Development And Validation Of The SaniPath Rapid Assessment Tool: A Simple Tool And Its Applications For FSM


*Emory University, Rollins School of Public Health, Atlanta, GA, USA
**Improve International-Atlanta, GA, USA
***Research Triangle Institute International, Research Triangle Park, NC, USA
****Water Research Institute, Accra, Ghana

Theme: Health and Environmental Risks of Fecal Sludge Management

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Background and Methodology

The SaniPath Rapid Assessment Tool is a rapid sanitation risk assessment tool for low-resource urban settings; this presentation details the development and validation of this tool and its applications for informing fecal sludge management. Rapid urbanization has led to a growing sanitation crisis in urban areas of low-resource countries. However, there are little data to inform strategies to mitigate risks of exposure to fecal contamination. The Center for Global Safe Water at Emory University used the lessons learned from an in-depth, 2-year, investigation in Accra, Ghana (Phase 1 of the SaniPath Study) to develop the SaniPath Rapid Assessment Tool. The tool is a simplified, yet informative, means of characterizing the risk of exposure to feces from multiple transmission routes in the public sphere in order to inform advocacy, prioritize investments, and respond to complex urban sanitation needs.

The tool provides a standardized methodology with a customizable format that guides the user through a rapid 4-6 week assessment that includes both behavioral and environmental microbiology components. The behavioral survey can be used in households, schools, or community groups and assesses the frequency of behaviors of children and adults that bring them into contact with fecal contamination. Simple environmental microbiology methods, using membrane filtration or the IDEXX Quant-Tray®/2000 method, are employed to quantify the concentration of E. coli associated with samples from various exposure pathways. Pathways of exposure include contact with surface waters, contact with public latrine surfaces, ingestion of raw produce, contact with drains, and ingestion of municipal drinking or bathing water.

The SaniPath Rapid Assessment Tool assesses public health risks from exposure to fecal contamination due to an inadequate FSM service chain (containment-emptying-transport-treatment-reuse). For example, the implications of risk of exposure to fecal contamination due to inadequate containment can be seen through data collection on human exposure to and contamination of soil samples in public spaces, surface swab samples at public latrines, and samples of public water supplies.

The environmental microbiology data are used along with average intake volumes to determine the dose of fecal contamination (concentration of E. coli) ingested during one exposure event. Intake volumes are pre-set in the tool and are derived from literature review and SaniPath Phase 1 data. Relative risk is defined as the product of the dose of fecal contamination per event and the frequency of exposure events. The tool runs off of a flash drive, and data are entered directly into the tool’s software. Relative risk plots are automatically generated for each relevant exposure pathway using the data entered by the user. The resulting risk plots allow users to understand what components (frequency of exposure vs. magnitude of contamination) and pathways contribute the most to the risk of
exposure to fecal contamination in different neighborhoods as well as how the relative risk of exposure to fecal contamination aligns with the FSM service chain.

In order to test the tool's validity, it was piloted in the same four neighborhoods in Accra, Ghana as the in-depth SaniPath Phase 1 study. To test the tool's applicability to diverse urban contexts, it was piloted in two neighborhoods in Vellore, India. In Accra, 432 behavioral surveys were administered and 301 environmental samples were collected. In Vellore, 216 behavioral surveys were administered and 104 environmental samples were collected. All the environmental samples were processed via membrane filtration and incubated on m-ColiBlue24® broth to quantify the concentration of \textit{E. coli}.

**Results and Significance**

Data collected from Phase 1 behavioral surveys and environmental microbiology in the Shiabu neighborhood of Accra were analyzed using the same risk plot methodology that was developed for the SaniPath Rapid Assessment Tool. There were sufficient comparable data from Phase 1 and the rapid assessment tool pilot to allow for the direct comparison of three pathways: ingestion of raw produce, ingestion of ocean water, and contact with public latrines. Despite differences in sample size, laboratory dilution factors, and exposure frequency categories, the two studies produced the same ranking of the relative risk of the exposure pathways. Ingestion of raw produce posed the highest relative risk when examining the risk plots from both Phase 1 and the rapid assessment tool pilot. This was followed by accidental ingestion of ocean water from swimming or wading and public latrine contact, respectively. The estimated risk of E. coli ingestion from raw produce in adults in Shiabu ranged from $3.5 \times 10^5$ CFU/month in Phase 1 to $5.7 \times 10^5$ CFU/month in Phase 1.5, and the estimated risk from ocean water ranged from $1.4 \times 10^3$ CFU/month in Phase 1 to $1.3 \times 10^2$ CFU/month in Phase 1.5.

Results from the pilot in Accra were translated to improvements in survey tools and protocols, as well as software usability. An improved version of the tool was piloted in Vellore, India in March 2014. These data will be used to determine how applicable the tool is to different cultural and geographical contexts as well as how the methodology may have influenced data quality. Over the next year, the SaniPath Rapid Assessment Tool will be implemented in new urban settings and better adapted to understand the health and environmental risks of fecal sludge management. The tool can help foster more systematic approaches to understanding the health implications of breaks in the FSM chain and understanding what contributes to sustainable and effective sanitation programs and policy. Through continued refinement and application of this tool, we aim to enable evidenced-based sanitation investments and policies for low-resource urban settings.

**References**


Health risks of sanitation workers associated with faecal sludge management in India

SC Srinivasa Murthy*, P Drechsel **, K Nelson***

* sharadaprasad@berkeley.edu

** p.drechsel@cgiar.org

*** nelson@ce.berkeley.edu

Theme: Health and environmental risks of faecal sludge management

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Background and Research Question:

India’s sanitation problem is as complex as its society. At one end, 65% of its rural population defecates in open (WHO & UNICEF, 2012) and on the other end, 80% of its urban population is connected to septic tanks (CSE, 2011) which need to be emptied at least once in five years (Philip, Maunoir, Rambaud, & Philippi, 1993). In India, the emptying of septic tanks is undertaken by Dalits (Anand S, 2007; Chaplin, 2011), the untouchables of the Hindu religion, and in one of the three ways – manual emptying, mechanical emptying with vacuum pumps, or a combination of both. As these sanitation workers are forced to work without any safety gear (Batra, 2012; Singh, 2014), they resort to substance abuse to ward off the stench, exposing themselves to multiple health risks. With increased urbanisation, the number of urban households with septic tanks is bound to raise. According to a USAID study (USAID, 2010) by 2017, 148 million urban households will be connected to septic tanks though India has been expanding sewerage infrastructure in its urban areas. As a result, either more number of Dalits will be exposed to health risks or health risks of existing Dalits will continue to increase.

Considering the depletion of the global Phosphorous, India may show a renewed interest in managing its faecal sludge. But if the current management practices continue, what are the health risks Dalits, a socially marginalized group in India, are exposed to and how can they be mitigated?
Approach:

Our study, which is still under way, employs Quantitative Microbial Risk Assessment (QMRA) (Haas, Rose, & Gerba, 1999) to assess the risks sanitation workers are exposed to. Close to 200 sanitation workers are interviewed and observed in ten Indian towns, five in North India and five in South India. In six towns, both mechanical and manual emptying of pour flush toilets are studied. In four towns, along with pour flush toilets, manual emptying of dry toilets is also considered. Risk is characterized for seven pathogens by adjusting the EPA suggested ingestion quantities for sewage sludge (US EPA, 2011) for two exposure pathways - inhalation and ingestion. A wide spectrum of ingestion amounts are considered under different scenarios to create a risk portfolio and calculate the respective disability-adjusted life years (DALYs). This risk portfolio is then compared with the DALYs calculated for substance abuse, which primarily includes alcohol, tobacco, opioids, and cannabis.

Results:

This is an ongoing study and is expected to be complete by end of November, 2014, with all the data available in time for FSM3. Preliminary analysis of the data collected so far shows a large variation in risk for different scenarios. Sanitation workers, invariably Dalits, who empty the pits manually are exposed to higher amounts of risk than the workers who use mechanical setup. Truck drivers, mostly non-Dalits, are exposed to the least amount of risk. The risks primarily depend on the type of the septic tank, use and quality of the safety gear, and the pit emptying practices. Most of the domestic septic tanks in India are mere cesspits. Calculation of the DALYs for faecal sludge exposure and substance abuse will be completed by November 2014. Upon completion, the comparison of the two DALYs may prove to be insightful. Among the workers interviewed, 90% consumed, on an average, 90ml of hard liquor, 68% smoked a pack of beedi and 10% smoked cannabis every day. DALY of substance abuse may be almost as high as or even higher than the DALY of faecal sludge exposure. Apart from health risks, sanitation workers are also vulnerable to public violence and extortion. As most of the Indian cities don’t have a designated place to dispose sludge, sanitation workers, sometimes under time pressure, dump the sludge in the vicinity of the city
clandestinely. In such cases, 70% of the workers interviewed were either beaten up or extorted by the public at least once a year. All these risks are borne exclusively by the Dalit community.

Conclusions:

The study estimates two types risks sanitation workers are exposed to – faecal sludge exposure and substance abuse. Introduction of mechanisation and safety gear can considerably reduce the health risk. Elimination of stench using masks may further reduce the dependence on alcohol and other drugs. Construction of cesspits should be discouraged by regulating the construction of septic tanks.

To reduce the cases of public violence and extortion, it is recommended that the city provide the necessary space and infrastructure for disposal and treatment of the sludge. In Mangalore, truck operators are paying Rs.150 per truck load for dumping the sludge in any of the 21 wet wells spread all over the city. In Bangalore, all the interviewed truck operators expressed the willingness to pay as much as Rs.6000 per month just for a designated place to dump the sludge. Also, most of the farmers who use the fertilizer derived from septage are willing to pay for it. With all this revenue, the facility, at the least, may be able to meet the cost of the maintenance if not the capital.

Existence of manual scavenging in India, even after declaring the practice as unconstitutional, clearly shows the ineffectiveness of juridical measures and lack of political will to create dignified and safer working conditions for sanitation workers. 22,000 Dalits die every year doing sanitation work (Anand S, 2007). Modernisation of sanitation work may reduce the job opportunities for Dalits in the sanitation sector but it will surely emancipate them from the wretched condition they are currently entrenched in.

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Nutrient values and Health Risks of Combined Human and Animal Excreta Management in Vietnam


*Center for Public Health and Ecosystem Research, Hanoi School of Public Health, 138 Giang Vo, Hanoi, Vietnam
**Vietnam Public Health Association, 138 Giang Vo, Ba Dinh, Hanoi, Vietnam
***Institute of Environmental Science and Engineering (IESE), Hanoi University of Civil Engineering
****Swiss Tropical and Public Health Institute, Basel, Switzerland

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Introduction
In Vietnam, the untreated human and animal excreta once released into the environment can be a hazard to the environment and human health by possible pathogens and chemical residues (WHO 2006; Jensen et al. 2008). Combined human and animal manure management faces challenges given that livestock is kept in proximity to human residencies and large amounts of human and animal manure are produced in limited space. Meanwhile the demand to reuse livestock and human manure in agriculture and fisheries is widespread. It is important that the hygienic safety of both treated human and animal excreta is ensured and their nutrient contents remain high. This research aims were to understand the practice, as well as evaluate the nutrient values and the risks of combined treatment of human and animal waste for human health and environment in Vietnam.

Methods
The study was conducted in Hoang Tay commune, Ha Nam province situated about 60 km south of Hanoi. This commune has a population of 5,500 (1,500 households) inhabitants. Most households have livestock in their compounds. The residential areas are in the vicinity of fields used for rice cultivation, vegetable planting and fish breeding. Human and animal excreta are used as fertilizer in Hoang Tay commune, as in many other places in northern and central Vietnam. A baseline survey conducted at 202 households which were randomly selected from the households list provided by the Commune People’s Committee. A set of experimental models for combined treatment of human and animal excreta was designed and implemented, including 04 aerobic and 04 anaerobic treatment prototypes. Each experimental model was built as a storage vault with the same sizes (high: 70 cm; width: 70 cm; length: 100 cm). The process of storage started after well mixing of human and animal excreta with adding materials (rice husk, sawdust, kitchen ash). The top of the vault was covered by mud for preventing smell, insects or pathogens spreading around by animals. During 9 months, 96 repeated samples from both aerobic and anaerobic models have been collected. All samples were analyzed for the physical and microbial indicators.

Results
A total 202 respondents aged 16 to 75 participated in the study (45.5% female, 54.5% male). The average age was 51 (SD ± 12.1). The education of respondents were 26.1% graduated primary school, 66.3% secondary school, and 7.6% high school or had higher qualification. Most respondents were engaged in agriculture (94%). The average income was VND 3,151,000 or USD 175 per month (SD ± 2.2). Most households were engaged in rice cultivation (96%); raising cattle (61.4%), raising poultry (57.4%); and raising fish (5.5%). Water sources used for cooking and drinking was 92.3% rainwater, 3% dug wells and 4.4% from drilled wells. Most households used wood and straw stoves (69.3%), used gas stove (26.2%), and those who used Biogas for cooking accounted for 6.6%.
The study showed that 85.6% of the households had pit latrines or temporary latrines; and 10.4% had double vault latrines. Only 19 households (9.5%) practiced storage/treatment of human excreta. Among them, 2 households stored human excreta inside a latrine vault. Most storage piles of human excreta were kept nearby the animal keeping place or located at backyard. The average time storage of human excreta was 12 months inside latrine vault and 3.8 months for outside storage piles. Most households used kitchen ash (90.3%) and lime (4.9%) mixed with excreta during the storage. No other adding materials such as rice husk, sawdust was found in the latrine vaults and storage piles in the surveyed area. The households used compost product after storage for rice cultivation (82.5%). The animal excreta in most of households were mixed with kitchen ash (59.1%), lime (2.8%) before sending to storage pile. The average time for storage of animal excreta was 3.5 months (SD ± 2.12). The composted animal excreta after storage was also used for rice cultivation (81.7%).

The percent of dead *Ascaris* eggs increased from 74% to 100% at the aerobic models and from 65% to 100% at the anaerobic models. *Salmonella* sp. concentration (CFU/g excreta) also decreased from 25,125 ± 47,507 to 436 ± 531. The pH value fluctuated from 6.57 ± 0.89 to 7.16 ± 0.95. The relative humidity was consistent around 92 - 97% during the whole process of storage. The temperature in all storage models was not higher than the outside temperature, while there was no significant difference among models.

The percent of total nitrogen decreased from 1.96 ± 0.49% (Mean ± SD) to 1.60 ±0.42% of the total solids. On the contrary, the percent of available nitrogen increased from 0.15 ± 0.17 to 0.18 ± 0.04%. The percent of total phosphorus (P₂O₅) decreased from 1.93 ± 0.26% (Mean ± SD) to 1.89 ±0.26%. However, the percent of available phosphorus increased from 1.26 ± 0.39 to 1.46 ± 0.29%. The percent of available potassium increased from 1.44 ± 0.47 to 1.61 ± 0.42%.

**Discussions and Conclusions**

Combined human and animal excreta storage/composting can be used as a relevant model to treat and produce a value and safe product fertilizer for the farmers in the agricultural areas. Study results show that the nutrient values (Nitrogen, Phosphorous and Potassium) after storage are still remaining. The *Ascaris* eggs dead was depended on the storage duration. 9 months period of storage allowed to having a safe fertilizer product. This confirms the recommendation of the Vietnam Ministry of Health that the excreta should be stored over six months to ensure safety for using as fertilizer (MOH 2005). However, the difference of pathogens inactivation efficiency between the aerobic and anaerobic models was not found. Also it was not clear the effects of temperature, pH and moisture for the die-off of *Ascaris* eggs. These parameters were not controlled during the experiments. Besides, un-control of materials input before the storage process might lead to the ratio C:N beyond optimum range for the composting process (Chongrak Polprasert & Lourdes Gamboa Valencia, 1981).

The results from the study can be utilized for the further steps of the potential intervention research with controlled composting conditions aiming at producing of safe and valuable fertilizer from the human and animal excreta.

**References**

