Learning Brief

SNV

Estimating Safely Managed Sanitation in Nepal

June 2018

Sustainable Development Goal (SDG) 6.2 for sanitation calls for universal access to a safely managed sanitation and hygiene service. Introduction of the "safely managed' qualifier ensures that faecal waste from improved latrines is safely emptied, transported, treated, disposed of and/or reused.

This learning brief shares the experiences of a process facilitated by IRC and SNV in Kathmandu in June 2018. To estimate levels of access to safely managed sanitation, facilitators used available knowledge and data in current practices of pit construction and handling of faecal waste during emptying, transport and disposal within various contexts in Nepal. The shit flow diagram (SFD)[1] methodology was applied during the process using a combination of information from:

- indicators when faecal waste is not safe;
- data from SNV's endline survey in 2018; and
- field experience of SNV's SSH4A team from stakeholder engagement.

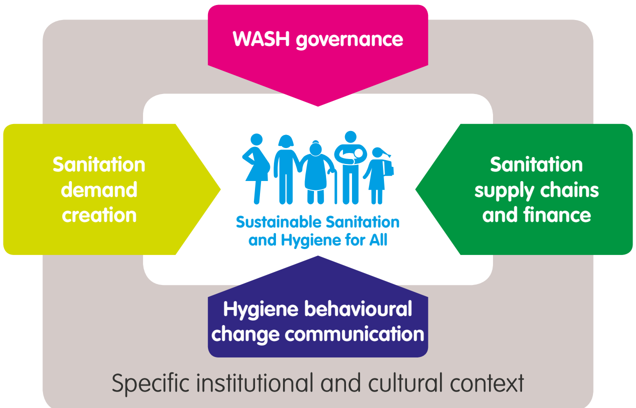
The results illustrate the likelihood of existing systems being safely managed, if current practices in faecal waste management are to continue. The process supported teams and decision-makers to identify major risk areas and tailor interventions to further improve the probability of safely managed sanitation systems. Safe reuse of faecal waste is not within the scope of this study.

Background

SNV works as a capacity development and knowledge-sharing organisation at national and sub-national levels. In Nepal, SNV's Sustainable Sanitation and Hygiene for All (SSH4A) programme has contributed to realising universal access to open defecation free (ODF) environments in target Village Development Committees (VDCs) and districts. With support from the Australian Government, the programme engaged in eight rural districts, continuing with three remote mountain districts (Jumla, Kalikot, Dolpa) and expanding to three new hill districts (Rukum, Rolpa, Salyan) and two districts in the terai[2] (Sarlahi and Mahottari) from 2014-2018. Much of the emphasis

Inside Sustainable Sanitation and Hygiene for All (SSH4A)

SNV's Sustainable Sanitation & Hygiene for All (SSH4A) programme supports local government to lead and accelerate progress towards district-wide rural sanitation and hygiene services with a focus on institutional sustainability and learning. The SSH4A approach has four integrated components supported by performance monitoring and learning. Developed in Nepal since 2008, SSH4A is implemented as part of government-led rural sanitation programmes across 19 countries in Africa and Asia.



has been on access to and use of improved sanitation, environmental safety of sanitation facilities in relation to groundwater contamination and improving hygiene behaviours. To examine safe faecal waste management practices, the programme used a uniform benchmark of timely emptying after five years, but in the context of most rural areas, this has proven to be too frequent.

Nepal has made great strides in reducing open defecation and increasing access to improved sanitation. The baseline for the SDGs reported 30% of the population of Nepal were defecating in the open and 46% had access to improved sanitation in 2015 (UNICEF/WHO, 2017). However, there was insufficient data for the Joint Monitoring Programme (JMP) to generate data on safely managed sanitation services. As such, a deeper understanding of pit management in different contexts was needed.

SDG Definitions

Open defecation	Disposal of human faeces in fields, forest, bushes, open bodies of water, beaches or other open spaces or with solid waste
Unimproved	Use of pit latrines without a slab or platform, hanging latrines and bucket latrines
Limited	Use of improved facilities shared between two or more households
Basic	Use of improved facilities which are not shared with other households
Safely managed	Use of improved facilities which are not shared with other households and where excreta are safely disposed in situ or transported and treated off-site

When is faecal waste NOT safe to handle?

While it is difficult to determine when faecal waste is safe to be exposed, to handle or to reuse, some simple indicators can help practitioners to ascertain when faecal waste is NOT safe to handle. Faecal waste is most efficiently digested by anaerobic (no air) + aerobic (with air) processes:

- Aerobic digestion: more efficient in reducing pathogens (i.e. faecal bacteria, parasites and viruses) → **Public Health**
- Anaerobic digestion: more efficient in reducing solids (including biological oxygen demand (BoD), nitrogen and phosphorous) → **Environmental Health**

Faecal waste is comprised of sludge (solids) and effluent (liquids). The public health risk from faecal waste is primarily determined by the effectiveness of the aerobic processes in neutralising pathogens. The efficiency of the aerobic processes is, however, often determined by the effectiveness of the anaerobic processes in removing the solids from the liquids and the liquids from the solids. That is, the aerobic bacteria cannot neutralise the pathogens in faecal waste unless the effluent is clear and the sludge is dry.

> Faecal Waste CANNOT be safe if:
>
> - the faecal slude is NOT dry, or
> - the faecal effluent is NOT clear.
>
> This does not imply that it is always safe to handle when the sludge is dry and the effluent is clear.

Estimating access to safely managed sanitation

The SFD is a tool designed to understand and communicate how safely excreta is managed from defecation to disposal within cities and towns (https://sfd.susana.org/). Results of the endline survey in SNV Nepal's SSH4A project districts in 2018[3] found that the percentage of households (an average of 6.4 persons) with access to an improved toilet was 95.5%, while access to a handwashing station with soap was 74%. With the application of the SFD tool, the proportion of households accessing a safely managed sanitation service were estimated for the hill, mountain and terai regions. These estimates were developed by applying the above indicators for when faecal waste is unsafe, projecting data from currently known management practices of sanitation systems from the SSH4A endline survey and making assumptions based on stakeholder engagement. Given that only a small percentage of pits have filled or been emptied thus far, the SFD should be considered as a dynamic tool, and projections of safely managed sanitation systems should be regularly updated as more pits start filling up and more data on actual faecal waste management practices becomes available.

SSH4A hill region districts

SSH4A endline survey results in the hill project districts found that the percentage of households (an average of 5.2 persons) in 2018 with access to a limited and basic service was at 3% and 97%, respectively. Of these, 99% were using pour-flush toilets with a single offset pit, and 1% were using dry pits with water for anal cleansing. In terms of safe emptying practice, less than 0.5% of pits had become full, and were being safely emptied by householders themselves. Half of the households interviewed had unsafely disposed sludge into the drain whilst the other half had safely treated and disposed sludge through burial.

Assuming that only half of all households will practise safe emptying and that all dry sludge removed from any second pits will be buried, and noting that the dominant response to a full pit is to "dig and switch" to a new pit (based on stakeholder engagements), the likelihood of safely managed systems[4] was estimated at 81.1% *(figure 1)*.

SSH4A mountain region districts

SSH4A endline survey results in the mountain project districts found that the percentage of households (average of 6.1 persons) in 2018 with no service was 2%. Access to a limited and basic service was at 7% and 91% respectively, of which 93% were using pour flush toilets with a single offset pit and 7% were using dry pits with water for anal cleansing. Thus far, a total of 14% of the pits (98% pour flush) had been filled, with just under half being less than five years old. Data showed that 1% of households had already dug new pits and stakeholder engagement assumptions expressed that half of all households would dig new pits and switch in the future. Data from emptying practices showed that 88% of all household had pits that were unsafely emptied, 76% unsafely disposed faecal waste into drains, and 24% safely buried waste.

Projecting these survey results and assumptions to create an SFD for the SSH4A mountain project districts – 43.7% of faecal waste can be classified as being safely managed *(see figure 2 on next page)*.

Here, major faecal exposure risks are likely to occur due to the failure to safely empty and treat (i.e. bury) the faecal sludge. Another exposure risk may arise from the use of water for anal cleansing in dry pit latrines that destroys the aerobic bacteria within pits, thus rendering these toilets unsafely managed.

SSH4A terai region districts

SSH4A endline survey results in the terai project districts found that the percentage of households (average of 8 persons) in 2018 with no service was 0.8%. Access to a limited and basic service was 0.8% and 98%, respectively of which 100% were using pour flush toilets, with 2% discharging to a direct pit, 24% to a holding tank, 57% to an offset pit, 6% to a double offset pit and 11% to a septic tank/leach drain. Thus far, a total of 7.5% of the pits had been filled, of which 34% were less than five years old. These pits had been primarily emptied by sweepers, with 81% of the pits' content being unsafely emptied, 57% disposed unsafely into drains and 43% disposed safely by burial.

Utilising these survey results and the assumption that 5% of households would dig a twin pit in the future, creation of an SFD for the SSH4A terai project districts found that 13% of faecal waste can be classified as safely managed *(see figure 3 on next page)*. Major faecal exposure risks are likely to occur due to the failure to safely empty and treat the faecal sludge, especially in areas with high groundwater.

Figure 1: Projected safely managed sanitation estimates - rural hill districts

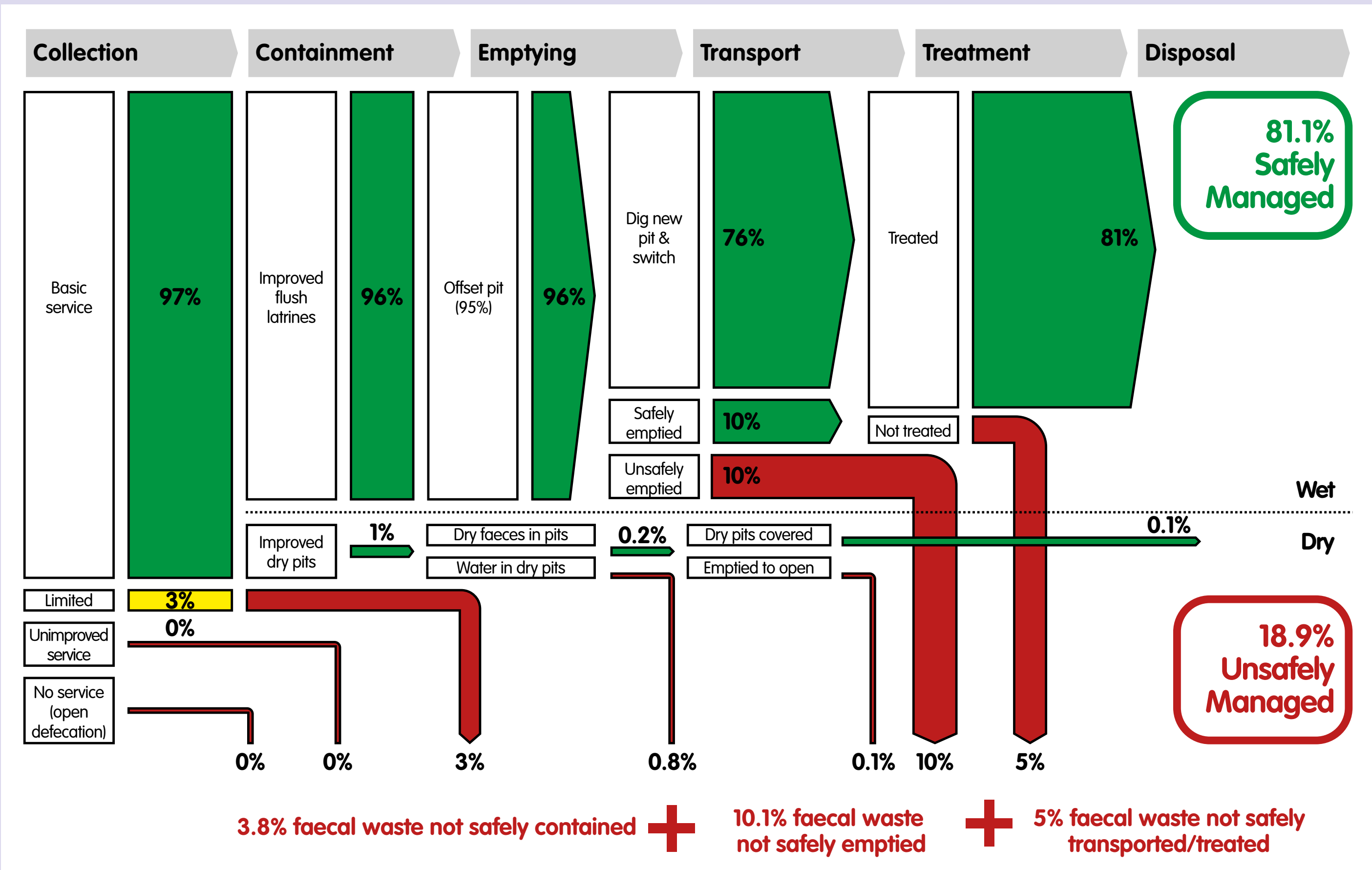


Figure 2: Projected safely managed sanitation estimates - rural mountain districts

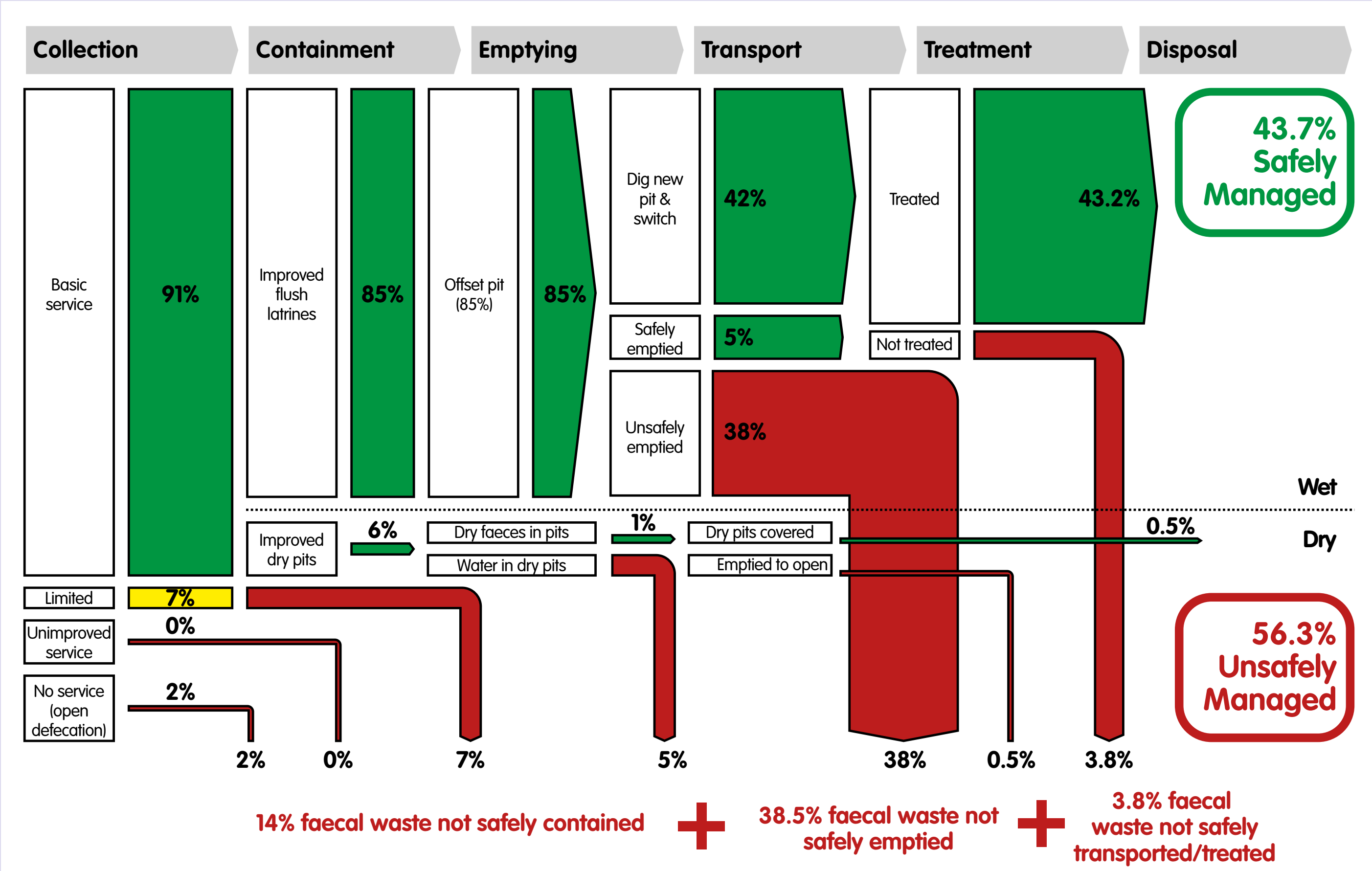
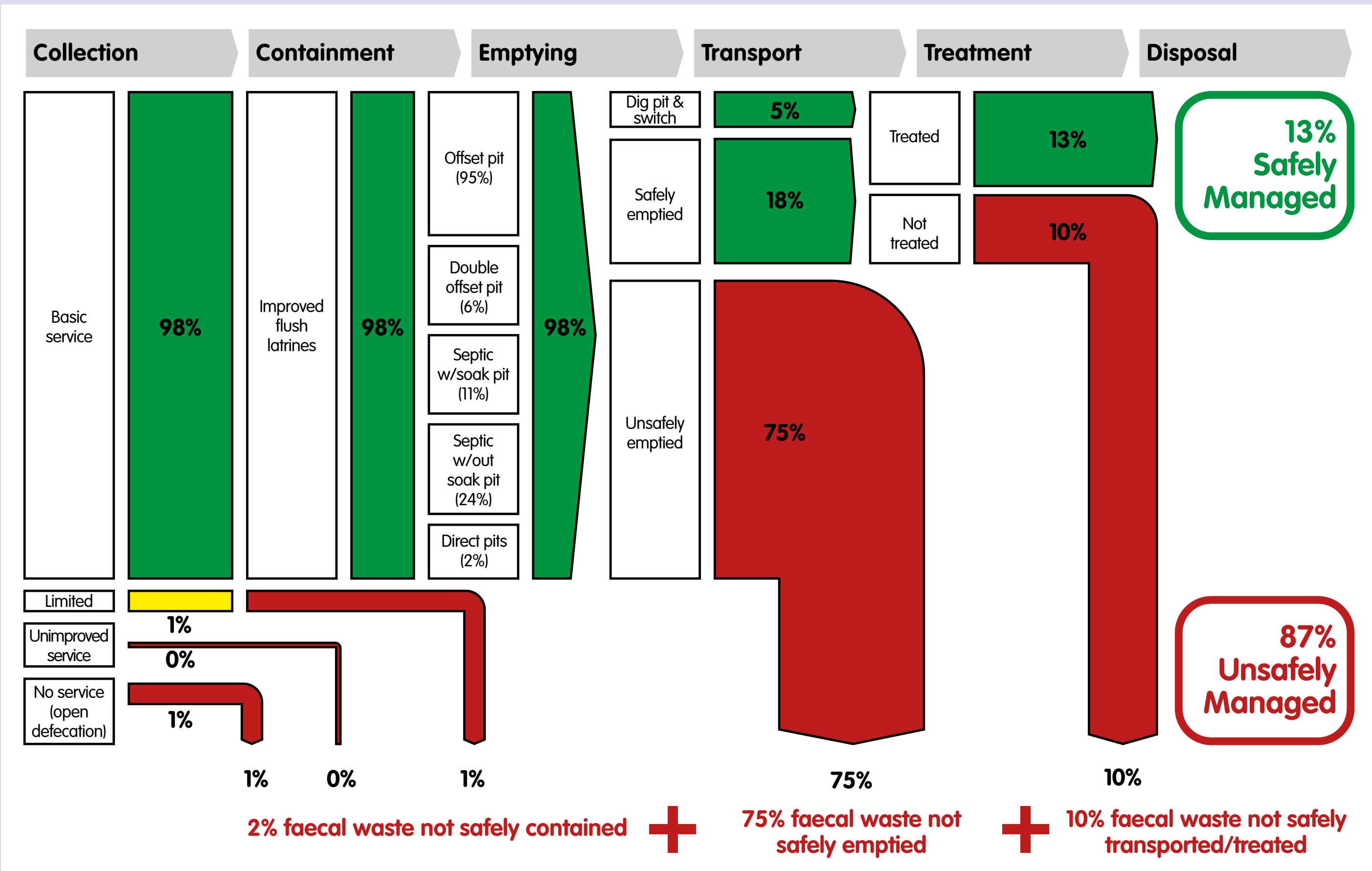


Figure 3: Projected safely managed sanitation estimates - rural terai districts



How often do pits need to be emptied?

The time taken for pits to fill depends on the following:

1. Number of toilet users and their diet.
2. Size of the pit.
3. Accumulated content in the pit:
   - Dry faecal sludge and urine (including the moisture evaporation rate).
   - Wet faecal sludge and effluent (including the moisture absorption rate).
   - Other (i.e. anal cleansing materials, fats and detergents, compost).
4. Digestion efficiency (i.e. aerobic or anaerobic processes at temperature and humidity).

In dry pit latrines, the dry sludge accumulation rates conservatively range from 25-40 litres per capita (lpc) per year depending on the addition of compost or anal cleansing materials. In pour flush toilets, wet sludge accumulation rates range from 25-40 litres per capita per year depending on the addition of grey water (Still et al., 2012). Though faecal sludge loading rates appear to be similar at 25-40 lpc per year, the efficiency of anaerobic processes in reducing solids is superior to that of aerobic processes as the wet faecal sludge generated in anaerobic pits will further reduce in volume when dry.

Sludge accumulation rates

Tabulating the fill times for different sized aerobic (dry pits) and anaerobic (wet pits + septic tanks), subject to different inputs (i.e. compost or no compost, black or plus grey water) from a varying number of users under different effluent dispersion conditions (i.e. leaching or no leaching) enables the operational boundary conditions to be established and compared against actual fill times. In establishing the boundary conditions, a safety factor of 150% has been applied to give a design a sludge accumulation rate of 40-60 lpc per year *(table 1)*.

- For rock lined pits of 1 m internal diameter and 1.5 m working depth, fill times will vary from three years and four months (for a mountain household of six using dry pits with compost) to six years (for a hill household of five sending black water to wet pits).
- For pits lined with three concrete rings of 0.84 m internal diameter and 1.2 m working depth used by a terai household of eight users with black water, the fill time will be just over two years.
- For septic tanks, 1 m wide by 2 m long with a working depth of 0.7 m and receiving only black water from a household average of 6.4 users, the fill time will be 5.5 years.

Effluent absorption rates

The effluent absorption capacity for different size pits in different soils indicates that:

- pits of 1.0 m outside diameter and 0.5 m deep can absorb 26 litres per day (or 4 lpcd for a family of six) in very fine sandy soil.
- in the terai, a pit of 0.9 m outside diameter and 0.45 m deep can absorb 21 litres per day (or 3 lpcd for a family of seven users) in very fine sandy soil.

Why do pits fill prematurely?

Sludge accumulation and effluent absorption rates suggest that premature fill times are most likely associated with the absence of appropriate provisions for

Table 1: Pit fill time with different faecal waste digestion options

Faecal waste digestion options		Loading (lpc/yr)	Users (#)	Depth (m)	Width/Dia (m)	Length (m)	Volume (m^3)	Fill time (yrs)
Dry pit	With compost (mountain)	60	6	1.5	1		1.2	3.3
	No compost (mountain)	40	6	1.5	1		1.2	4.9
Wet pit	Holding black water (terai)	1865	8	1.2	0.84		0.7	0.04
	Leaching black (terai)	40	8	1.2	0.84		0.7	2.1
	Leaching black (hills)	40	5	1.5	1		1.2	5.9
Septic tank	Holding black (Nepal)	1865	6.4	0.7	1	2	1.4	0.1
	Leaching grey (Nepal)	60	6.4	0.7	1	2	1.4	3.6
	Leaching black (Nepal)	40	6.4	0.7	1	2	1.4	5.5

the leaching of effluent. For single offset pit latrines in the terai, this is most likely due to the absence of lateral leaching provisions in the cast concrete rings. For septic tanks, this is most likely due to the absence of leach pits and the use of septic tanks as holding tanks.

Options to improve rural faecal waste management

Safe pit management options *(figure 4)* in rural Nepal are focused on burying the sludge. Covering the old pit and digging a new pit enables treatment to precede emptying or transportation.

If the contents of the pit are dry, then the sludge cannot be pumped out but may be dug out if turned into the soil.

If the contents of the pit are wet, then the sludge must be handled with caution.

- This is best pumped out and contained till dry.
- If it cannot be pumped out, then it may be bucketed out.
- Personnel should avoid direct contact with the faecal waste and should NOT ever enter the pit.
- Personal protective equipment should be worn when handling dry or wet sludge.

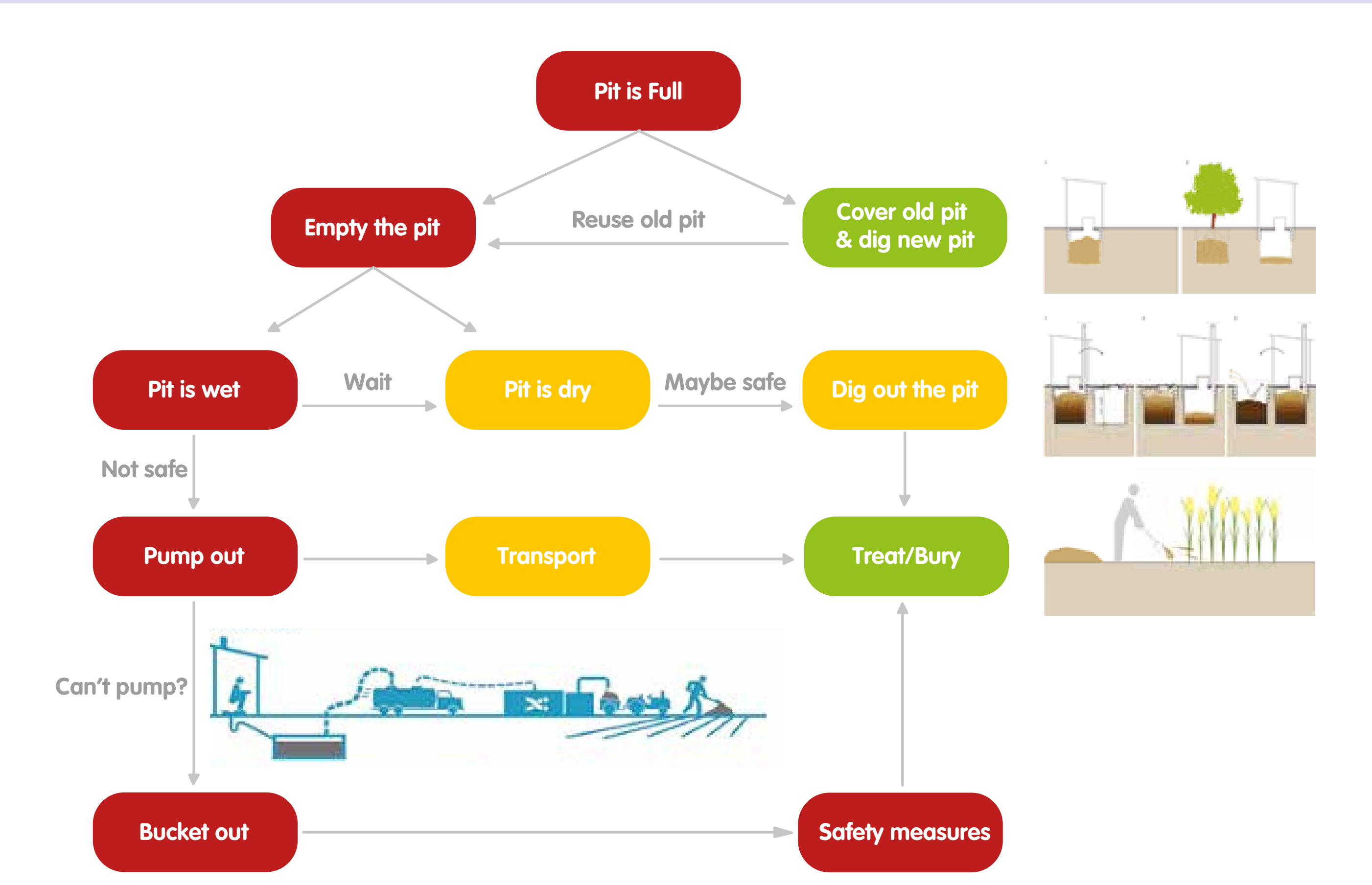
In rural Nepal, only 3% of the population continue to use dry pit latrines, of which 100% use water for anal cleansing. While dry pit toilets will remain an important technology option, minimising the moisture introduced into dry pits is crucial to ensure the effectiveness of aerobic processes. For pour flush toilets in rural areas, septic tanks do not present a superior technology option, particularly in remote areas where safely emptying wet faecal sludge from septic tanks is challenging. On the other hand, twin alternating offset pits enable households to avoid handling wet faecal sludge; only removing dry faecal sludge once it has been treated within the pits.

The premature filling of pits in the terai is most likely being caused by faecal effluent rather than sludge, i.e. excessive use of water for flushing or an excessive number of users. Underlying this is the inadequate leaching into the soil due to the absence of lateral perforations within the cement lined pits.

High and non-high water tables in the terai

Poor leaching in the **high-water table terai** could be addressed if the existing pit is operated as a septic pit; by adding another in-line perforated pit to perform as a soak pit *(figure 5 on next page)*. The first pit will be anaerobic, with minimal leaching from the bottom due to the clogging of the bottom with sludge and limited lateral

Figure 4: Safe faecal waste management



Diagrams from: Tilley, et. al., 2014.

A simplified faecal sludge accumulation estimate

Faecal sludge fill rates for a family of five using water for anal cleansing into pits of 0.84 m internal diameter and 0.45 m height are at half-a-ring per year. Faster fill rates could be due to a greater number of users, filling of pits with effluent (rather than sludge), entry of rain or flood water or the incomplete leaching of effluent into the soil.

percolation through the cement ring joints. A single perforated cement ring of 0.9 m outside diameter by 0.45 m height can aerobically treat and leach up to 20 litres of effluent per day (i.e. 4 lpcd for a family of five) in very fine sandy soil *(figure 6)*.

Nevertheless, it is recommended to maintain a lateral distance of 10 m between leach pit and shallow drinking water wells and vertical distance of 5 m from the bottom of the leach pit to the groundwater table.[5] Wet sludge from the septic pit will also need to be safely removed, transported and treated every two years (for a family of eight using a septic pit of three cement rings). Greater aerobic activity close to the surface of the soil and slower vertical leaching rates (as compared to horizontal leaching rates) suggests that this will present a lower groundwater and environmental contamination risk than deep holding pits that may be leaking or overflowing.

Poor leaching in the **non-high water table terai** can be addressed by adding another offset pit (pit #2), enabling switching between the two pits. If pit #1 has filled prematurely it will most likely be full of effluent. Installing perforated concrete rings will improve the leaching. Pit #2 will fill with sludge after two years (assuming three cement rings and a family of eight) at which point the faecal waste could be diverted back to pit #1. Pit #2 could be safely emptied once the faecal sludge is dry and before pit #1 fills with effluent.

Undertake a soil percolation test

The sizing of pits for the terai has assumed very fine sandy soil with a water percolation rate of 10 mm/hour equating to an effluent absorptive capacity of the soil of 17 litres m^2/day. To verify assumptions it is recommended to undertake water percolation tests in various soil topographies of the terai region (see https://greywateraction.org/how-do-percolation-test/).

Co-creation with sweepers and masons

Establishing appropriate guidelines and operational practices for emptying pits in the terai will need to be co-created with the traditional caste of sweepers. This is necessary because the masons that installed the latrines will not work on used latrines and therefore will never engage in the retro-fitting of modifications to the existing sanitation systems. Working with the sweepers could enable business opportunities from vertical and horizontal diversification to be identified.

The casting of perforated concrete rings could be achieved by drilling 10-20 mm diameter matching holes within the steel cement ring dies and fitting removable bolts or rods *(figure 7)*. Once the cement has been poured and begun to cure, the removal of the bolts or rods will create perforated concrete rings. An 80 mm pop-out steel die will enable PVC pipes to be inserted into the pit.

Alternatively, casting perforated concrete rings could be tested by adding an organic biodegradable product to the concrete slurry. The degradation of the organic additive would enhance the leaching properties of the concrete rings. Placing an 80 mm diameter banana tree stalk between the dies could provide a pop-out for PVC pipes.

Figure 5: Addition of a soak pit in very fine sandy soil in the high water table terai where pits are filling prematurely

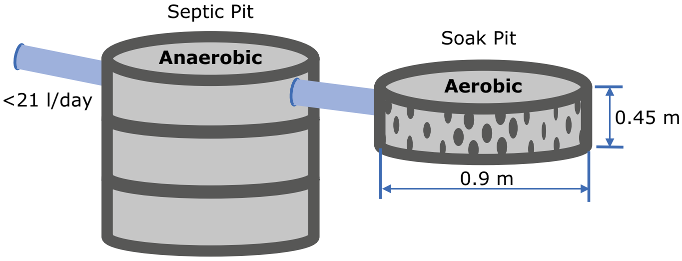


Figure 6: Installation of a second offset pit in very fine sandy soil in the terai where pits are filling prematurely

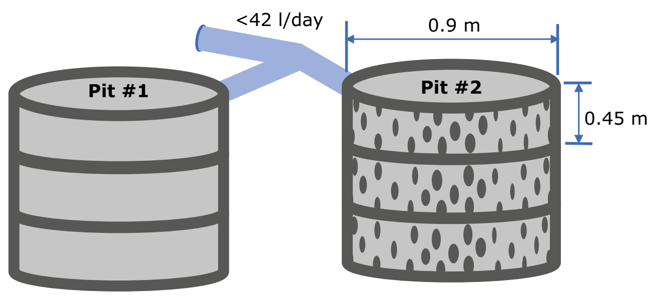
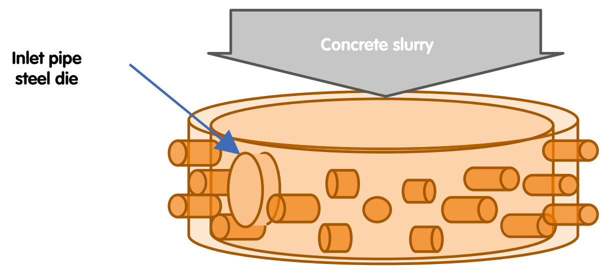


Figure 7: Steel dies with pull out bolts to cast perforated concrete rings



Source (figures 5 to 7): Illustrated by Mark Ellery, unpublished, 2018.

Programme implications

It is essential to understand the specifics of sludge accumulation and pit management in different ecological zones, and for wet and dry pits, to define pathways towards safely managed sanitation. This analysis of the data in project districts suggests that future programmes should seek to prioritise the following:

- Improving the leaching of effluent from pit latrines that are lined with concrete rings, while maintaining safety distances to groundwater sources. In the terai, this may be achieved in partnership with sweepers and masons.
- Reducing the moisture (i.e. urine and anal cleansing water) introduced into dry pit toilets. This may be achieved in partnership with users in the mountain regions, where there is a considerable legacy of experience with the use of dry pit toilets.
- Increasing awareness and the implementation of safety protocols during handling of faecal waste.
- Exploring appropriate treatment technologies and operation models, along with safe reuse practices of treated faecal sludge in dense rural settlements as current safe treatment is limited to burying faecal sludge.
- Undertaking regular analysis based on updated data and knowledge of actual faecal waste management practices is recommended to monitor improvements and changes in the likelihood of sanitation systems being safely managed.

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Endnotes

1 Shit Flow Diagrams were constructed with the SSH4A project staff during workshops on the 3-4/06/2018.

2 Terai is the term for the ecological zone in the low-lying plains in the south of the country.

3 Interviews of 1,148 households within sampled clusters in the eight districts of Dolpa, Jumla, Kalikot, Mahottari, Rolpa, Rukum, Salyan and Sarlahi conducted in April and May 2018.

4 In assessing the safety of sanitation services, systems in which a new pit is dug and the sludge in the old pit is left to dry before being emptied are considered safe for handling (emptying and transport).

5 These are the international standards as by the AGROSS "Guidelines for Assessing the Risk to Groundwater from On-site sanitation" (2001), British Geological Survey Commissioned Report. Note that in Nepal, a vertical distance of 1.5m was agreed for the Terai.

SUSTAINABLE SANITATION AND HYGIENE FOR ALL (SSH4A)

In Nepal, SSH4A is supported by the Australian Government in partnership with the Government of Nepal. IRC International Water and Sanitation Centre supports the programme as a knowledge partner.

SNV

SNV is a not-for-profit international development organisation. Founded in the Netherlands over 50 years ago, SNV has built a long-term, local presence in 38 of the poorest countries in Asia, Africa and Latin America. SNV's global team of local and international advisors work with local partners to equip communities, businesses and organisations with the tools, knowledge and connections they need to increase their incomes and gain access to basic services – empowering them to break the cycle of poverty and guide their own development.

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PHOTO ©SNV

(FRONT) Mason constructing an improved household latrine in Bashbitti Village Development Committee (VDC) Mahottari district. Photo credit: Md. Rahamul Miya, Project Coordinator, PAC Nepal.

More information on SSH4A Nepal is available at http://www.snv.org/project/ssh4a-nepal

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