need for further studies into thorough odour assessment with more scientific approaches such as atmospheric modelling and laboratory-scale analysis of odour-forming substrates. These further studies will lead to recommendations for improving the design and operation of these facilities to abate odour nuisance.

ACKNOWLEDGEMENT

This study was financed by the Bill and Melinda Gates Foundation under the SaniUp project.

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First received 13 June 2014; accepted in revised form 2 December 2014. Available online 11 February 2015