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37th WEDC International Conference, Hanoi, Vietnam, 2014**SUSTAINABLE WATER AND SANITATION SERVICES
FOR ALL IN A FAST CHANGING WORLD****Sanitation Safety Planning in Hanoi helps identify and
manage health risks to workers, farmers and consumers
from reuse of wastewater***D. Jackson & T. A. Vuong, Nepal***BRIEFING PAPER 1899**

Sanitation Safety Plannings (SSPs) are currently under a piloting phase by World Health Organisation (WHO). SSPs supplement and act as practical application guidance the four volumes of the 2006 WHO Guidelines for the Safe Use of Wastewater, Excreta and Greywater. Two pilot sites were selected in Hanoi, Vietnam to test WHO's upcoming Sanitation Safety Planning manual: (1) large scale agriculture on the outskirts of Hanoi which uses untreated sewage; and (2) an organic composting site which uses effluent from a purpose built on-site sewage treatment plant for moisture control of the compost. This paper presents a summary of how SSPs helped identify and manage health risks to workers, farmers and consumers of produce from reuse of wastewater. Simple risk-based prioritised low cost improvement plans are summarised.

Introduction

In many countries, including Vietnam, use of human waste for agriculture and fish farming is a long established tradition. As global water scarcity and urbanization increase, direct and indirect use of wastewater for irrigation is increasing both in places with established traditions, and in countries new to the practice (Hamilton et al. 2007). Global and country-level assessments indicate that formal and informal wastewater use is widespread, regardless of the development level and climatic conditions (Jimenez and Asano 2008; Raschid-Sally and Jayakody 2008). Reuse systems provide a valuable source of nutrients, reducing demand for chemical fertilizers, as well as relieving demand for fresh water resources. They can also provide a degree of cost effective land based treatment in the absence of advanced treatment processes. The resulting increase in food production can have important direct health gains in terms of food security and nutrition, and indirectly, additional income derived from resource recovery.

However, use of human waste also poses significant health risks to workers, surrounding communities and consumers that need to be identified and managed if the practice is to be safely and ethically promoted.

In 2006 WHO published the Guidelines for the Safe Use of Wastewater, Excreta and Greywater. The guidelines were a departure from the previous 1989 guidelines that had a strong emphasis on wastewater treatment limits. By contrast, the 2006 guidelines introduced a risk assessment and management approach derived from the Stockholm Framework and health based-targets. They provide a code of good practice and an integrated management framework to achieve these targets. Similar to the current Drinking-water Quality Guidelines (WHO 2011), they are based on the approach that “the most effective way to consistently ensure safety in using wastewater, excreta and greywater, is by a comprehensive risk assessment and risk management approach” (WHO 2006 Vol. :31). This approach provides treatment and non-treatment options on farms, in markets and at the community level to limit exposure to microbial and chemical hazards found in wastewater, greywater and excreta.

While the guidelines provide well researched and practical advice, they are necessarily bulky (over 600 pages) and are not readily accessible to the average wastewater sector professional in developing countries.

The Sanitation Safety Planning methodology addresses this by providing practical guidance on the implementation of the 2006 WHO guidelines. The approach builds on the success of the Water Safety Plan (WSP) initiative for implementation of the WHO Drinking-water Quality Guidelines.

Sanitation Safety Planning overview

The SSP approach moves the users through six steps. After the system boundaries are established, SSP identifies elements in the sanitation chain. Ideally, these sanitation-elements begin at waste production (e.g. toilets), and continue through waste collection, treatment and re-use. In each sanitation-element, groups of people who may be exposed to hazards are identified. These exposure-groups can often be classified as: workers of the system (e.g. operators who maintain the system and operate wastewater treatment plants); farmers who use the wastewater or its by-products; communities which live beside these system; and consumers or users of the final product (e.g. the public who buy and consume the produce from the farms which use the wastewater or its by-products).

For each of these identified exposure-groups, element-by-element, the associated hazards and hazardous events are identified with a focus on health related issues (as opposed to equipment operational hazards or conventional occupational health and safety concerns). Existing control measures that are in place (either consciously or unconsciously) are identified and a risk assessment is carried out for all hazardous events. This risk assessment is either qualitative (i.e. team judgment decision) or semi-quantitatively (using a likelihood/severity matrix).

Interventions to reduce the risk where it is considered unacceptably high are then identified. These are known as Improvement Plans, adopting the same terminology as is Water Safety Plans. Operational monitoring and verification plans are also developed.

Normal and abnormal conditions (e.g. floods, equipment malfunction) are considered in the risk analysis.

The SSP manual is currently in a draft format. As part of a larger program to develop the concept and practicalities of the SSP concept, in 2013 and early 2014, WHO supported a pilot test program of SSP in five cities/localities: (1) Lima in Peru, (2) Hanoi in Vietnam, (3) outside Bangalore in India; (4) Kampala in Uganda and (5) Benevente (near Lisbon) in Portugal. One of the purposes of the pilot program was to learn lessons before issue of the first SSP manual.

The two Hanoi SSP pilot sites

This paper reports on the two sites used for this pilot testing in Hanoi.

Wastewater use in agricultural and conveyance system

Salient features of this pilot are summaries in Table 1.

Characteristic	Comment
Overview and scale of the SSP area	<p>(1) Bang B Village area: Water is pumped to the farming area from wastewater canals using a pump station with a capacity of about 38 m³ per day (0.44 litres/sec). Manually intensive farming is practiced with a total farming area of 88 hectares. There are also 10 fish raising ponds (also using wastewater canal water). The farming community has about 3,000 people. Vegetables grown include: morning glory and wormwood (year-round), neptunia (from April to August), watercress and water dropwort (from September to March) and houttuynia and pumpkin buds.</p> <p>(2) Wastewater conveyance system from Hanoi in “wastewater canals”. For this trial, a specific sub-set of sanitation elements was included in the vicinity of Bang B village. This system conveys untreated wastewater (from domestic and industrial sources). It includes a pump station (used for flood management purposes of about 7,800 m³ per day (90m³/sec).</p>
Operators and responsible agencies	<p>The operator of the wastewater drainage canal and conveyance system is the HSDC (Short title: Hanoi Sewerage and Drainage Company). In the farming community, there are several stakeholders and agencies involved including the People’s Committee of Hoang Liet Ward & Farmers Association.</p>

Wastewater parameters	<p>The catchment area for the Bang B farming area includes a mixture of domestic sewage, industrial, hospital wastes and stormwater. Under some conditions, there are about 83 types of industries with 223 manufacturing factories and companies in the wastewater catchment. <i>E. Coli</i> in the irrigated water in November 2013 was measured as: 2.4×10^6/100 ml and helminth egg numbers of 1000 per litre. Irrigation water is drawn from canals which are downstream of detention basins/lakes. The configuration varies depending of the season.</p> <p>Indicative concentrations of parameters of the main wastewater in 2009 are: BOD₅ of 77 mg/l, COD of 152 mg/l, ammonium NH₄ 40 mg/l, grease proportion is 2.13 mg/l, DO of 1.69 mg/l - all well exceed the national standards for surface waters. The concentrations of several metals including lead and chromium are in excess of the national standards by several times. The water is very dark and often has strong unpleasant odours. Variations in quality occur by seasons.</p>
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Apart from small localised treatment plants, most wastewater has no formal treatment. However, there are a series of lakes which do provide informal treatment although under variable and relatively uncontrolled conditions. For this pilot study, the SSP did not include the fish pond farming operation.

Composting plant SSP pilot

Salient features of this pilot are summarised in Table 2.

Characteristic	Comment
Overview	<p>A municipal organic composting plant uses treated sewage from a purpose built on-site sewage treatment plant for moisture addition to the compost product at two points. Feed material for the main organic compost is from fruit and vegetable markers in Hanoi. Sewage is collected from 180 public toilets in Hanoi.</p> <p>The final compost material is packed and sold for use in coffee, tea and other commercial (e.g. ornamental) farms. This current restriction is related to concerns by the authorities of potential contamination of the organic input (not related to sewage addition).</p>
Scale of the project	<p>Up to 25 tonnes of sewage is collected per day which matches the current capacity of the on-site sewage treatment plant but only about 2% of this is used in the compost plant. About 15 tonnes of compost are produced per day.</p>
Main operator	<p>The operator of the compost plant is URENCO (Short title: Ha Noi Urban Environment Company). URENCO's main responsibly is solid waste management.</p>
Years of operation	<p>In the 1990s, the sewage treatment plant was constructed and about 8-10 years ago, the compost plant was built.</p>
Number of staff	<p>Public toilets staff: 100 staff Vacuum tankers 3 number ($2 \times 3.7\text{m}^3$ and $1 \times 0.75\text{m}^3$) and 6 staff Composting plant including on-site sewage treatment plant staff: about 25 staff.</p>
On-site treatment plant overview	<p>Anaerobic digestion supplemented with addition of enzymes and bacteria. The main processing elements are 2 x sedimentation tanks (total of 20m^3) which uses a proprietary enzyme and microbiological supplement, and a final settling tank of 48m^3. Effluent which is not used in the compost plant is discharged to the environment and is treated with chlorine prior to discharge.</p>

Risk management plans

Tables 3 and 4 summarise the highest risks identified and the existing or proposed risk mitigation measures. In the SSP, hazards were generally considered separately for *E. Coli* (as an indicator of faecal contamination) and helminth eggs but these tables simplify the findings for the purposes of this paper.

Wastewater use in agricultural and conveyance system

In regards to farming practices, the quality of wastewater of the irrigated water is critical. Of concern is that: (1) the helminth egg concentration in the water used for irrigation (about 1000 / litre) is much higher than recommended limits; and (2) the effective log-reduction of pathogens before application in the field is only

about 1 log. The 2006 WHO guidelines recommend that for very safe farming practices in the highly labour intensive farming operations used, the log-reduction of pathogens should be 3 log. Helminth egg counts (as a surrogate for nematodes) should be < 1per litre for adults working in field and < 0.1 for children under 15 years. This explains the high risks allocated to these groups in Table 3.

Table 3. Risk management summary for agricultural re-use and wastewater conveyance sites				
Exposure Group	Hazard and exposure pathway	Existing controls	Existing risk	Comments
<i>Sanitation-element: Use of waste in agriculture and fish farming activities</i>				
Farmers working in the fields	Hookworm and similar infections through feet. Dermatitis. Inadvertent consumption of contaminated soil/water.	No treatment. No rules or practice or protective clothing.	High	
Consumers of farm produce and surrounding community members	Faecal—oral route from deliberate consumption of farm produce.	Washing of vegetables with tap water before eating or cooking (post-harvest).	High	
	Mosquitoes via vector borne routes.	Mosquito nets. Insecticide use for mosquito control.	High	
Local community (Farmers & families near the re-use site and children playing in the fields)	Skin (esp. for nematode egg via bare feet). Inadvertent consumption of contaminated soil/water.	Little controls.	Moderate	Children are especially vulnerable to helminth egg infections.
<i>Sanitation-element: Wastewater conveyance system</i>				
Sewerage wastewater canal system workers	Pathogens. Direct contact. Vector borne.	Personal protective measures (gloves, footwear etc). Personal hygiene. Occupational Health and Safety training and company regulations.	Low (under normal operations) High (under flooding conditions).	Good personal hygiene regulations but less than optimal practice followed.

Composting plant SSP pilot

A summary of the key exposure groups and risks is shown in Table 4.

Table 4. Risk management summary for composting plant				
Exposure Group	Hazard and exposure pathway	Existing controls	Existing risk	Comments
Workers at public toilets	Pathogens and sharps. Direct contact.	Personal protective measures (gloves, footwear etc). Personal hygiene Occupational Health and Safety training.	Moderate	75% use gloves 75% use handwashing with soap after work 100% trained

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Vacuum tanker operators	Pathogens and sharps. Direct contact.	As above	High	83% use of gloves 67% use handwashing with soap after work 100% trained
Workers at the on-site sewage treatment plant	Pathogens . Direct contact.	As above	Moderate	50% use of gloves and boots No use of face masks 0% o not wash hands and feet after work 100% trained
Workers in the compost plant	Pathogens . Direct contact.	As above	Moderate	44% use gloves; 33% use shoes; 89% use mask

The vacuum tanker operators (6 no.) are at the highest risk due to the necessary handling of hoses and equipment that come into direct contact with the sewage. However, the risk assessment also considered the number or people exposed and, although the risks for many of the workers in the compost plant is moderate, there are considerably more of this exposure group potentially exposed to the relevant hazard than vacuum tanker operators.

The proposed new control measures (as part of improvement plans) to better manage the risks at both sites are summarised in Table 5. Each of the improvement plans is accompanied in the SSP by simple but practical monitoring plans, and verification plans. For each improvement, the SSP identifies specifically what is monitored, how it is monitored, who is responsible for this, by when, and corrective actions to take if the action is not satisfactory. Table 5 gives examples only but, does not include monitoring plans, and verification plans.

Table 5. Improvement plans		
Site	Timing	Example of new actions proposed with comments
Wastewater use in agricultural and conveyance system	Immediate and short term	<ul style="list-style-type: none"> targeted education to farmers and workers aimed at improving practices by farmers in using appropriate and practical personal protective equipment , and in personal hand and feet washing with clean water during and after the day's work increased regular mosquito spraying to reduce vector borne risks targeted education about the dangers of children playing in and near the wastewater irrigation sites, especially with bare feet de-worming of targeted populations every 6 months consider improved pre-harvest food protection (e.g. 1-2 day before harvest to stop irrigation with poor quality wastewater – this will allow up to 2 log pathogen reduction) targeted education safe handling of crops (e.g. vigorous washing or washing with disinfected water) especially those crops eaten raw
	Medium - long term:	<ul style="list-style-type: none"> reduce chemical contaminates of wastewater being irrigated (e.g. improved enforcement of regulations) increase treatment in the system upstream to improve quality of water discharged to the canal from which the farmers draw irrigation water
Organic compost plant	Short term	Internal training on the importance of work place health and safety specifically related to the risks identified Review technical operations and procedures to reduce risks related to vacuum tanker operation and addition of wastes to compost from the on-site treatment plant (e.g. re-instatement of broken pump to transfer treated effluent from the sewage plant to the compost piles rather than using vacuum tanker)
	Medium – long term	Improved and increase vehicle and equipment maintenance to reduce the likelihood of mechanical breakdowns (during which workers are more exposed to hazards) Upgrade the toilets to reduce risk to workers and the public using the facilities (related to the environmental sanitation of the toilets)

Summary

The world is increasingly viewing wastewater as a resource because the nutrients in wastewater are simply too valuable to be disposed of. Wastewater also offers potential for increased food production and improved nutrition. However, it carries risks of water borne diseases to workers and consumers that need to be well managed. The WHO 2006 Guidelines on the Safe Use of Wastewater, Excreta and Greywater, and WHO SSP manual can be key tools to do this. SSP has helped the agencies in Vietnam who own and operate sewerage systems, and users of the wastewaters become more aware of the risks to human health from the wastewater operations and/or wastewater use.

SSPs seek to proactively manage the risks by practical, achievable and measurable means. The action plans allow resources to be prioritised to those activities and practices that present the greatest risk. In these two pilots, the measures proposed in the SSPs are not generally capital intensive – rather, simple changes to operation and practical but targeted monitoring tools will help to reduce the risk to the exposure groups. Initial findings from the SSP trial highlight the following potential and challenges for further scale up of the SSP approach in Vietnam:

- **Potential:** There is large scale use of wastewater for agricultural production in Vietnam, although much of this is seen as informal. The piloting of the SSP at the two sites in Hanoi show that relevant stakeholders are very interested in applying the principles and approaches of SSP. Both sites demonstrate the potential of SSP to complement occupational health and safety at workplaces where wastewaters are used or re-used.
- **Challenges:** By its nature, managing wastewater use is a multi-disciplinary task involving authorities, ministries and agencies of health, agriculture, environment, urban planning and academic institutions. Working across sectors to achieve the goal of SSP can be difficult and challenging, but is essential. Because of the informality of this farming sector, coordination of and responsibility for taking action to reduce farmer's and consumer's risks are especially challenging. A challenge demonstrated from the compost trial is that there are often other factors beyond the wastewater inputs that affect the final product's use.

Acknowledgements

The authors would like to extend thanks to WHO (in Geneva and in Vietnam) and to the officers of HSDC and URENCO and the SSP team members.

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