



University of Colorado
Boulder

Duke University / University of Colorado Boulder Sanitation Odor Survey

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1. Overview & Highlights

1.1. Survey Overview

- Designed and administered using Qualtrics
- Responses gathered from June 25, 2015 through March 22, 2016

1.2. Respondents

- Total respondents (n) = 258
- Participants were recruited from 2015 Fecal Sludge Management Conference attendees, the SuSanA on line sanitation forum, 2014 Delhi Toilet Fair exhibitors, and referrals from respondents who completed the survey themselves.
- Respondents were heavily weighted toward solution providers (47%), on-site researchers (39%) and sanitation technology developers (36%). 31% of respondents described themselves as users. Most respondents identified with multiple roles.
- 53% of respondents described themselves as having 5 or more years of first-hand experience with sanitation in developing countries. An additional 35% had 2-4 years' experience.

1.3. Sanitation Systems Described

- Each respondent was asked to describe up to 3 different sanitation systems. In total, the 258 participants provided data on 265 systems.
- Sanitation systems were profiled in terms of six subcomponents or stages in the sanitation value chain: the location of defecation (here the terms 'toilet' and 'latrine' were used interchangeably), on-site containment, waste transport, waste processing, application of treated byproducts, and the release of untreated waste. Systems are made up of anywhere between one and all six of these components.
- Sanitation systems in 57 different countries were described. The top three countries accounted for only 23% of all systems; they were India (40 systems), Kenya (32) and Uganda (20).
- The toilets described were spread somewhat evenly across urban (34%), peri-urban (29%) and rural (37%) settings. More private toilets (single or multiple family use, 48%) were cited by far compared to any other category.

1.4. Key Outcomes

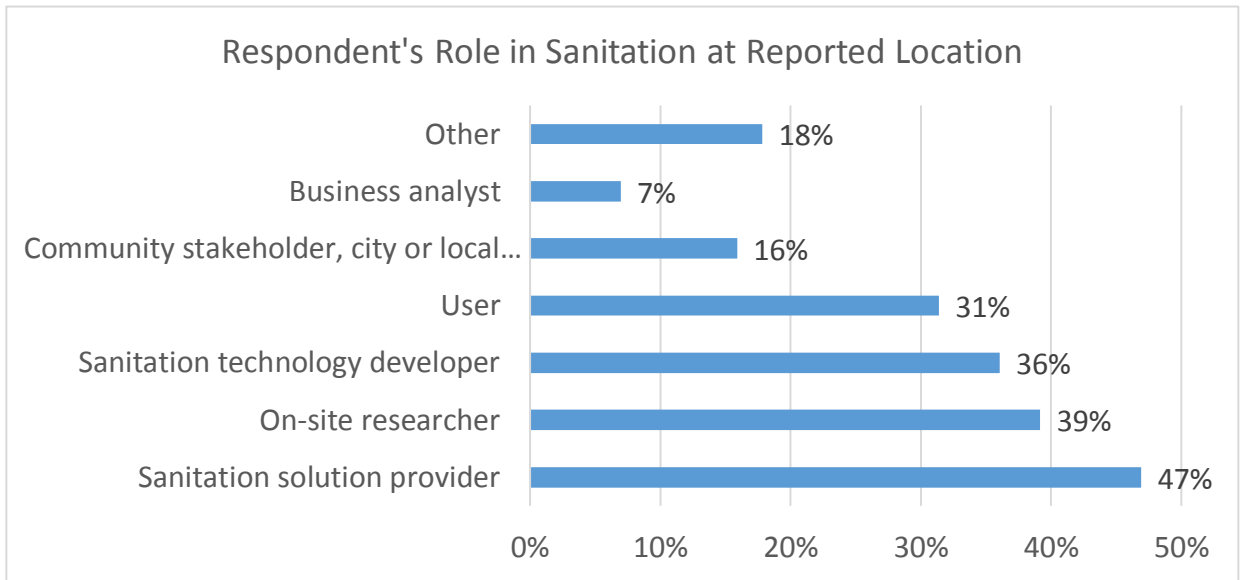
- 94% of respondents felt malodor was an important barrier to toilet adoption.
- Odor at the location of defecation itself (at the toilet) was ranked fourth among system components for very bad or unbearable odor (27%). Odor associated with the release of untreated waste was ranked as the most severe (51% very bad or unbearable), followed by transportation of waste (38%), then processing of waste

- (31%). Eliminating the release of untreated waste into the environment would simultaneously address the source of the most severe sanitation related malodor.
- For all six stages in the sanitation value chain, *'both poor design/technology and poor maintenance/operation'* was selected as the most common cause of odor with 43-56% of the responses. The causes *'generally poor design/technology'* and *'generally poor maintenance/operation'* were the second and third most frequently chosen response for every location, receiving a very similar number of votes. Still, the second highest ranked response was 17 to 44% below the number one response in each case. *'Exclusively poor design/technology'* and *'exclusively poor maintenance/operation'* were only chosen 2-9% of the time.
 - For toilets specifically, numerous factors play a role in the degree of odor, but cleaning and maintenance had the strongest influence according to survey results.
 - The impact of sanitation odor was varied, with 235 respondents identifying 606 effects. The top three responses were (1) odor attracts flies and other bugs (42% of the responses), (2) users are forced to endure the unpleasant odor (also 42% of the responses), and (3) individuals choose open defecation instead (36%). This question was asked with regard to sanitation odor in general and not linked to any specific source of that odor.
 - 51% of participants felt that some progress has been made in addressing sanitation malodor. 28% felt that no progress has been made at all. Only 3% (5 respondents) felt that most odor issues have been resolved.
 - In free form responses, participants shared numerous successful odor control measures in use at different stages in fecal sludge management. In addition to specific methods of cleaning, urine separation, odor seals and ventilation in toilets, the successful use of dry additives to the waste was frequently cited (sawdust, ash, lime) as well as the successful use of odor reducing chemicals in the latrine.
 - Educating end-users on proper operation and maintenance was cited by many respondents as both a successful method being employed and an area needing more work to overcome odor problems.
 - The tradeoff of masking or neutralizing odors that may serve to warn users of unsanitary conditions which could threaten their health was also shared by several participants as an important unresolved issue.
 - Issues presented as needing more research and development were diverse. The need for simple, low cost, water efficient solutions was a common theme. Better chemical products for cleaning and odor control, a better understanding of the factors contributing to odor, and better ways to measure odor were also common.

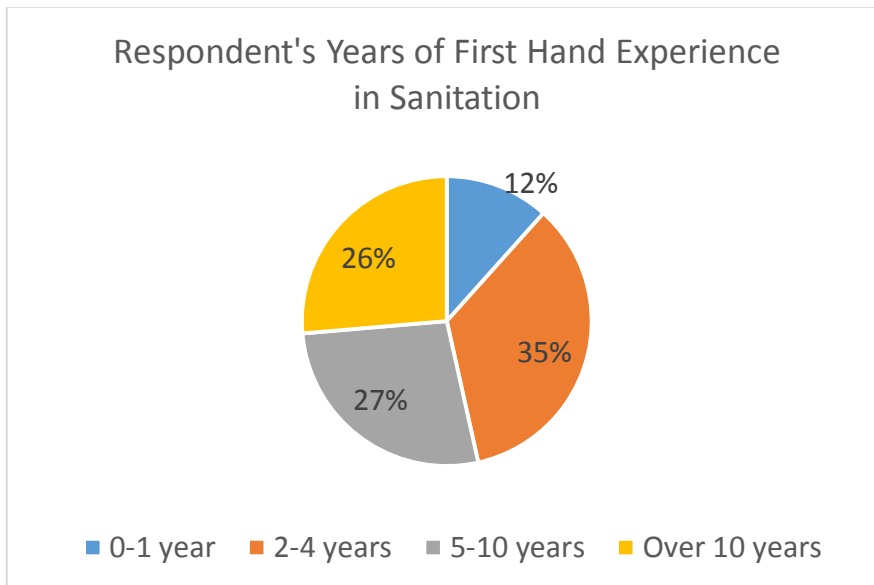
2. Respondent Profiles and Perspectives

258 individuals responded to our survey with differing amounts of information. The following questions describe our respondents themselves.

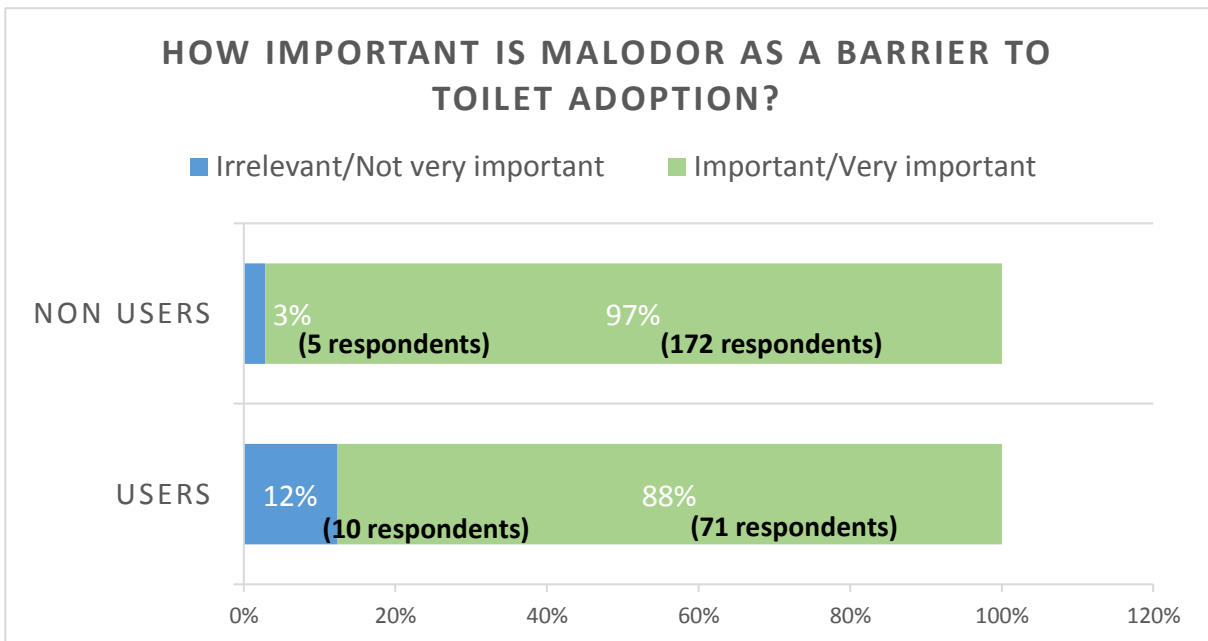
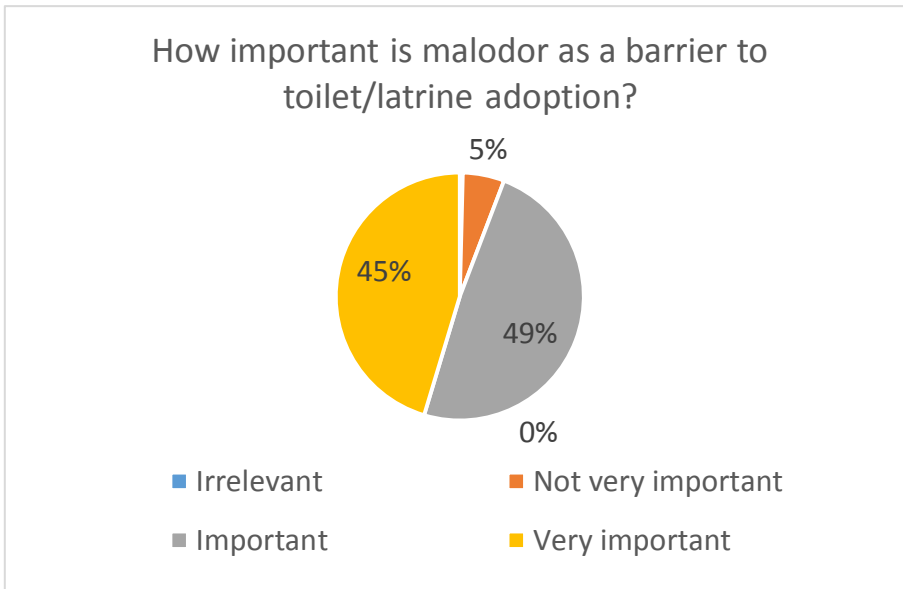
2.1. Please select all of the following that describe your role with regard to sanitation in developing countries: (n=258)



2.2. How many years of first-hand experience do you have in this sector? (n=258)

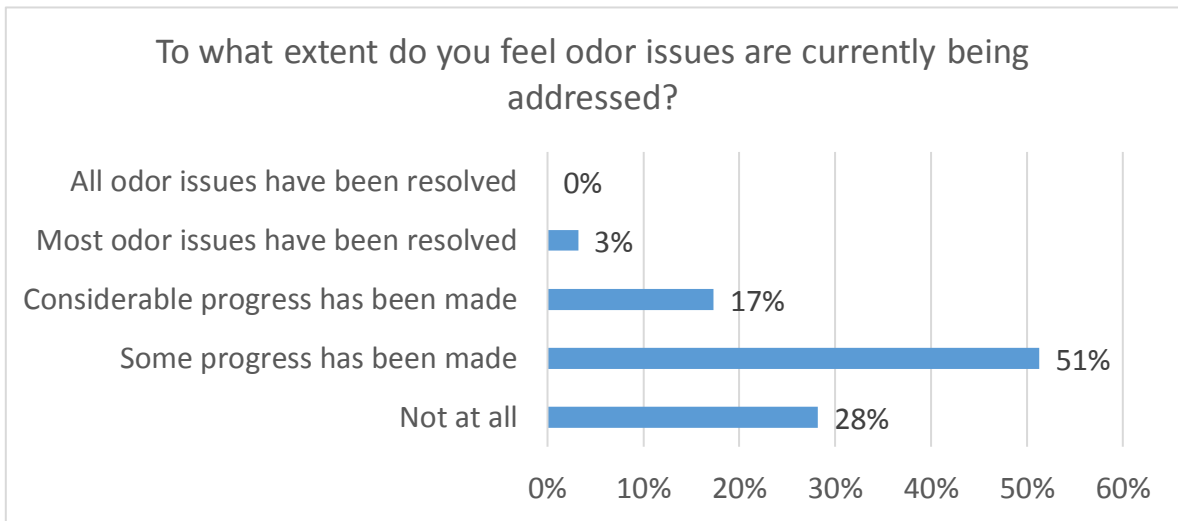


2.3. In your experience, how important is malodor as a barrier to toilet/latrine adoption? (n=258)



Though not statistically significant, it may be interesting to note that more users felt malodor was irrelevant or not very important to toilet adoption than did non users.

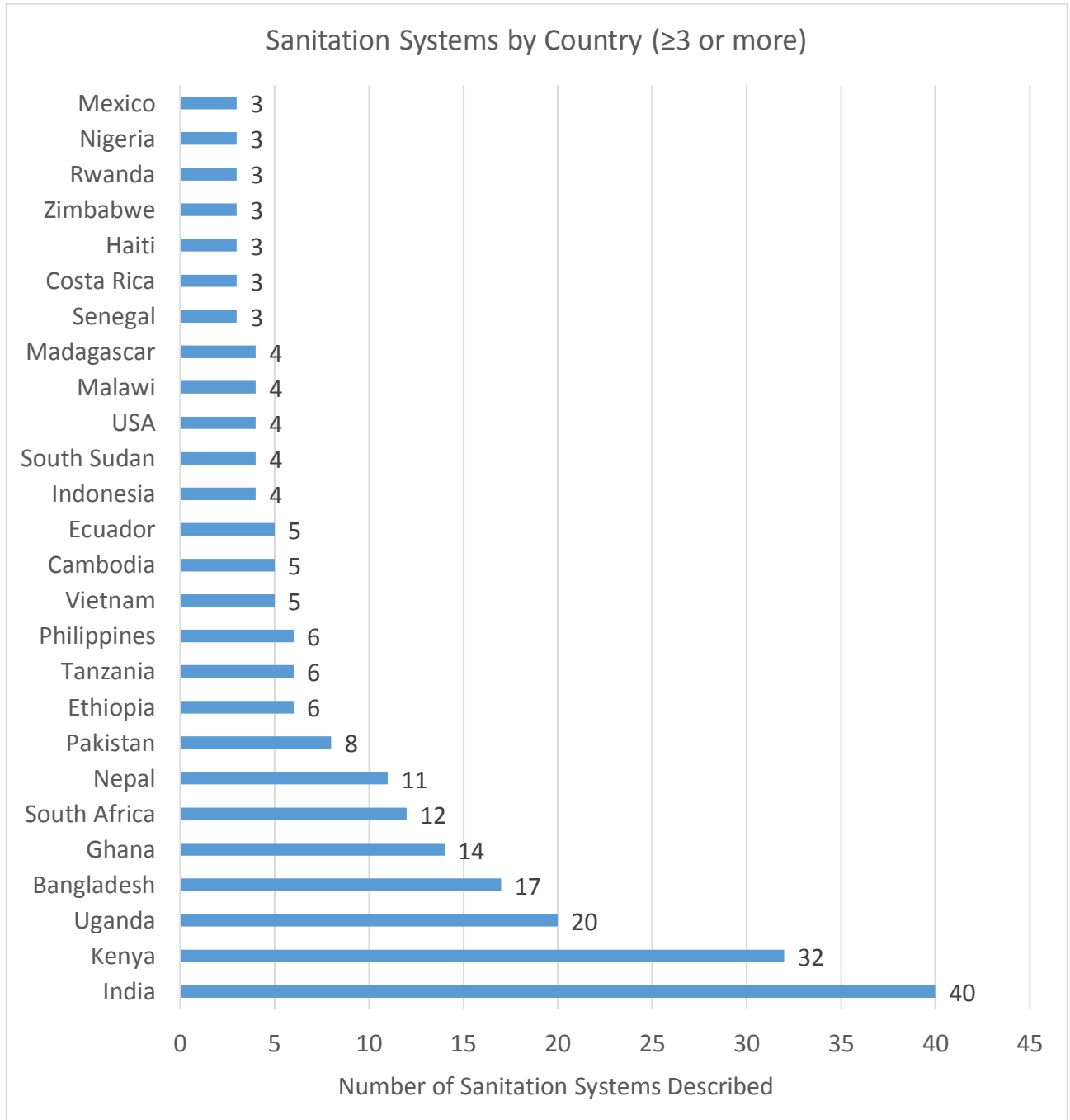
2.4. To what extent do you feel odor issues in fecal sludge management are currently being addressed? (n=156)



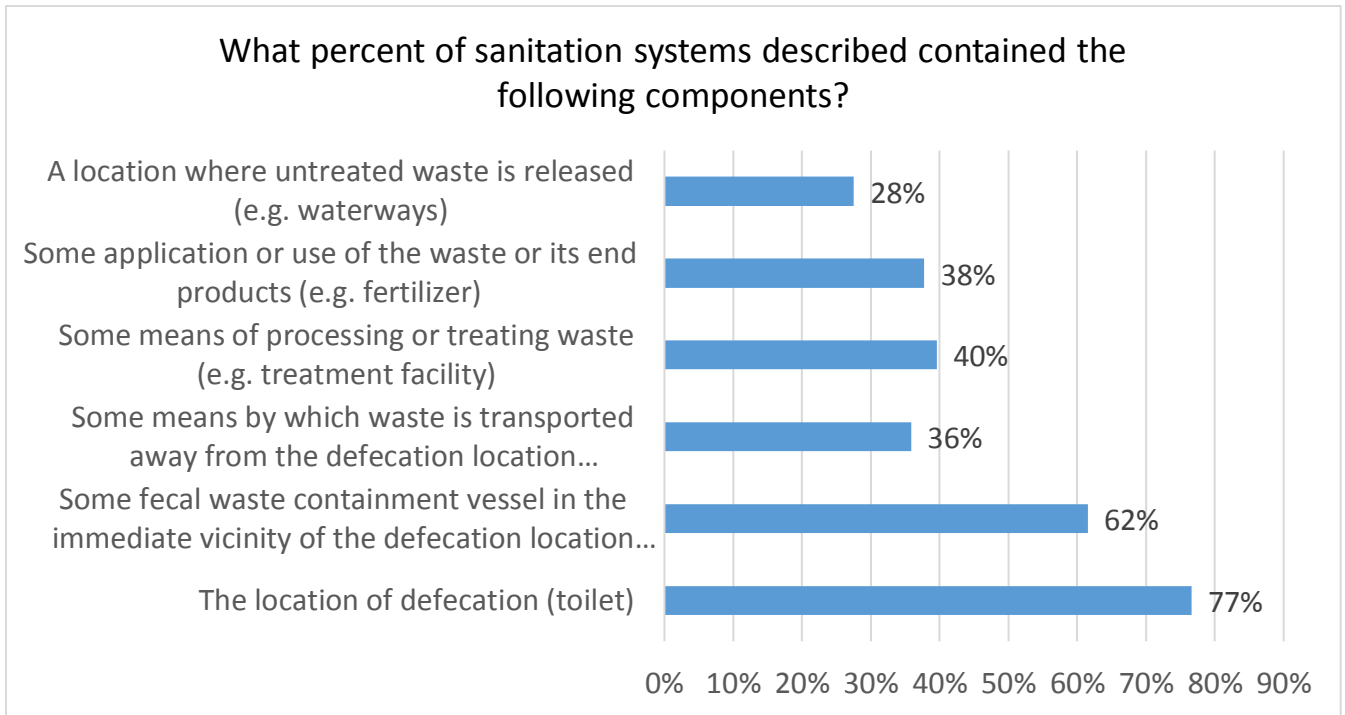
3. Sanitation Systems and Their Odor

265 sanitation systems were profiled by respondents. The following data describes those systems, the components that make them up and some odor related highlights. Where numbers are overlaid on the bars in a graph, they represent the number of respondents.

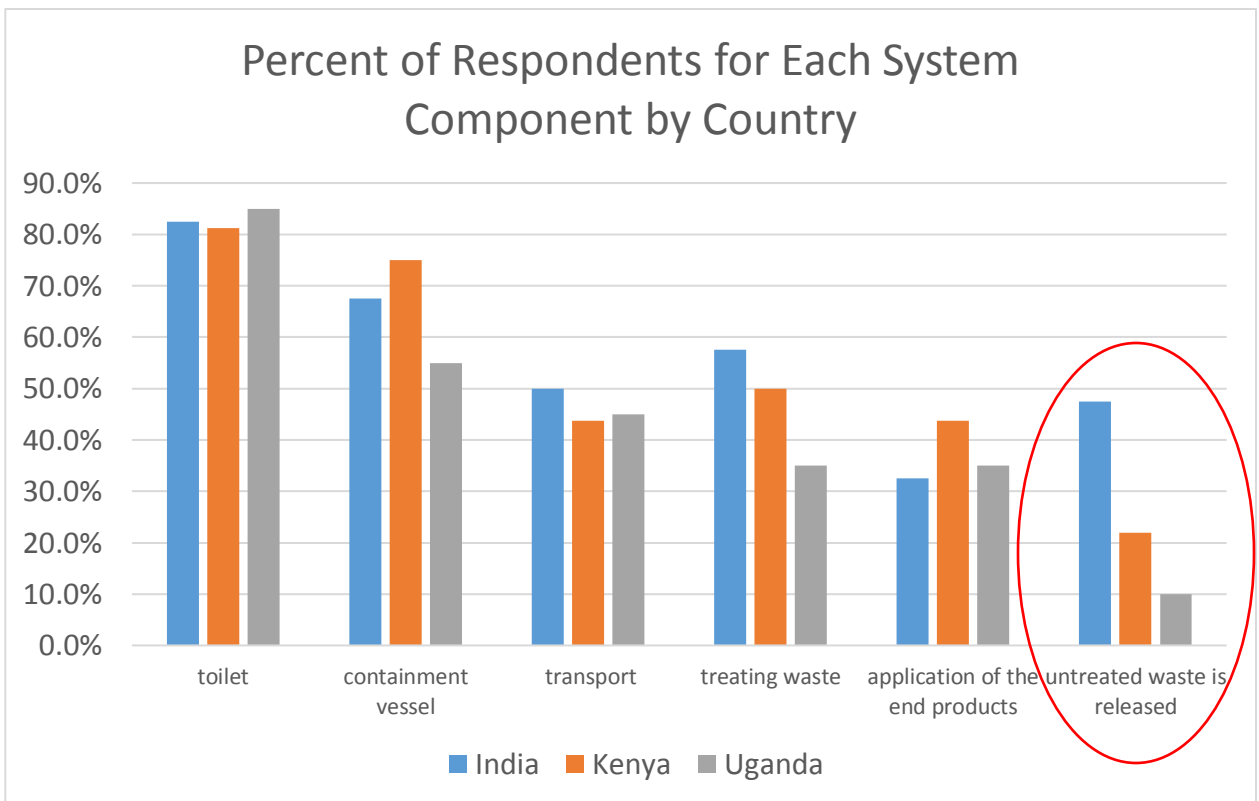
3.1. Select the country in which the sanitation system for which you'll provide feedback is located. (n=265)



3.2. Components that make up the 265 sanitation systems described:

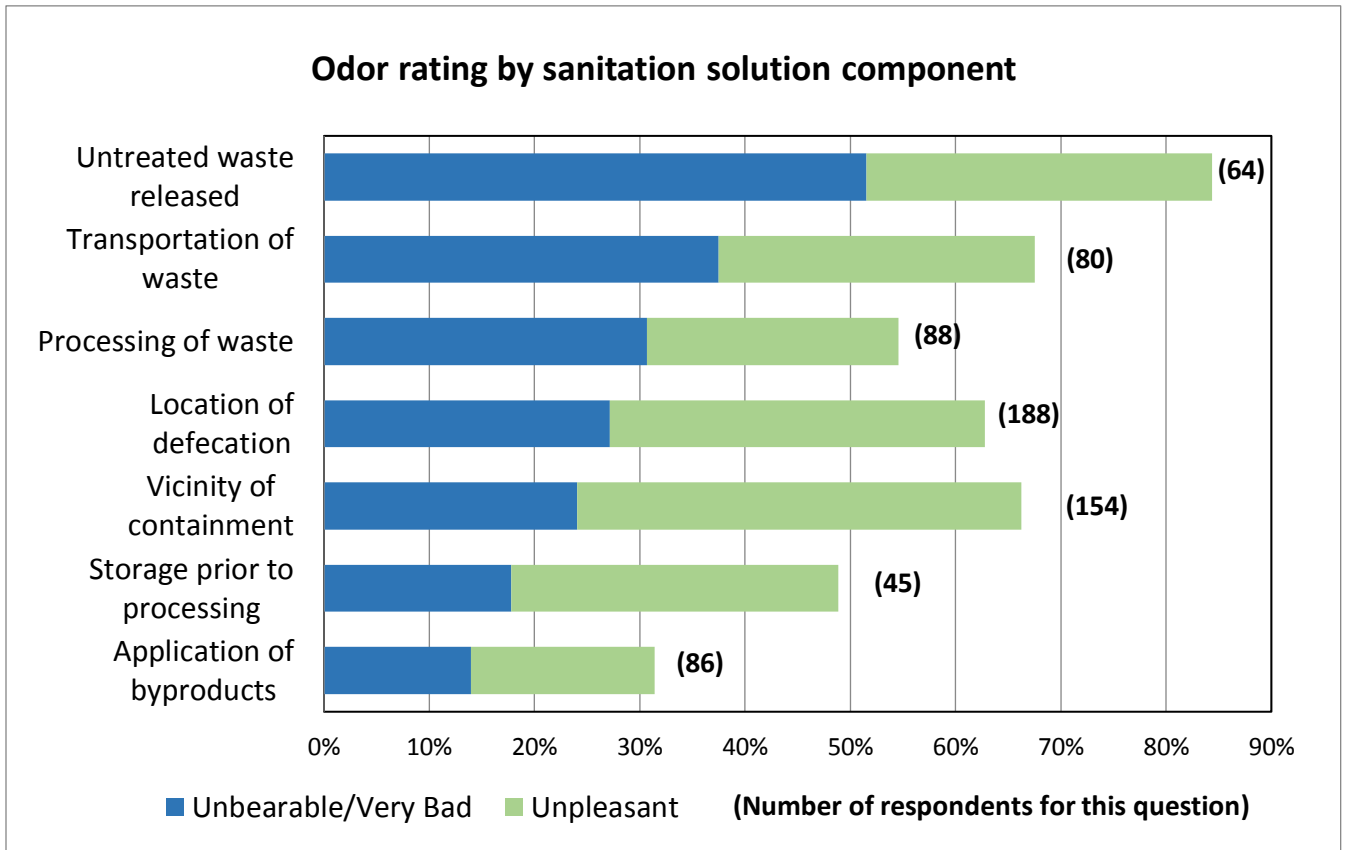


3.3. Components that make up the systems described by country:



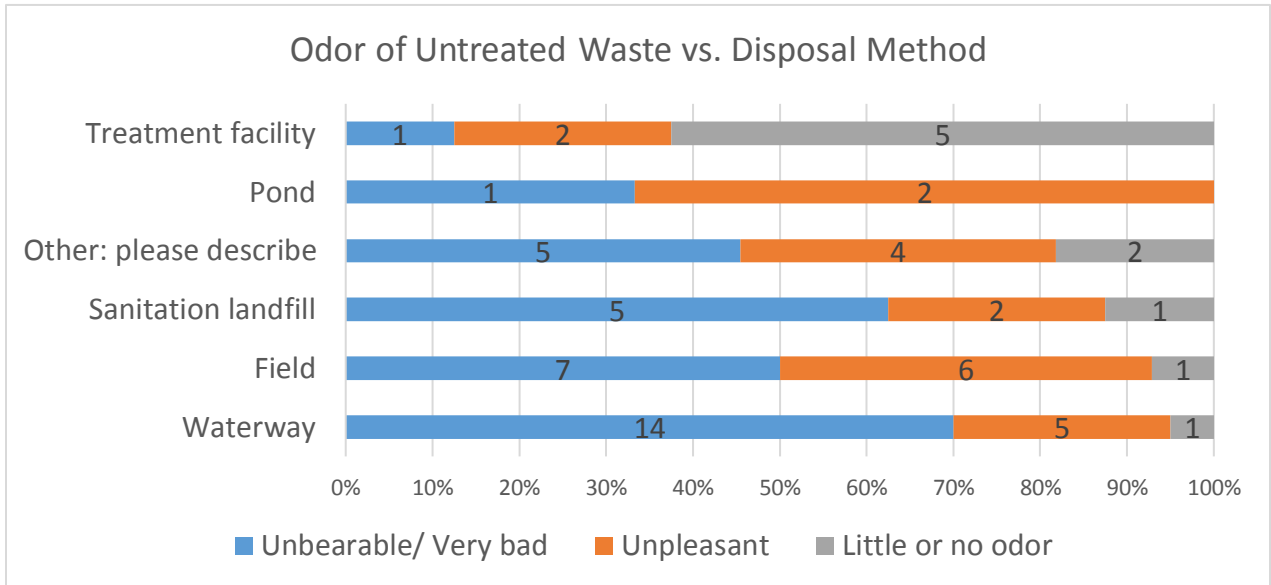
A higher percent of respondents describing sanitation systems in India reported on untreated waste being released (48%) compared to those in Kenya (22%) or Uganda (10%). Again, it is important to note the total responses from these countries were low (40, 32 and 20 respectively).

3.4. Where in the sanitation value chain does odor present the biggest problem?



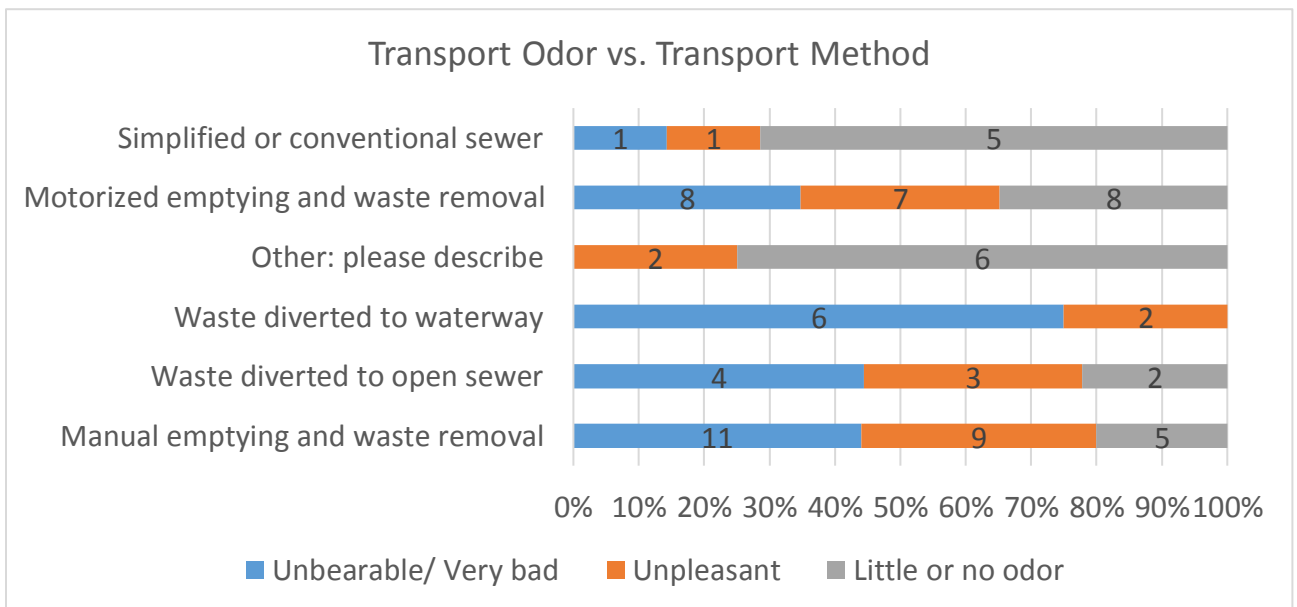
Odor at the location of defecation (at the toilet) was ranked fourth among system components. Odor due to the release of untreated waste was ranked most severe.

3.5. Odor of untreated waste by disposal method



Odor from the disposal of untreated waste in waterways and sanitation landfills was ranked worse than other disposal methods. Eliminating the release of untreated waste into the environment by any method would simultaneously address the source of the most severe sanitation related malodor.

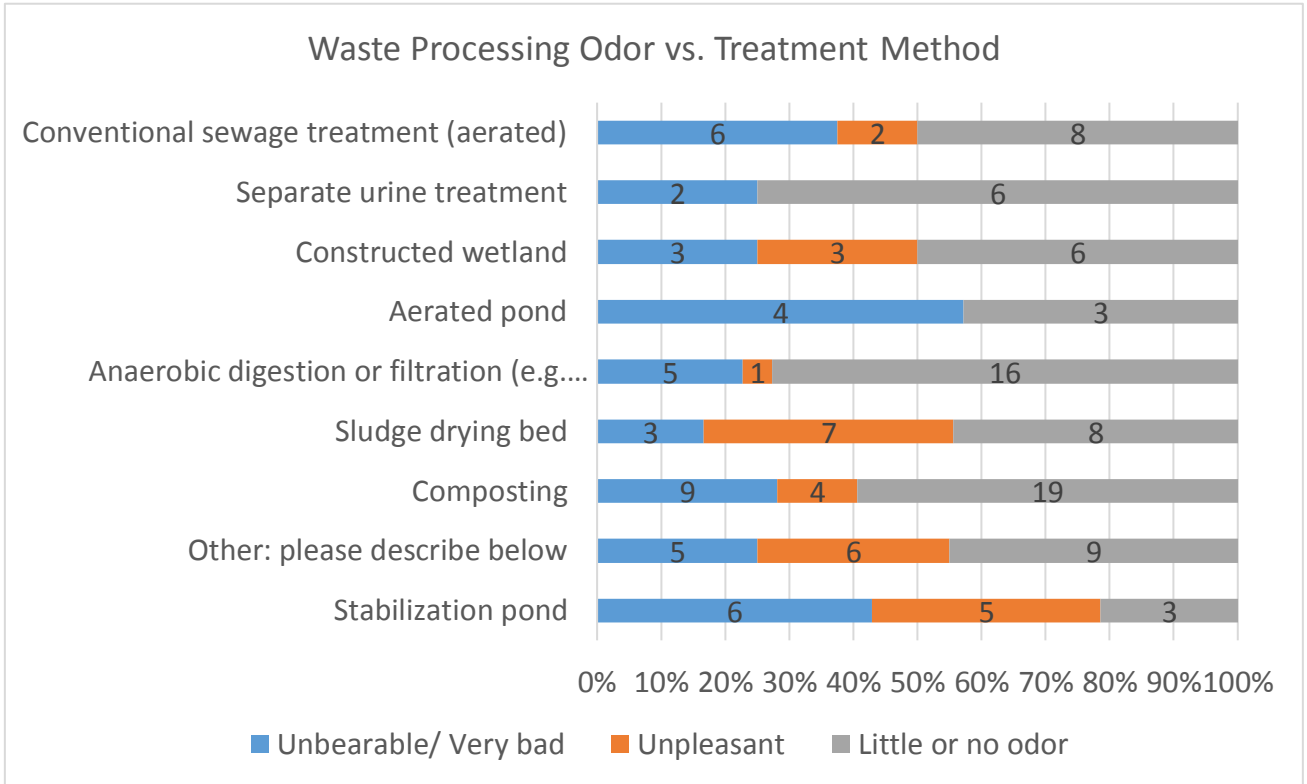
3.6. Odor of waste transport by transportation method



Among transportation methods, waste diverted to waterways or manually emptied were rated as having the worst odor. Odor from simplified or conventional sewers was rated as

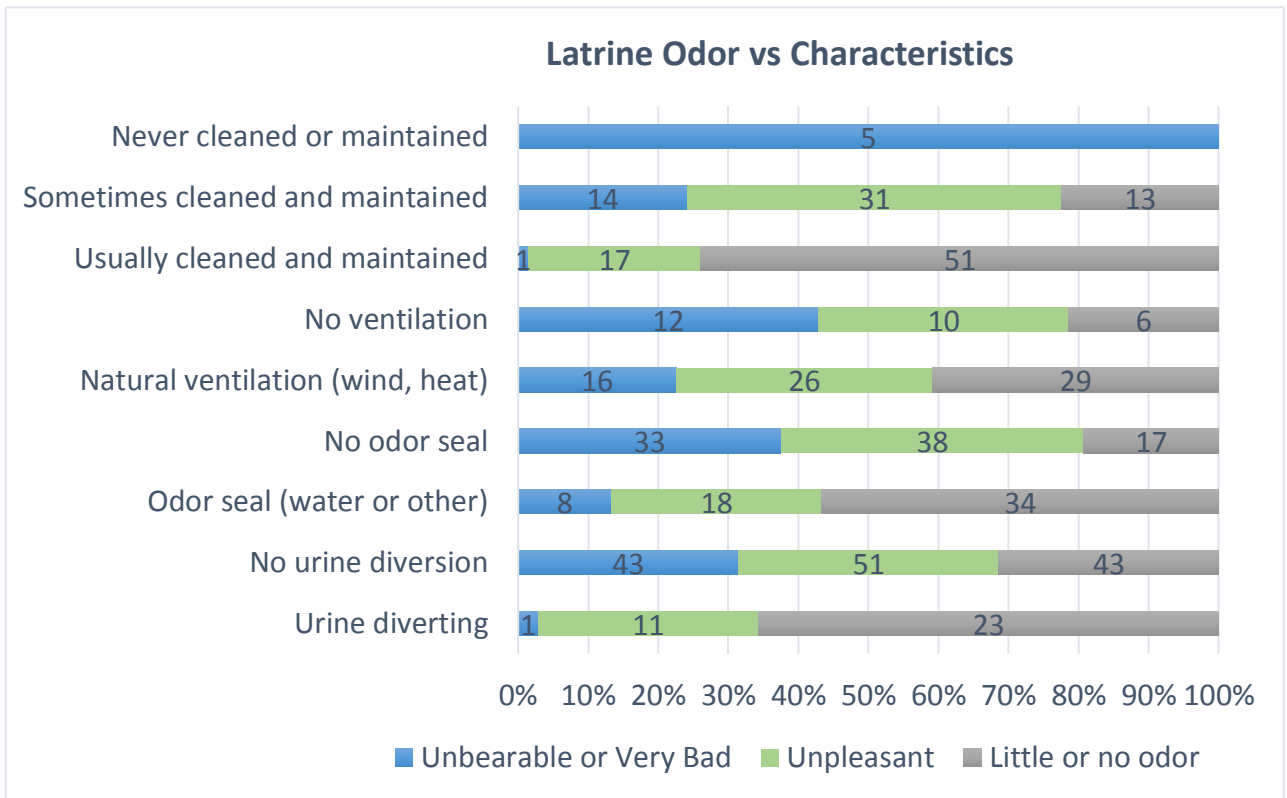
the lowest. As with the release of untreated waste, eliminating open sewers and manual pit emptying would simultaneously address the source of significant malodor issues.

3.7. Odor of waste processing by treatment method



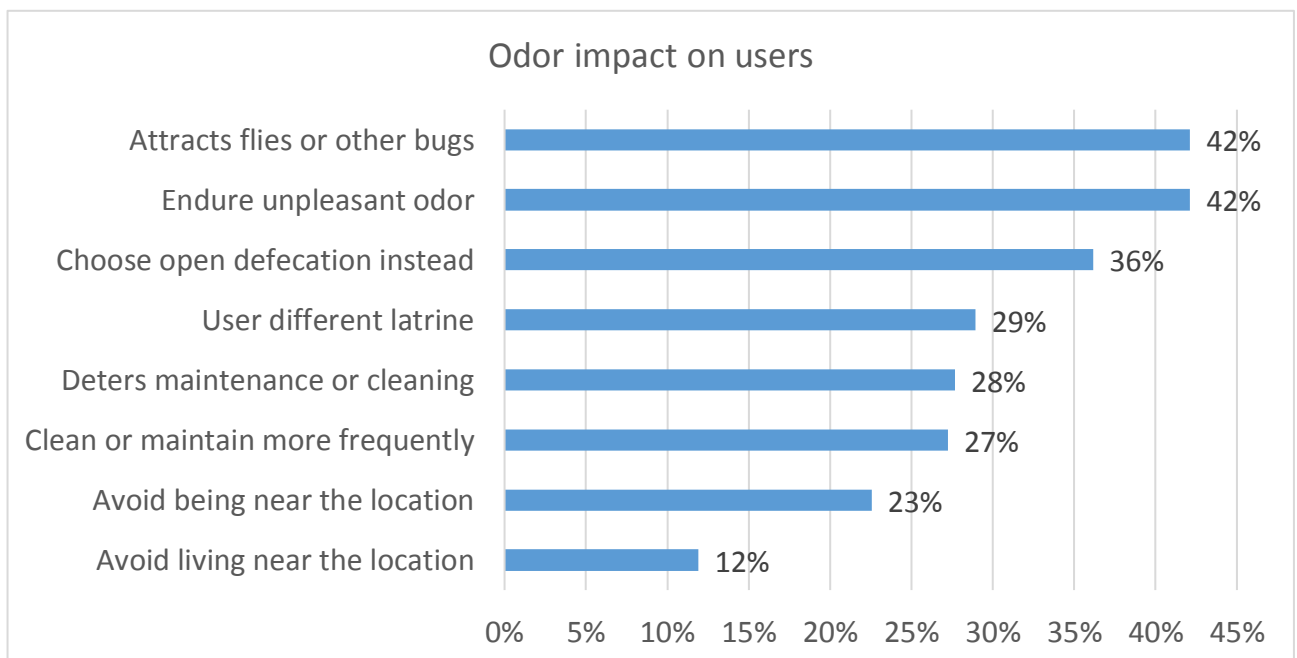
Odor rating by specific treatment method varied, but overall the odor from stabilization ponds, aerated ponds and conventional sewage treatment was the worst and odor from separate urine treatment and anaerobic digestion or filtration was the least problematic.

3.8. Latrine odor by latrine characteristics

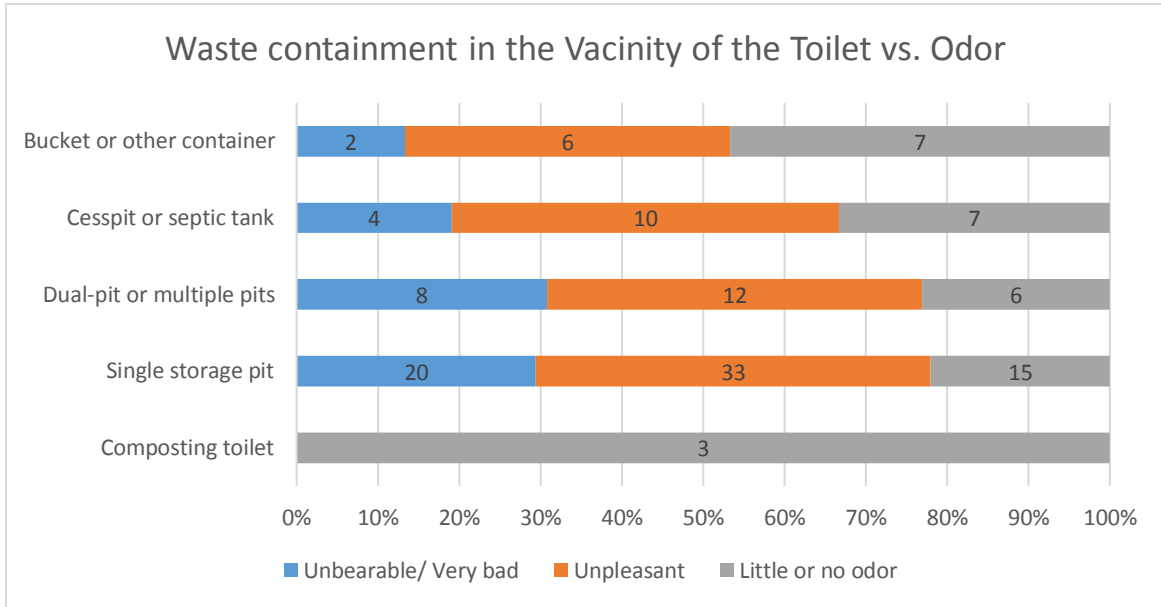


The positive effects of cleaning and maintenance, ventilation, odor seals and urine diversion on minimizing odor are evident from the responses above. Cleaning and maintenance had by far the largest correlation with reduced odor, followed by urine diversion. Both odor seals and ventilation contributed some improvement.

3.9. Latrine odor impact on users



3.10. Odor associated with waste containment in the vicinity of the toilet



In general, odor is a problem with 4 of the 5 types of waste containment in the vicinity of the toilet. Unfortunately there were only 3 responses for composting toilets, however all three indicated little or no odor associated with the composting unit.

4. Responses to Individual Questions by System Component

4.1. Locations of Defecation

4.1.1 In what setting is your experience with these locations of defecation (toilets)?

Answer	Responses	%
Urban	68	34%
Peri-urban	57	29%
Rural	73	37%
Total	198	100%

4.1.2. How would you describe the facility in terms of its users?

Answer	Responses	%
Private latrine (e.g. single or multiple family use)	96	48%
Public latrine	33	17%
Community ablution block	10	5%
Other: please describe below	22	11%
School or clinic latrine	26	13%
Site not designated as a toilet (e.g. open defecation)	12	6%
Total	199	100.0%

4.1.3. Please select the user interface (type of toilet) at this defecation location:

Answer	Responses	%
Squat plate	88	49%
Hole	36	20%
Pedestal	37	21%
Other: please describe below	17	10%
Total	178	100%

4.1.4. Do these have a flushing mechanism?

Answer	Responses	%
Mechanical flush	22	18%
Pour flush	45	37%
No flush	55	45%
Total	122	100%

4.1.5. Is urine diverted to a different destination than feces?

Answer	Responses	%
Yes	35	20%
No	140	80%
Total	175	100%

4.1.6. Is a water seal or other kind of seal used to prevent the release of odors?

Answer	Responses	%
Yes	62	36%
No	89	52%
Other: please specify	20	12%
Total	171	100%

4.1.7. Is the user interface (toilet) enclosed by solid walls that restrict air flow?

Answer	Responses	%
Yes	129	75%
No	43	25%
Total	172	100%

4.1.8. Is there any ventilation at this defecation location?

Answer	Responses	%
Natural ventilation by wind or heat convection (e.g. VIP)	72	59%
Other means of ventilation: please describe below	19	16%
Mechanical ventilation (e.g. fan)	3	2%
No ventilation	28	23%
Total	122	100%

4.1.9 How would you describe the level of cleanliness of this location of defecation?

Answer	Responses	%
Usually clean and regularly maintained	69	51%
Sometimes cleaned and maintained	60	44%
Never cleaned or maintained	5	4%
Don't know or does not apply	2	1%
Total	136	100%

4.1.10. Based on your experience, how would you rate the level of malodor nuisance at this location of defecation?

Answer	Responses	%
Unbearable	13	7%
Very bad	38	20%
Unpleasant	67	36%
Little or no odor	70	37%
Total	188	100%

4.1.11. Based on your experience, what do you think are the causes of the malodor at this defecation location: poor design and/or technology, poor maintenance and/or operation, or both?

Answer	Responses	%
Exclusively poor design / technology	8	7%
Generally poor design / technology	17	15%
Both poor design / technology and poor maintenance / operation	60	53%
Generally poor maintenance / operation	24	21%
Exclusively poor maintenance / operation	4	4%
Total	113	100%

4.2. Waste containment in the immediate vicinity of the toilet

4.2.1. Select the item below that best describes the fecal waste containment in the immediate vicinity of the defecation location.

Answer	Responses	%
Composting vessel / composting toilet	3	2%
Single storage pit	68	44%
Dual-pit or multiple pits	26	17%
Cesspit or septic tank	21	14%
Other: please describe	21	14%
Bucket or other container of limited volume	16	10%
Total	155	100%

4.2.2. How would you describe the level of cleanliness and maintenance of this containment?

Answer	Responses	%
Regularly emptied or maintained	41	35%
Sometimes emptied or maintained	46	39%
Never emptied or maintained	24	21%

Don't know or does not apply	6	5%
Total	117	100%

4.2.3. How would you rate the level of malodor nuisance in the vicinity of the waste containment?

Answer	Responses	%
Unbearable	11	7%
Very bad	26	17%
Unpleasant	65	42%
Little or no odor	52	34%
Total	154	100%

4.2.4. What do you think are the causes of the malodor in the vicinity of waste containment?

Answer	Responses	%
Exclusively poor design / technology	4	4%
Generally poor design / technology	16	16%
Both poor design / technology and poor maintenance / operation	52	52%
Generally poor maintenance / operation	18	18%
Exclusively poor maintenance / operation	10	10%
Total	100	100%

4.3. Transportation away from the area of defecation or containment

4.3.1. How is fecal waste transported away from the area of defecation and/or containment?

Answer	Responses	%
Manual emptying and waste removal	28	32%
Waste diverted to open sewer	9	10%
Waste diverted to waterway	8	9%
Other: please describe	11	13%
Motorized emptying and waste removal	25	28%
Simplified or conventional sewer	7	8%
Total	88	100%

Many respondents indicated under 'other' that the waste is never transported away from the pit latrine. Underground drainage and a combination of manual emptying and motorized transport were also mentioned.

4.3.2. How would you rate the level of malodor nuisance originating from the transportation of the waste?

Answer	Responses	%
Unbearable	8	10%
Very bad	22	28%
Unpleasant	24	30%
Little or no odor	26	33%
Total	80	100%

4.3.3. What do you think are the causes of the malodor associated with the transportation of the waste: poor design and/or technology, poor maintenance and/or operation, or both?

Answer	Responses	%
Exclusively poor design / technology	2	4%
Generally poor design / technology	11	21%
Both poor design / technology and poor maintenance / operation	23	43%
Generally poor maintenance / operation	14	26%
Exclusively poor maintenance / operation	3	6%
Total	53	100%

4.4. The location where the untreated waste is released

4.4.1. Please describe the location where the untreated waste is released.

Answer	Responses	%
Waterway	20	30%
Field	15	23%
Sanitation landfill	8	12%
Other: please describe	12	18%
Pond	3	5%
Treatment facility	8	12%
Total	66	100%

Participants commented under ‘other’, that untreated waste frequently stays in a pit, accumulates over years and is then covered and another pit is dug.

4.4.2. How would you rate the level of malodor nuisance at the location where the untreated waste is released?

Answer	Responses	%
Unbearable	12	19%
Very bad	21	33%
Unpleasant	21	33%
Little or no odor	10	16%
Total	64	100%

4.4.3. What do you think are the causes of the malodor at the point of release: poor design and/or technology, poor maintenance and/or operation, or both?

Answer	Responses	%
Exclusively poor design / technology	4	8%
Generally poor design / technology	10	19%
Both poor design / technology and poor maintenance / operation	29	56%
Generally poor maintenance / operation	6	12%
Exclusively poor maintenance / operation	3	6%
Total	52	100%

4.5. Waste storage prior to processing

4.5.1. Is the waste stored prior to being processed?

Answer	Responses	%
Yes	45	50%
No	45	50%
Total	90	100%

4.5.2. How would you rate the level of malodor nuisance originating from the storage of the waste prior to processing?

Answer	Responses	%
Unbearable	1	2%
Very bad	7	16%
Unpleasant	14	31%
Little or no odor	23	51%

Total	45	100%
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4.5.3. What do you think are the causes of the malodor originating from the storage of the waste prior to processing: poor design and/or technology, poor maintenance and/or operation, or both?

Answer	Responses	%
Exclusively poor design / technology	1	5%
Generally poor design / technology	4	20%
Both poor design / technology and poor maintenance / operation	9	45%
Generally poor maintenance / operation	5	25%
Exclusively poor maintenance / operation	1	5%
Total	20	100%

4.6. Waste processing

4.6.1. By what means is the waste processed?

Answer	Responses	%
Stabilization pond	14	16%
Other: please describe below	22	25%
Composting	33	38%
Sludge drying bed	18	20%
Anaerobic digestion or filtration (e.g. biogas reactor)	23	26%
Aerated pond	7	8%
Constructed wetland	12	14%
Separate urine treatment	9	10%
Conventional sewage treatment (aerated)	16	18%
Total	154	100%

Other methods of treatment listed under 'other' include aerobic digestion and spreading on fields.

4.6.2. How would you rate the level of malodor nuisance originating from the processing of the waste?

Answer	Responses	%
Unbearable	8	9%
Very bad	19	22%
Unpleasant	21	24%

Little or no odor	40	45%
Total	88	100%

4.6.3. What do you think are the causes of the malodor during the processing of the waste: poor design and/or technology, poor maintenance and/or operation, or both?

Answer	Responses	%
Exclusively poor design / technology	4	9%
Generally poor design / technology	4	9%
Both poor design / technology and poor maintenance / operation	25	56%
Generally poor maintenance / operation	11	24%
Exclusively poor maintenance / operation	1	2%
Total	45	100%

4.7. End product application

4.7.1. How are the processed waste or end products used or applied?

Answer	Responses	%
Spread on fields as fertilizer	40	47%
Surface disposal or storage	5	6%
Released into waterways	9	10%
Other: please describe below	18	21%
Burned; used as fuel for heating or cooking	6	7%
Used for irrigation	8	9%
Total	86	100%

4.7.2. How would you rate the level of malodor nuisance originating from the use or application of the byproducts?

Answer	Responses	%
Unbearable	2	2%
Very bad	10	12%
Unpleasant	15	17%
Little or no odor	59	69%
Total	86	100%

4.7.3. What do you think are the causes of the malodor from the application of the byproduct: poor design and/or technology, poor maintenance and/or operation, or both?

Answer	Responses	%
Exclusively poor design / technology	1	4%
Generally poor design / technology	6	26%
Both poor design / technology and poor maintenance / operation	10	43%
Generally poor maintenance / operation	6	26%
Exclusively poor maintenance / operation	0	0%
Total	23	100%

Please direct any questions or comments about this report to odorsurvey@duke.edu.