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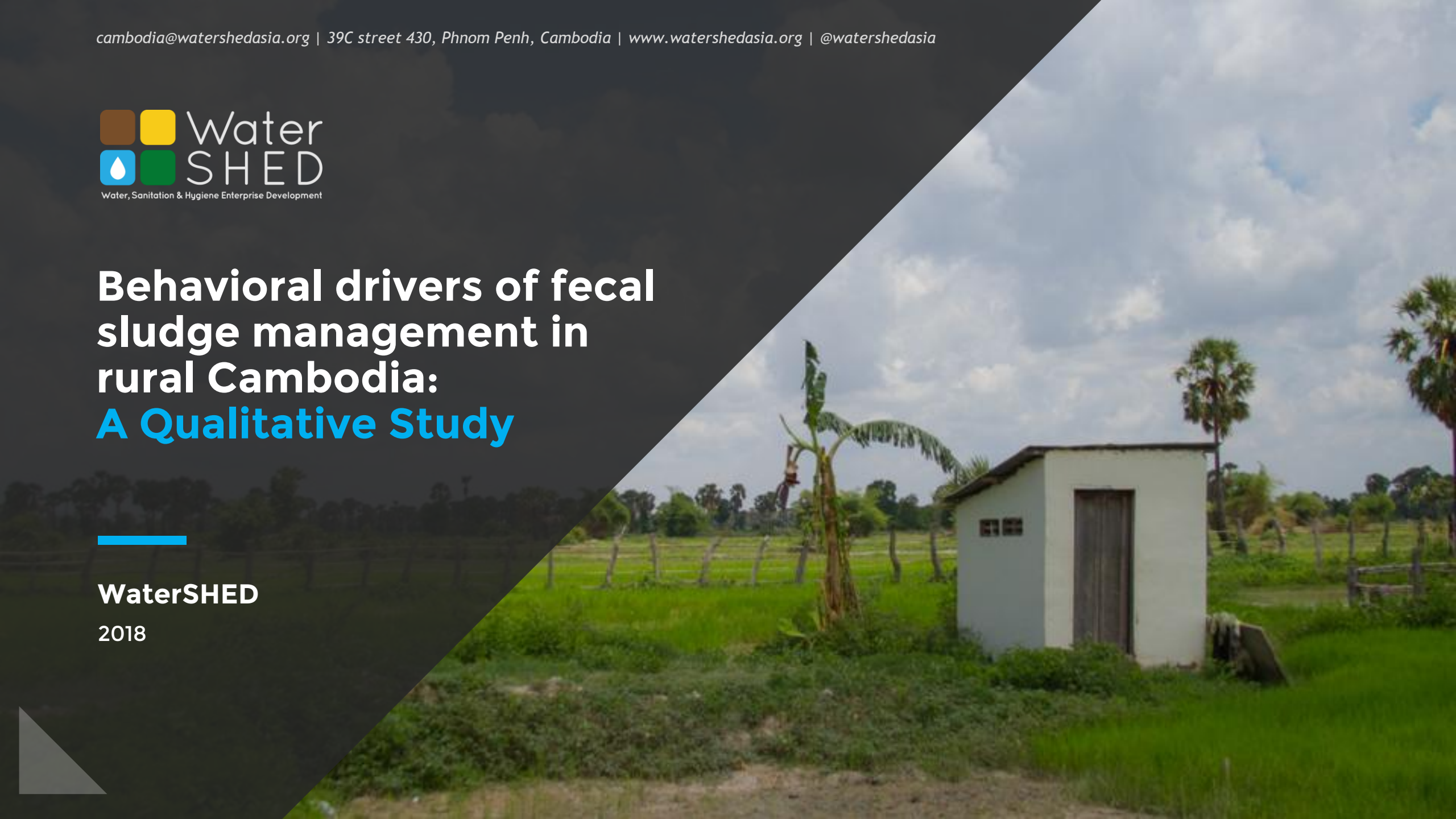
Water SHED
Water, Sanitation & Hygiene Enterprise Development

Behavioral drivers of fecal sludge management in rural Cambodia:
A Qualitative Study



WaterSHED

2018

Content

a. Study context of villages

b. Current fecal sludge management practices

c. Behavioral drivers of current practices
   - Risk perception
   - Emotions
   - Physical ability, access & cost
   - Physical environment
   - Attitudes toward reuse

d. Cross-cutting issues
   - Gender
   - Seasonality
   - Key influences

Abbreviations

CF	Chemical fertilizer
FSM	Fecal sludge management
FS	Fecal sludge
HH	Household
OD	Open defecation
PESP	Pit emptying service provider
PES	Pit emptying service
SSC	Sanitation service chain
WTP	Willingness to purchase

I. Introduction

International Context

More than two billion people worldwide use toilets with onsite containment of feces. This is especially true in rural areas. But safe options for fecal sludge management (FSM) for rural households are often limited or non-existent. This means untreated fecal sludge is likely to be disposed of improperly, leading to contamination of local waterways or agricultural lands.

Unsafe disposal of pit waste has serious negative impacts on both public health and the environment – and might undo much of the progress made in increasing access to toilets.

The Cambodian Context

Sanitation Situation

Over the last 15 years, sanitation coverage has increased rapidly in rural Cambodia, from only 4% in 2000 to 49% in 2015.

Most latrines in rural areas are pour-flush, with onsite containment of feces. Pits are usually lined with cement rings.

As pits continue to fill, fecal sludge management is an emerging challenge for rural sanitation in Cambodia.

Geography

This report focuses on households living in the lowlands where two thirds of the Cambodian population live.

The lowlands are characterized by seasonal flooding during the rainy season (May to November), high ground water tables, and rock soil conditions. High quality data on the geographic conditions across the country was not available at the time of the study.

Households living in floating communities along the Tonle Sap lake were not included in this study.

History

From 1975 to 1979, the Khmer Rouge ruled Cambodia with a failed “agriculture first” policy. Under the regime, approximately one quarter of a population of around eight millions were killed or died of starvation.

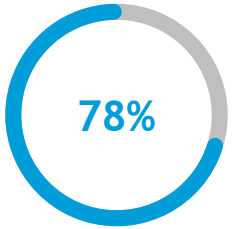
During this period, the regime forced the people to collect their own excreta to use as fertilizer in rice fields.

Fecal sludge in the pan-Indian cultural sphere

(Pakistan, India, Bangladesh, Nepal, Tibet, Sri Lanka, Burma, Thailand, Cambodia, Laos, Indonesia)

Under the influence of Hinduism and Islam, people usually wash their excrement with water. Cow manure is often used as a fertilizer and fuel.

FSM in rural areas



Cambodian population lives in rural areas.

Rural areas are characterized by:

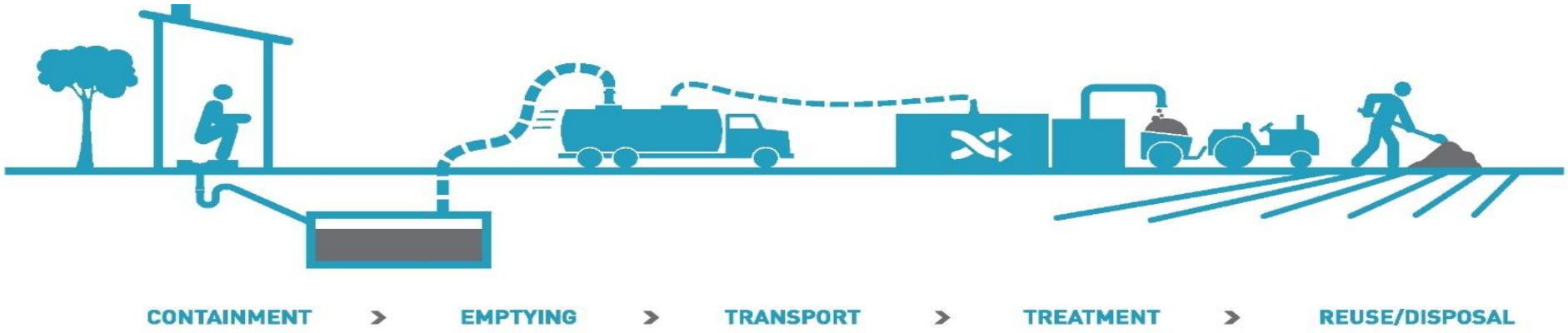
- Low population density with dispersed housing in most places
- High concentration of agricultural activities
- Proximity to agricultural land
- Higher poverty rate (approximately 90% of poor HHs live in the countryside)

These characteristics have implication for FSM in rural areas:

- Low population density means sewage systems are not cost-effective, thus on-site sanitation will be prevalent for the foreseeable future.
- FS usually has a high water content and is therefore very expensive to transport over long distances; highly decentralized solutions for FSM are needed.
- Households' proximity to agricultural land means discharging untreated FS directly into the land can represent a no-cost alternative to safely disposing of FS.

Because of the distinct challenges posed in Cambodia's rural areas, unique solutions are needed for safe FSM compared to those commonly discussed and applied in the urban areas.

The Sanitation Service Chain



In this study, we define **safe fecal sludge management** when feces/fecal sludge are **separated from human contact** at every stage of the sanitation service chain (SSC), i.e. during containment (or capture), emptying, transport, treatment, and reuse/disposal.

Path Dependency: The steps in the SSC are not independent from one another. Decisions made in an earlier step of the SSC can affect the choices at later steps and vice versa. Preferences regarding later steps in the SSC might influence decisions made earlier in the SSC.

Previous FSM research in Cambodia

This research builds on and complements previous studies on FSM in rural Cambodia. A literature review identified five relevant studies, which focus on the assessment of supply and demand for FSM services, FSM technologies and FSM business models.

Key findings from previous studies

- Pit emptying services are limited
- DIY pit emptying is prevalent
- Attitudes toward fecal sludge vary. Some studies found a preference for reusing FS as fertilizer in rice fields; others reported an apprehension toward using FS in agriculture. Mixing FS with animal waste to use as fertilizer in agriculture appeared to be acceptable.

Gaps in the existing literature

- There is little consideration of decentralized solutions which are suitable for the rural context.
- Limited attention has been paid to social and environmental drivers of FSM practices, especially in rural areas.

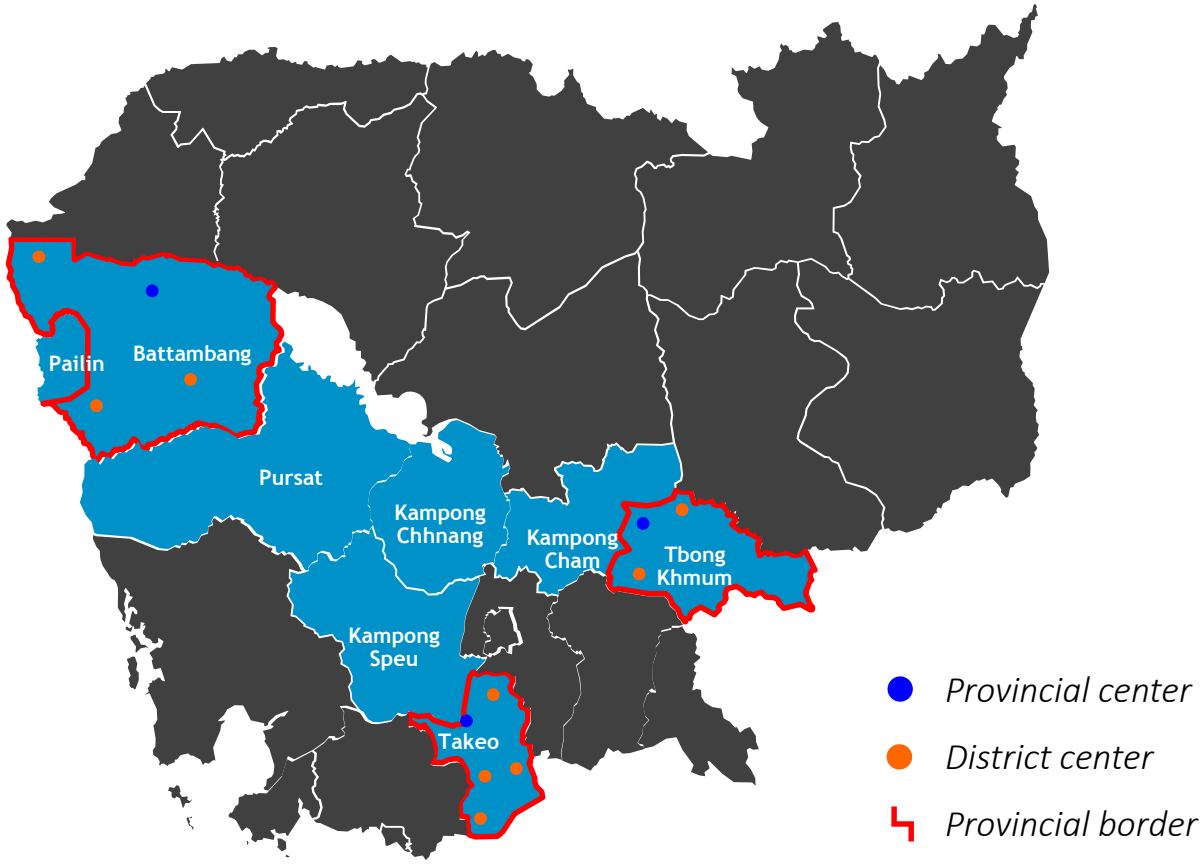
Research Questions

In order to design and implement solutions that are adequate to rural settings, we must first understand the current FSM practices as well as their behavioral drivers. Thus, we ask the following questions:

1. **What are the current FSM practices in rural Cambodia?**

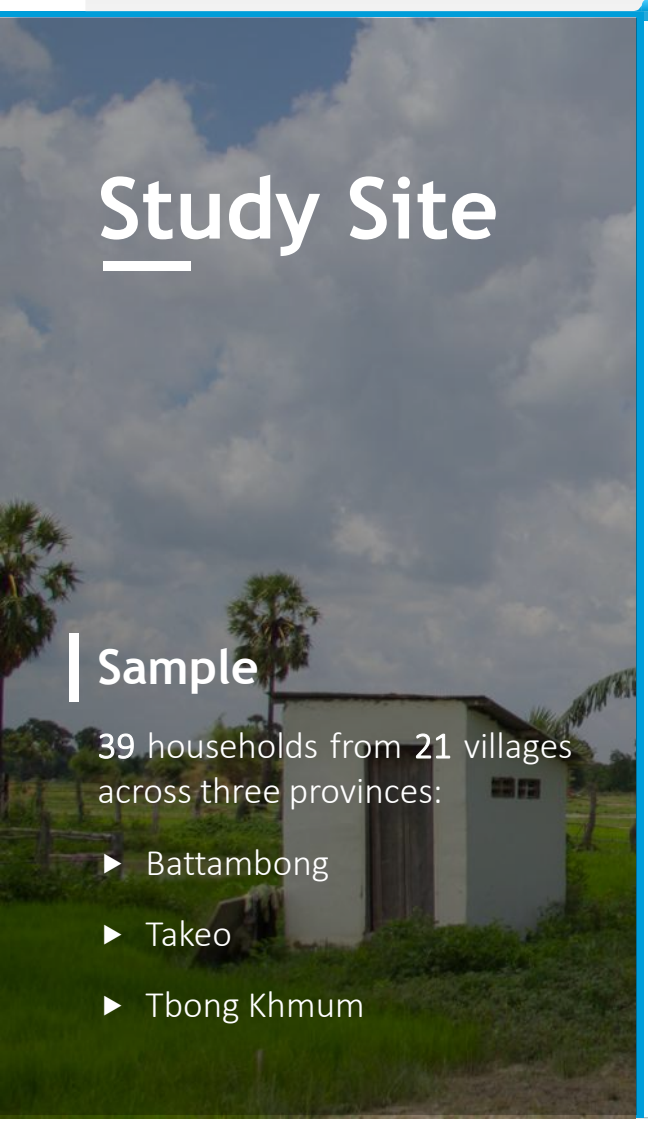
2. **What are the behavioral drivers that motivate or constrain rural Cambodian populations to safely manage their pit waste?**

II. Methods



Map of Cambodia Showing Study Locations

Takeo	*: 9 villages*
Tbong Khmum	*: 6 villages*
Battambong	*: 6 villages*



Study Site

Sample

39 households from 21 villages across three provinces:

- Battambong
- Takeo
- Tbong Khmum

Sample selection

Three-step process to select villages in which households have emptied their pits but where PESPs (i.e., vacuum tanker service) are unlikely to be available:

01. **Province selection:** purposely selected to represent a diversity of environment and economic activities

- Takeo: presence of garment factories and other non-traditional income generating opportunities
- Tbong Khmum: largely remote rural communities with high concentration of rubber plantation
- Battambang: agricultural hub with easy access to the Thai market in the east

02. **District selection:** 3-4 districts per province purposely selected based on following criteria:

- Far from provincial centers (where most vacuum tanker services are located)
- Have small or no market centers

03. **Village selection:** random sampling of district villages meeting these criteria to ensure remoteness from vacuum tanker service

Not included in the sample: challenging environments (e.g. floating communities, mountainous terrains) and households representing ethnic minorities

At village level, household selection criteria included:

- Latrine ownership
- Pit emptying experience
- Diverse socio-economic and demographic characteristics to obtain maximum variations of practices, circumstances, beliefs, and attitudes

Data Collection, Sampling & Analysis

Research techniques

- **In-depth interviews** with adult head of households and/or his/her spouse who takes part in decision-making
- **Observations** of sanitation infrastructure

Data Collection

- April and August 2017
- Interviews were conducted at the respondent's home in local language (Khmer) and transcribed and translated into English
- Interview continued until saturation point was reached

Data analysis

- Grounded theory
- Iterative coding and analysis process using Atlas.ti 7.5.7
- Adopted some constructs from RANAS and Social Learning Theory

Summary of respondents' profile

Respondent Characteristics		Number of Respondents
Gender	*Male*	*17*
	Female	*22*
Age	*25 - 40*	*11*
	41 - 55	*17*
	56 - 70	*11*
Ownership of agricultural land	*Yes*	*33*
	No	*6*
Years of owning latrine	*Less than 5*	*14*
	5 - 9	*13*
	10 or more years	*12*
Location	*Battambong province*	*13*
	Takeo province	*14*
	Tbong Khmum province	*12*
Main occupation	*Community leader*	*11*
	Rice farmer	*11*
	Plantation owner	*6*
	Head of public primary school	*3*
	Other	*8*

Study Limitations

Small sample size of respondents with pit emptying experience

- In most study villages, less than half of latrine owners had pit emptying experience.
- In some villages, there was an absence of a large number of people due to migration to the city and/or other countries. These villages were then replaced with new village from back-up list.
- Despite fewer respondents with pit emptying experience, we found little difference in the views of respondents with and without pit emptying experience.

Role of researcher

- Local researcher was sometimes seen as NGO or PES representative, which could affect respondents' answers to questions such as willingness to purchase.
- To reduce biased answer on willingness to purchase, both open-ended question & close-ended question were used.
- Both types of questions helped researcher test consistency of respondents' answers and detect outliers.

III. Results

Current FSM Practices | Behavioral Drivers | Cross-cutting Issues

Study context of villages

Predominant economic activities found in the study villages at the time of the research included:

- Agriculture (e.g., rice, rubber, pepper, pineapple)
- Home-based grocery retail
- Growing trend of migration to the city and other regional countries

The majority of the villages at the time of the study also had:

- No main or national roads nearby
- Small dirt roads that were either inaccessible by vacuum truck or very difficult to access especially in the rainy season
- An average distance of 15 km from their district centers (where PESPs were known to be based)

Current FSM Practices

Interviewees reported current **FSM practices** that could be **grouped into five categories:**

01 Self-empty, either manually or mechanically, or hire manual labor and apply on agricultural field

02 Hire a vacuum tanker service to empty and apply on agricultural field

03 Install a drain pipe to allow pit waste to flow into local water bodies or open land

04 Install an additional pit in series up to maximum of 3

05 Abandon the latrine and build a new one (acceptable to do one time)

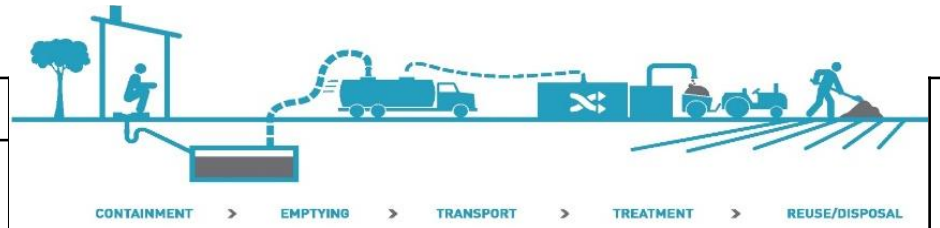
Long-term vs temporary practices: The first three practices were seen as long-term and repeatable.

The forth and fifth practices were seen as temporary or one-off solutions. When the limits on the acceptable number of added pits or rebuilt latrine have been reached, households stated the intention to revert to one of the first three options.

Intention vs Practice: Households without pit emptying experience (n=21) reported a strong preference for hiring vacuum tanker service (n=12, 57%) and few reported planning to empty the pit themselves (n=2, 10%). Among households with pit emptying experience (n=18), only a minority hired a vacuum tanker service (n=6, 33%), while most emptied by themselves (n=9, 50%). See table on next slide.

Table 2: Responses to pit filling, frequency of mention by households with (practice) and without (intention) pit filling experience, and the researcher's overall assessment of the safety of FSM practices in each step of the sanitation service chain

Reported response to full pit		Response to full pit: Practice (n=18)	Response to full pit: Intention (n=21)	CONTAINMENT > EMPTYING > TRANSPORT > TREATMENT > REUSE/DISPOSAL	Seen as long-term solution for FSM?
Self-emptying	Manual	6	1		Yes
	Mechanical	3	1		
	Hire labor	0	1		
Hire vacuum tanker service		6	12		Yes
Install drain pipe		1	4		Yes
Add new pit		1	1		No
Build new toilet		1	1		No



Safe

Uncertain (further assessment needed)

Unsafe

Current FSM Practices

Respondents reported that they discharged only black water (feces, urine, and water for cleansing and flushing) into their pits. Grey water from shower or laundry was discharged elsewhere, for example into nearby banana thickets or water canals.

Respondents described the consistency of FS in the pit as liquid, comparable to that of water.

Respondents reported that their decisions regarding what kind of pit to install and how to install were strongly influenced by masons who base their recommendations on their experience and size of the household. Masons influenced the following decisions:

- Number of pits to install
- Number of cement rings per pit
- Connection between pits in series*
- Design and installation of pit covers
- Material at the bottom of the pit (cement, rocks, charcoal, etc.)
- Increasing subsurface infiltration (e.g., increasing gaps between cement rings)

These choices at the design and construction stage of latrine pits have major implications for access to the pit for emptying and for how fast pit fills up and thus the frequency of emptying.

"[I] took (fecal sludge) out with a small plastic container, put it in a bucket, and then carried it to the rice field […] It's liquid; so it's like when [we] draw water out of a well."

"The mason did like this for us. […] They didn't advise us to have only one pit [because] they're afraid it would be quickly full; so they told us to install two [pits]."

**Note: Most double pits found were in series. Alternating pits were not used for managing pit contents.*

Self-emptying or hiring labor

- **Tools:** Respondents reported using buckets, ropes, and sticks for manual emptying, and using buckets, water pumps, and hoses for mechanical emptying
- **Protective gear:** Respondents reported using gear such as disposable masks, gloves, and socks for manual emptying to avoid smell and contact, but not so for mechanical emptying (which was thought to be less exposed to FS)
- **Time required:** Respondents reported that it took half a day for two people to empty a pit.
- Respondents compared manual pit emptying to drawing water from a well, while they said mechanical emptying required more "technical" skill.
- Respondents reported **that manual laborers who do this work were hard to find**. According to some of them, those who choose to do this type of work in their villages were usually adult men with daily drinking habit and were often referred to as "drunkard." Pit emptying process was said to be the same as manual self-emptying, but performed by someone outside the household.

"[My sons] pumped it bare hands at that time. It didn't stain [their] bodies. We used machine to pump it, so it didn't dirty our bodies."

"I don't think the villagers will do this work for us. […] To hire them to do [pit emptying], we'll have to spend lots of money; if we pay them little, they definitely won't do it."

Hiring vacuum tanker service

- Respondents reported vacuum tanker uses big pipe, machine, and truck to pump and store the FS.

Self-emptying or hiring labor

- Respondents reported transporting FS on foot if disposal site was nearby, using sack or bucket.
- Respondents reported transporting FS on their bicycle, motorbike or semi-tractor if disposal site was farther away.
- Respondents described tying sacks to avoid spillage during transport, but when buckets were used, usually no lids were used. Spillage could happen on bumpy or muddy road (especially during the rainy season).
- When the pit was emptied by a manual laborer, this person carried the FS on foot to dispose of in HH's rice field or orchard.

"[We] put [the sludge] into plastic sacks, tied the mouths [of the sacks] tight and then transport [them] to [our] rice field."

"[…] I saw others in this village hire the men to scoop [the fecal sludge] and carry it [on foot] to put in their rice fields."

Hiring vacuum tanker service

- When pit was pumped by vacuum tanker, FS was transported by truck to be disposed of in HH's agricultural field or orchard (if possible), or taken away if the path was too small for the truck.

Self-emptying or hiring labor

- Respondents reported putting ash, gasoline, liquid toilet cleaner, liquid fertilizer, and/or odor-controlled tablets into the pit before manual emptying to reduce or eliminate the smell of FS.
- After placing FS in the bucket, households added water to dilute the FS before transporting and applying to their agricultural fields. Other than that, no other treatment was described.
- Respondents reported no treatment of FS before or after the pit was emptied manually by a hired laborer, apart from diluting the FS with water.

"[…] It does not have bad smell. […] [We] used liquid fertilizer to prevent bad smell; [the fecal sludge] is completely liquid."

Hiring labor

- Most respondents reported having no knowledge of what vacuum tanker did with the FS when it could not be put in their agricultural field or orchard.

"After it's emptied, (the FS) is theirs; I don't know what they (vacuum tanker service) will do with [it]."

Self-emptying or hiring labor

- Respondents reported disposing of FS on their own in home gardens, rice paddies, plantations or orchards.
- Disposal of FS was usually done immediately after emptying (especially in the rainy season). But, if reused as "fertilizer," FS was mixed with water first (see next slide for more detail about disposal/reuse reported by respondents).
- When labor was hired, they were told to dispose of FS in the households' premises or agricultural land.

"[After] I drew [the fecal sludge] out, […] I just applied it on my plants [at home]."

Hiring vacuum tanker service

- When vacuum tanker service was hired, FS was immediately disposed of on households' agricultural land if this land was nearby and accessible by the vacuum truck via road (with no extra transportation cost charged to the HH). When FS was taken elsewhere*, respondents reported having no idea where the disposal site was.

"[We] don't know where they dumped [the waste]. […] After [they pump it], it's done for [us]. Whatever they did with it (the waste) was their business."

*At the time of the study there is no functional treatment site for FS in rural Cambodia. So vacuum tanker service had no choice but to dispose of the untreated sludge at an unofficial site.

Behavioral Drivers

When talking about risks associated with handling FS, respondents …

… mainly **focused on their individual health risks**, rather than the potential environmental contamination caused by unsafe handling and disposal of fecal sludge into agricultural lands or local waterways.

… were **most concerned about skin contact with FS.** Skin contact with FS was thought to cause rashes and/or swollen limbs.

… thought that wearing disposable masks, gloves, socks, and other **protective gear would prevent or reduce the risk of personal contact contamination.**

… believed **smell to be the main or only vector of "diseases" transmission.** Some respondents also believed that if FS had no smell, it would impose low or no health risk to humans.

Behavioral Drivers

This study found that FS was perceived to be less harmful and safer to handle if…

… feces were **completely dissolved into liquid** compared to solid feces.

"If [we] talk about bacteria, feces are 100% dangerous, [whereas] this one (FS) is 50% less [dangerous], or even lower [than that]."

… feces were **produced by family members only** compared to feces of others outside the household.

"I know what diseases the people in my family have, but people from outside never tell me what [diseases] they have."

Behavioral Drivers

Disgust was found to be the major emotional factor affecting respondents' decision to empty the pit by themselves and/or reuse the FS in their agricultural fields. Some respondents reported that a strong **feeling of disgust prevented them from self-emptying** their pits.

"If I needed to empty, I would do it. But I just don't want to do it. Let me tell you, even the poop from baby will make me feel like vomiting."

A number of respondents said the **foul smell of FS was the main cause of their disgust**. Some respondents reported finding FS (also referred to as **"black water") less disgusting than feces** because of its liquid texture. A few respondents also found the feces of their family members less disgusting than those of other people.

"If I knew how to empty [pit], I would do it because there's only our family members using [the latrine]. Nobody else uses it that would make me feel disgusted to do it."

Physical ability

Most respondents described (manual) pit emptying as **heavy, exhausting work** that requires a lot of physical strength. Because of their lack of physical strength, **old people were seen as unfit to manually empty pits.**

"In the future, [I] will not empty [pit] myself. [I] can only hire them (service provider) to pump it. […] When I was young, I could do this work. Now [my] strength is gone."

Access: Actual availability of vacuum tanker service

Some respondents reported that there were vacuum tankers available in their area, although the reported **responsiveness of the vacuum tanker varied** from a few hours to weeks between the time the service was solicited and delivered. While waiting for the service to be delivered, some respondents accessed their **neighbors' latrines** while other reported they **reverted to open defecation.**

"[It] was half a month, I think, that [we] had to wait for them (vacuum tanker) to come. […] Some of us went out to [defecate] in the plantation because we have eight people here."

Access: Information about vacuum tanker service

Most respondents reported having **limited or no access to information about vacuum tanker service.** Most common source of information about the availability and modality of vacuum tanker service were either **neighbors** who had used the service or **advertisement stickers** with contact details distributed by the service provider. However, **most respondents did not actively seek information** about pit management options until their pits were full. They explained their difficulty to think about a problem and its solutions before it occurred.

"We may have hired, too, if only we'd known about the [service]. But we didn't know until [now] there were such service providers to pump fecal matter."

"[I] don't have full pits yet, so [I] don't know. [I] will ask the others […] when my pits are full. […] When the pits are not full, it is hard to think about what to do."

Cost

Most respondents who had not yet emptied their pits said **they could pay between US $10 and $25** for vacuum tanker service, while actual service was reported to cost from US $50 to $100.

Respondents **explained their willingness** to purchase vacuum tanker service was because of:

- Their physical inability
- Their unwillingness to self-empty the pit; and/or
- Their high levels of **disgust** of FS.

Some respondents **compared the cost** of hiring vacuum tanker service to:

- The money they would otherwise spend on **medical treatment** if they became sick from handling FS in the process of self-emptying their pit; and/or
- The **cost of installing a new pit** instead of emptying the existing pit.

"If we get ill, we'll spend much more money than we will on hiring the service. For example, if we spend 200,000 riels (~US $50) to hire [service], if we get ill, we'll spend millions of riel for [treatment]."

Household location

All respondents reported they were **concerned that the smell resulting from self-emptying their pits would irritate their neighbors or even physically affect their neighbors' health**. Hence, for those households living in the center of the village with many neighbors close by, self-emptying was considered an unacceptable option. Whereas those households who lived at the edge or the back of their village or those in areas with low population density and large distances between houses, self-emptying their pits was seen as an acceptable option because they could **store and/or dispose of the sludge without other villagers being affected by the smell**.

"We can empty [pit] easily because our house is at the end of the village. For those living in the middle, it's hard to do because they don't know where to put [the waste]. […] They can't leave it in the village since the smell affects others."

"My husband and I thought if we could empty [pit] ourselves [instead of hiring vacuum tanker service], we could use it (FS) as fertilizer in our rice field. But there's not enough space here [at our house] to store it. […] I'm concerned about the smell, which can disturb others."

Ownership of and distance to agricultural land

Respondents reported that **FS could be dumped only on one's own agricultural land**, but not on other people's agricultural land, because FS was a "smelly" waste. Hence, those households without agricultural land said they were not inclined to self-empty their pit because of a lack of disposal options.

Some respondents also reported their reluctance to empty pit themselves if the distance to their agricultural land was far and the road going there was in poor condition (e.g., narrow, bumpy or muddy).

Perceived benefits of FS reuse in agriculture

Respondents, even those who found the waste disgusting, **perceived FS as a good, "natural" fertilizer**.

When evaluating the value and risks of FS as fertilizer, respondents **compared FS to chemical fertilizer**. Specifically, respondents believed:

- FS **made soil "black" and "loose,"** whereas CF made soil "red" and "hard."
- The **fertilizing effect of FS lasted longer** than that of CF.
- (Untreated) FS was **safer to use than CF**.

Reusing FS as fertilizer is reported to also have economic benefit as it allows respondents to reduce the amount of CF they purchase to use in their agriculture.

"No, it (fecal sludge) is not the same as chemical fertilizers. Chemical fertilizers can affect our health, but this one does not because it's already dissolved into liquid."

Specific beliefs about how to use FS as fertilizer

Respondents expressed a series of **detailed beliefs about the use of FS as fertilizer** in various agricultural activities. Some of these views appeared contradictory:

Some respondents considered raw FS as "too strong" to use directly in agriculture. This required the FS to be diluted with water first before reuse.

Others considered raw FS to be suitable for slow-growing crops (e.g. rice) but not for fast-growing vegetables (e.g. cabbage) because they feared the fast-growing vegetables would retain the smell of FS.

"Some people even taste the sludge after they mix it with water [...] to know how salty or bland it is. If [it] is salty, [it] can damage the crops easily."

Cross-Cutting Issues

Gender | Season | Key Influences

Pit emptying and transportation of sludge were commonly perceived by both male and female respondents to be the **work of men** for two reasons. Respondents perceived…

… pit emptying as **"technical" work**; women lacked the "technical" ability which men naturally had to do the work.

> *"As women, we are weak, so when [we] smell the bad odor of [fecal sludge] we can pass out or collapse. […] But men have more physical strength; they could bear the smell to cope with that kind of work."*

… women lacked **physical strength** to empty pits and **endured the bad smell** of FS.

Respondents also reported that women were more disgusted by FS than men. Some female respondents explained their feeling of disgust was heightened compared to men because of their primary role in preparing food for the family.

> *"It's men's job. Men don't do cooking […] so they don't find it (FS) as disgusting. As women, we do cooking. [We] may think about that stuff and get disturbed while [cooking]."*

Despite these perceptions, we found both men and women involved in emptying their own pits.

Cross-Cutting Issues

Respondents reported that seasonal fluctuations in cash flows affected their ability to pay for vacuum tanker service if their pit filled up. Specifically, some respondents said they were likely to experience financial problem in the rainy season because …

… they had **seasonal debt** resulting from borrowing money to invest in agriculture; and/or

… they experienced **unpredictable crop failure**, which worsened their ability to pay off their debt.

The respondents explained these seasonal financial problems **undermined their ability to afford vacuum tanker service**, especially in the pre-harvest wet season.

The study found **no evidence of pit filling fluctuating by season.**

"We're experiencing a loss in our harvest […] but we still haven't paid the big tractor rent and so on. So we don't have the ability to afford the [vacuum tanker] service.."

Historical experience

Many respondents who emptied their own pits reported that they learned this practice during the **Khmer Rouge era** (1975-1979) when they had been **forced to carry feces by hand from pits** to use as fertilizer in agriculture.

For these respondents, manually emptying their pit was seen not only as a solution to a full pit but also a way to access "natural" fertilizer for their crops. Some respondents also reported that this past practice and exposure to untreated FS led them to **believe untreated FS had no harmful effect on health.**

> *"For feces, during the Khmer Rouge, people even squeezed it with their bare hands and there were no [health] effects at all."*

What neighbors do

Most respondents asked their neighbors who had had pit emptying experience for solutions to full pits and their cost. They ended up paying the same amount of money as their neighbors previously had for hiring vacuum tanker service. Thus, the price paid by first service user in a village was likely to determine the price paid by the following users in that village, as respondents reported that the price was non-negotiable.

> *"[We] paid the same [amount] as the person before [us] had done. […] If price increases and other people agree to pay, we'll follow them. If they're not willing, we won't be either."*

Unwillingness to lend equipment to empty

Most respondents explained their fellow villagers were more likely to lend money to other villagers to pay for vacuum tanker service than to lend or let them rent their equipment (generator, pipe, bucket, etc.) to empty a pit because of their disgust of fecal sludge.

Community leaders

Respondents reported that community leaders (e.g., village chief) had no significant role in influencing or regulating FSM practices. Neither were they equipped to provide information or guidance about safe FSM options.

Masons

Because HHs let masons decide the design and installation of their latrine pits, masons are a key influencer on the subsequent set of pit-emptying options available to HHs made when their pits are full and on how often they need to empty.

IV. Discussion & Conclusions

Current Practices

The study found that current FSM practices in rural Cambodia posed significant public health & environmental risks, especially the lack of FS treatment prior to disposal into agricultural sites or other open space. Unsafe option such as installing drain pipe to empty pit content into the environment to avoid pits from getting full also represented a very risky practice to public health and the environment.

Cross-cutting Issues

Gender. FSM was regarded as men's work because of their perceived physical strength and ability to endure the bad smell. However, the study also found that women were also involved in managing their pit content.

Season. Seasonal fluctuations in cash flow was found to undermine the household's ability to afford vacuum tanker service when the pit filled in the rainy season.

Key influences. For some households, past exposure to handling human excreta (e.g., during the Khmer Rouge era) led them to manually empty their pits and reuse the FS, and also made them believe (untreated) FS had no health effect. Local masons were more influential in villages than community leaders.

Behavioral Drivers

Risk Perception. Smell and skin contact with FS were believed to be the main source of contamination. Some respondents used protective gear when manually emptying the pit. There was little mentioning of environmental contamination from unsafe disposal or reuse of FS. We also found risk perception that liquid FS was safer than feces and feces of family members was safer than non-family members.

Emotion. Disgust induced by foul smell of FS was found to be the most important emotional driver affecting the decision to self-empty pit.

Ability, access & cost. Households had limited access to information about vacuum tanker service and safe FSM practices, and did not actively seek information until their pits were full. We identified households' ability to pay for vacuum tanker service did not match the actual cost of the service. Physical strength was found to also affect the decision to manually self-empty the pit.

Physical environment. Ownership of agricultural land and distance between houses to prevent smells from affecting the neighbors were found to be necessary to manually self-empty the pit.

Attitudes toward reuse. FS is valued as organic fertilizer. FS is compared to chemical fertilizer and is judged as safer and better for the soil.

Discussion

We identified a latent demand for vacuum tanker service among households with pour-flash latrines in communities far from where the service operated. This confirmed the findings of previous studies in Cambodia. Despite latent demand for a vacuum tanker service, we found no evidence of latent or real demand for safe FS disposal; in fact, HHs expressed strong preference for dumping pit waste on their agricultural lands (if possible) when vacuum tanker service was used. There was also some latent demand for hiring manual labor, but almost nobody in study villages was willing to do this work.

We further identified barriers that impeded households' ability to translate their latent demand for vacuum tanker services into actual demand. These included:

- Preference to use one's own FS (but not others') as fertilizer on one's own agricultural land
- Lack of forward thinking to prepare for full pits
- Cash flow constraint to pay for PES (i.e., vacuum tanker service) when needed, as well as low ability to afford vacuum tanker service
- Unavailability of information about PES, PESP and alternative pit emptying options
- Preference for lower cost alternatives (installing a drain pipe, adding new pits, self-emptying, etc.)

We also found that health risk perceptions did no always match actual risks. For example, smell of FS was perceived as the main vector of disease transmission. Skin contact with fresh FS was also perceived as a health threat, but for not the enteric diseases.

Implications for developing safer FSM practices in rural Cambodia

Key barriers to accessing a vacuum tanker service include lack of information, cash flow problem, plot access, distance to the nearest service, and high cost. To turn latent demand of rural households into actual demand, these barriers need to be removed or lowered. However, bigger barriers to safe FSM than accessing tanker services is the strong preference of HHs for dumping the (untreated) tanker waste on their agricultural land and the lack of any FS treatment facilities for safely disposing of tanker waste.

Fecal sludge should be seen as an opportunity. Farmers see value in FS as organic fertilizer and interventions need to take this into consideration when designing solutions.

The study showed that adult men and women in the village were at risk of direct exposure to untreated FS during manual pit emptying, although adult men may be at higher risk because of their expected role to manage their families' pit waste. Some groups of HHs (e.g., headed by seniors, female-headed, waiting for vacuum tanker service to come) may revert to open defecation for a period of time when their pit is full.

> Female-headed households and those with senior citizens only may be more vulnerable as these groups may be unable to manually empty their pit and/or pay for a pit emptying service provider.

The results of the study also imply some beliefs and norms may need to be changed (e.g., risk perceptions), while others (e.g., fear of affecting others with smell of FS) could be leveraged for safer FSM behaviors. We found a number of shared norms around FSM, of which these were widely held:

- Avoid irritating neighbors with smell
- Fecal sludge can only be disposed on one's own agricultural land
- Fecal sludge management is the responsibility of adult men and requires male strength and stamina to do
- Manual pit emptying/labor is not an activity that gets looked down on by the community

Recommendations

A holistic approach for identifying solutions to FSM is needed to ensure that the technological solution fits local preferences and is embedded into local government structures.

Particularly, BC strategies should build on:

- Disgust as a major emotional driver of safer FSM behaviors
- Seeing FS as an opportunity rather than simply waste. Suggesting treatment of FS to improve its properties as fertilizer (safer to handle, easier to store, etc.) might be more effective in inducing safer practices than conventional awareness raising of health risks associated with handling and disposing of untreated FS
- Existing role of masons in influencing the design and construction of latrines which have consequences for safe FSM

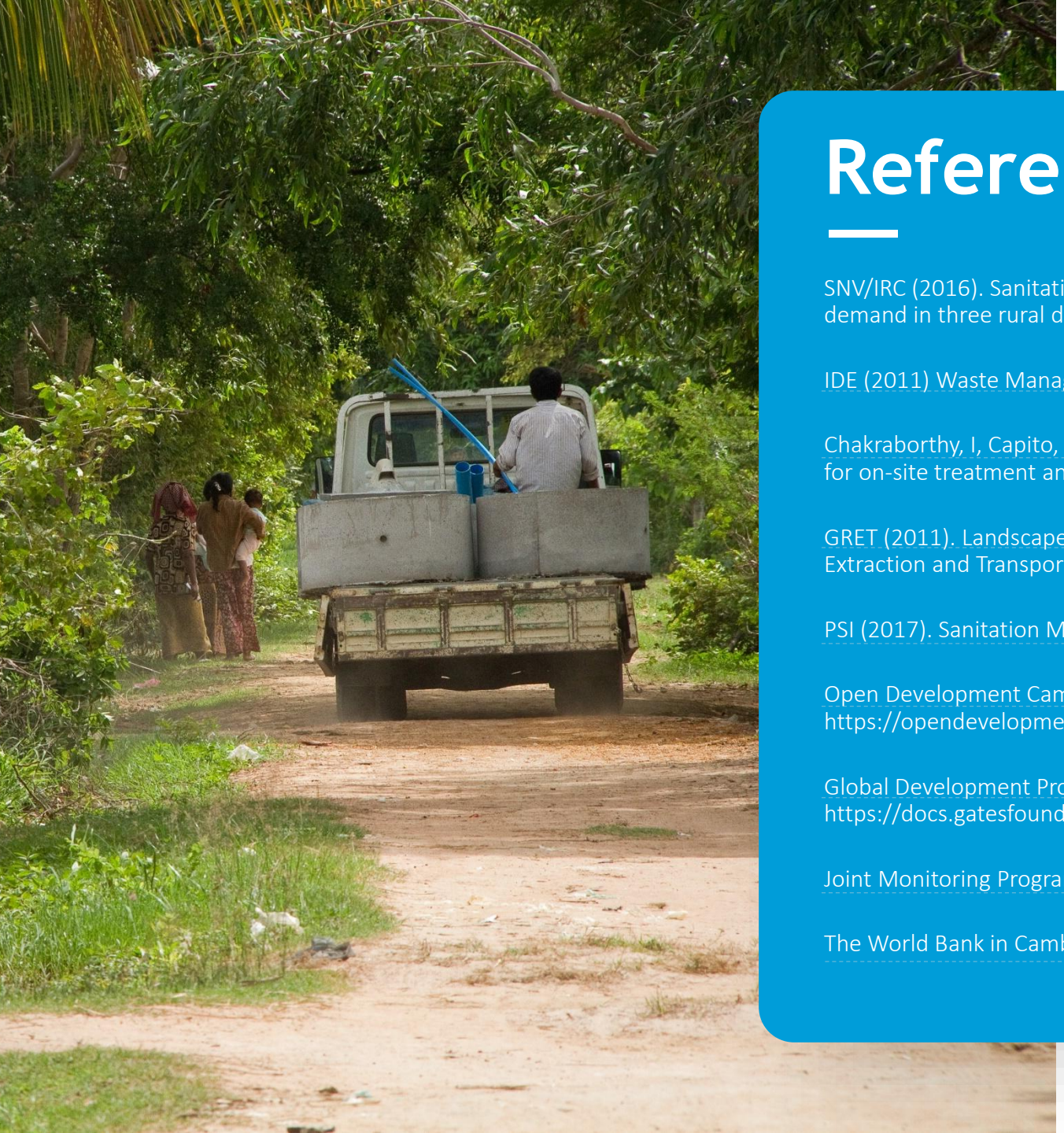
Key influencers. Strengthen local government (commune councilors, village chiefs) to be able to take a leadership role for safe local FSM, become a source of information and advice for safe practices for self-emptying and for reducing environmental and agricultural risks in the choice of places for disposal and the practices of FS reuse as fertilizer in their communities.

Technological solutions

- Develop locally adapted safe FSM solutions
- Solutions need to address the elimination of smell and reduce disgust
- Solutions need to allow reuse of FS

Next steps

- Validation of findings through quantitative study to test representativeness of findings
- Design workshop with local commune councilors to develop solutions for safer FSM that address DIY pit emptying, places to dispose of FS, and FS reuse as fertilizer in their communes



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