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Assessing the cultural potential of ecological sanitation in improving waste management and food security in the Taita Hills, Kenya.

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Autobiography

The author is an MSc with a specialization in development geography from the University of Helsinki. During his time in the University he gained experience both from academic life and from development fieldwork with an internship in Kumasi, Ghana and research fieldwork in the Taita Hills of Kenya. He actively participates in development cooperation through modest volunteering work with Taksvärkki Ry and Plan Finland Ry and is a member of Huussi Ry.

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Abstract

This paper aims at investigating the possibility of implementing ecological sanitation solutions in the Taita Hills, Kenya, therefore contributing to sustainable local development. The approach taken to this aim is that of a description and analysis of sociocultural preferences regarding sanitation and the idea of reusing human excreta in agricultural production.

Poor sanitation circumstances are a widely acknowledged and researched issue in the field of human development. In addition to putting a burden of disease on affected populations, lack of proper sanitation facilities are identified as both a cause and a consequence of poverty. Sanitation solutions also play a notable role in the interaction between settlements and the natural environment.

Ecological sanitation includes a wide range of technologies and other solutions with the aim of improving sanitation and simultaneously diminishing pollution, most notably of water bodies. An important aspect of ecological sanitation solutions in agricultural areas is the possibility of treating waste to produce fertilizers suitable for use in local farming. This would enable communities to close the cycle of nutrient flows as nutrients withdrawn from the soil in the form of agricultural produce would be returned as fertilizer. In addition, local, low-cost production of fertilizers can be a sustainable way of weakening dependence of international fertilizer markets, thereby improving rural livelihoods. The possibility of improved access to suitable fertilizers is also a key aspect of improved food security.

Understanding local perceptions and attitudes regarding sanitation is crucial in finding socioculturally applicable, acceptable and sustainable ecological sanitation solutions. This study uses semi-structured stakeholder interviews and expert interviews to investigate those attitudes, as well as to gain insights on current sanitation and farming practices. Involvement of the local views in the research process is enhanced by the use of a participatory ranking exercise, thereby enabling local views and preferences to find practical and specific expression. Current sanitation solutions and their connection to the environment are also included in the study framework. The results of the fieldwork are investigated with a qualitative content analysis to present a comprehensive picture of the current sanitation situation in relation to local livelihoods, to describe local attitudes towards different sanitation solutions and to describe how ecological sanitation solutions might be implemented that improve local livelihoods and food security. Through this, a framework is produced that can be used for further work on ecological sanitation in the Taita Hills area and other similar contexts.

The ultimate objective of the study is to assess the feasibility and potential of using ecological sanitation to improve food security and sanitation in the study area. The results of this study point to the conclusion that reusing human waste cannot be considered as a taboo in the Taita Hills but could be promoted through locally designed solutions that emphasize simplicity of use as well as education

and training regarding ecological sanitation. Comparison between results gained from the different methods point to the conclusion that the more participatory section of the study demonstrated a greater emphasis on the need for awareness-raising and cultural sensitizing about ecological sanitation among the stakeholders to realize to potential of a positive approach.

Keywords: Sanitation, ecological sanitation, waste management, food security, sustainable development, participatory action methodology

Introduction

Sanitation is one of the most established and wide-ranging themes in global human development and development cooperation. It has far-reaching consequences on environmental degradation, health, education and economic development, and it is usually estimated that to date over two billion people still live without adequate access to basic, safe sanitation. Inadequate sanitation is a principal reason for a great amount of suffering and poverty (e.g. Okun 1988, Langergraber & Müllegger 2005, Werner et al. 2009). This is underlined by not only its inclusion in the Millennium Development **Goals (UN 2014a)** but also most probably in the upcoming **Sustainable Development Goals (UN 2014b)**.

As human beings, we produce waste matter in the form of excrement that we have as societies in most cases learned to treat as disgusting and often also dangerous. The same matter is often harmful also for the various ecosystems we inhabit. A backdrop for this is formed by the emerging global water crisis that finds strong expression especially in semi-arid regions in the developing world, such as East Africa. Still, human excreta can have a notable value, if a cycle of nutrients is in place. The obvious alternative is to steer the nutrients back to the soil and establishing the cycle. This is how solving sanitation problems can also have an effect on food security in developing countries and there is a possibility where ‘shit could equal money’ (Jewitt 2011).

For many reasons conventional sanitation solutions used in most of the developed world are not applicable on a large scale in the developing world and there is a widespread understanding in the science and development cooperation community that alternative solutions should be developed for the global south. These solutions are based on the idea of saving water and reusing as much as possible of the toilet waste and are described with the concept of ecological sanitation, which is gaining in popularity among the development research community as well as development cooperation practitioners (e.g. Winblad & Simpson-Hébert 2004, Langergraber & Müllegger 2005, Werner et al. 2009).

A challenge that has received relatively little attention in research and practice on ecological sanitation especially in developing country contexts are the cultural and social factors that affect the acceptability and usage of technologies.

The ultimate goal of this work is to investigate the potential of introducing ecological sanitation solutions in the Taita Hills of south-eastern Kenya and what features those solutions should include. The approach is that of the perceptions and views on the theme of the local population, the potential end users of ecological sanitation. Therefore the focus is on the cultural applicability of ecological sanitation in the Taita Hills. The presented work was done as a part of a Master’s Thesis at the University of Helsinki (Andersson 2014).

Study area and context

The most important basic premise for the study is that conventional developed sanitation systems, most importantly flush toilets, are not suitable in the study area. The Taita Hills (Fig. 1 and fig. 2.) are located in the Taita District in the Coast Province of southern Kenya, along the main road from Nairobi to Mombasa



Figure 1. The Taita Hills seen from the west (Andersson 2013).

and reach 2200 meters over the Serengeti plains. The area is well described as rural and the agricultural production includes cassava, mango, banana, cabbage, potatoes, tomatoes, peas, maize and beans etc. (Pellikka et al. 2009). Local land use changes (Pellikka et al. 2004), are an obvious threat to the natural resources and environment.

The local context relevant to issues connected to ecological sanitation is that of an area characterized by permanent agricultural production practiced by a permanent population. This highlights the need for efficient recycling of waste as polluted areas cannot be easily abandoned due to the population density in and the topography of the study area. The sanitation situation can by no means be described as a disaster as an overwhelming majority of households do have access to toilets in the form of pit latrines that are from a health-standpoint relatively safe if not always convenient or environmentally friendly. Unpredictable rains and soil problems cause concern regarding future food security, which also motivates the need to reuse all possible nutrients.

The hills are richly vegetated, covered in old cloud forest and rain forest (Rogo & Oguge 2000) and have been described as one of the biodiversity hotspots in Africa with reference to the many endemic species that can be found in the area. Vast areas of dry savannah and grassland lie around the hills.

The land use in the study-area is dominated by small-scale and rain-fed agriculture with some relatively pristine forests still found on higher altitudes. The steep topography provides the basic circumstances for any land use changes in the area.

The water availability in the study area is reported as deteriorating due to many reasons, among them climate change, population growth and overexploitation of water and other natural resources (Kivivuori 2013; Hohenthal et al. 2014). Water is more readily available in the highlands than in the lowlands. Food and water security risks are in conclusion evident in the area.

This paper investigates the potential of ecological sanitation solutions in addressing the above mentioned issues in global development on a local level through a case study on the local applicability of ecological sanitation solutions in the Taita Hills. This local applicability involves the suitability of different practical solutions with regard to cultural values, norms and acceptability as well as existing communal and household-level waste management systems. The focus will be on stakeholder level perceptions, as the premise is one where attitudes affect practices which in turn can affect policies thereby starting a continuous loop of change (O'Neill 2012). In this way, the study takes a sociocultural approach to waste management at the interface of technology, culture and environment with the focus being on what Sarah Jewitt (2011) terms the 'software' of sanitation solutions. A qualitative approach is emphasized in the study as the deep understanding it produces is of great help in possible future application of new technologies and practices (O'Neill 2012). The main research question is: To what extent are eco-sanitation solutions applicable in the Taita Hills? Here a special focus is put on cultural sustainability (regarding for instance collection of waste and food production) without forgetting ecological and economical sustainability? More specific themes to be touched upon include:

- What are the challenges to the enforcement of eco-sanitation in the Taita Hills? To what extent are they connected to for instance attitudes, costs and technology?
- What are the challenges to using treated human waste as fertilizer in food production?



Figure 2. The location of the Taita-Taveta county in southern Kenya. The study area is located close to the town of Voi, north of the road leading towards Taveta and the Tanzanian border. All data from WRI (2014).

- What are the attitudes towards eco-sanitation in Taita?
- Can it boost the ecological cycle so as to enhance food production?

Methods

The data for this study was gathered within a framework consisting of three interconnected methods. Firstly, a set of 61 single-informant semi-structured stakeholder interviews was conducted. These targeted mostly local households but also businesses and services such as restaurants, hotels and schools. This was done in order to understand how the participants' views on different aspects of sanitation and waste management and how they understand the possibilities of sanitation and waste management to be used for benefits through recycling. Included in this was gaining knowledge of the current sanitation and agricultural practices and possible forms of eco-sanitation that are already in use.

Secondly, a set of nine expert interviews or group discussion were organized and conducted. The goal of this was to gain understanding of the communal, ecological, cultural etc. issues that rise above the household level regarding sanitation issues and eco-sanitation development in the study area. Such interviews targeted personnel from both local NGOs and international aid agencies, relevant representatives of the local authorities, local workers' associations and relevant private companies. When groups of people within such institutions were identified as relevant for the topic and were available for a discussion, the expert interviews took the form of a group discussion. The main issues and themes considered here included the communal issues to bear in mind when designing sanitation solutions; communal and natural features in special need of protection from pollution; descriptions of current settlement conditions; assessment of existing sanitation solutions and user priorities; identification and prioritisation of specific problems within sanitation systems; identification of feasible sanitation developments; existing frameworks for raising awareness of sanitation issues; the relationship between sanitation and waste management on the communal level; the cultural meanings attached to human urine/faeces (taboos, religion, witchcraft, medicine, initiation, disease, etc.); perceived readiness of the population to use treated human excreta and/or urine as a fertilizer; and possible reasons for a change in people's minds to start using human urine for growing food.

Thirdly, participatory ranking exercises (Chevalier & Buckles 2013: 162–165) were organized with the participants in the expert interviews and the groups discussions. The ranking exercise is a form of individual or collective brainstorming, where different alternative solutions are ranked according to a certain criteria or as Chevalier and Buckles (2013: 162–165) put it, 'to develop order within criteria'. In this case this took the form of ranking a set of six different specific toilet solutions according to their suitability to local habits and the environment. I also allowed more detailed discussions on specific proposals, where each alternative could be broken down to pros and cons on different aspects of suitability, such as cultural, environmental, technical, financial and legal. The six alternatives were the pit latrine (in order to provide the present local choice for comparison), the composting toilet, the UDDT, the biogas reactor, the fossa alterna and the arborloo.

The ranking exercise supported understanding of the technical features of toilets that are appreciated in the cultural context of the Taita Hills and the preferential relationships between these. It also added a sense of pragmatism and practical applicability to the research as well as generated practically oriented discussions on the topic, which was here considered a crucial aspect of research directed towards supporting human development. Because concrete options were presented to the participants, it constituted a 'reverse' flow of information from the researcher to the participants as opposed to the conventional flow to the other direction, a crucial aspect of participatory research. The exercise added to the degree of participation in the study, which answers to the call for participation when researching potential in ecological sanitation and designing its solutions (see for instance Nawab et al. 2006 & Werner et al. 2009).

The exercise resulted in a league table (presented in table 3 in the results chapter) of the six alternatives, starting from the alternative ‘most applicable in the Taita Hills’ on first place and the worst alternative on the last.

Data analysis

An inductive approach was taken to analysing the data gathered during the fieldwork. The basic goal was to understand the sociocultural approach to waste management and sanitation in the Taita Hills, and therefore it was motivated to let the ‘participants choose what to focus on’ (Schreier 2012) without using a too rigid standardized pre-structure as a framework. Most importantly, this means that the key concepts and categories in the analysis stem from the narrative of the interviews instead of previous research. As a drawback, this approach diminishes the possibilities of generalization based on the study since it is a naturalistic approach where the context is not under control. On the other hand, an inductive approach is effective in acknowledging that particular context, therefore adding strength to the work as a case study.

The principal method for analysing the interview material and describing results was a qualitative content analysis (QCA), following the framework set by for instance Margit Schreier (2012). QCA enables the researcher to understand meanings constructed by individuals or groups to certain issues and to identify biases and patterns by systematically describing collected material through ‘analysing written, verbal or visual communication messages’ (Cole 1988, cited in Elo & Kyngäs 2008) with a strong focus on certain, beforehand chosen respects (in this case specified by the research questions). Crang and Cook (2007) portray the process as one of ‘sifting, sorting and making sense’ of data, which in short is termed as a process of categorisation (Miles & Huberman 1984).

In short, QCA is a systematic but flexible way for condensing a large amount of information to gain a deeper understanding of what has been said in interviews and moving the data into a higher level of abstraction for interpretation (e.g. Berg 2009: 338–378; Schreier 2012: 1–19; Hsieh & Shannon 2005). This naturally involves losing some specifics but also producing information through taking a conceptual step back.

In QCA, the answers of the transcribed interviews are reorganized into main categories, which are further divided into subcategories. The relationships between these are then interpreted to gain a comprehensive understanding regarding the research questions. For the sake of simplicity I will term the main categories here dimensions, as has been suggested by Schreier (2012: 58–79). As the dimensions work best when forming big but fixed entities, they were in this case derived from the respective larger thematic sections of the interview templates for the stakeholder interviews on the one hand and the expert interviews and group discussions on the other.

Because the goals of the study included building a framework for future sanitation development that is grounded in views on the grass-roots level, the subcategories that build instances of the dimensions were determined in a data-driven and inductive way. Determining the subcategories inductively opens up the possibility of themes that have not been recognized beforehand being identified. In this way, a strong part of the analysis will be grounded in the actual data, without preconceived structures affecting the analysis.

A lightweight statistical overview of the participants was carried out in order to present the context in which the interviews were conducted and to have an overview of the most easily measurable aspects of local sanitation and waste management. The statistical context description can be used to explain certain results of the qualitative content analysis.

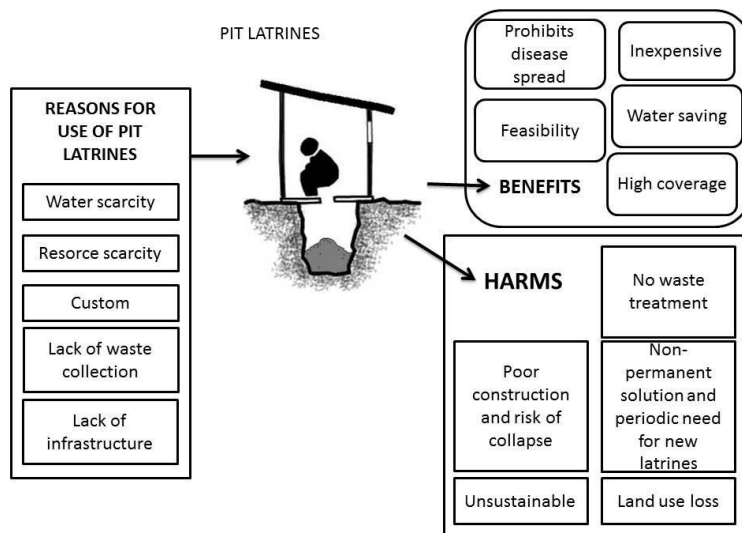
Results

Close to a third of the stakeholders reported having a tap as a water source. The reliability of these was however often described as weak at best and these stakeholders often stated that they also use a

secondary water source. Almost the same share of the stakeholders reported fetching water from a nearby stream. The average time spent on one trip fetching water was 25 minutes among those who did not have access to a tap at home.

When it comes to present sanitation solutions 53 out of the 61 stakeholder use pit latrines or VIP latrines, mostly because these are seen as the necessary cost efficient option where other options are limited. However, concerns were often expressed regarding the poor construction of pit latrines that affects security and that they are also used for waste dumping which contributes to ground pollution. The reasons for using pit latrines and the harms and benefits derives from them are summed up in fig. 3.

Figure 3. Reasons for choosing pit latrines as the household sanitation solution and the benefits and harms of this solution, as perceived by the study participants. Picture from SSWM (2014).



The households' toilets, most often pit latrines, were predominantly situated close to the farmlands or gardens. Of the 48 stakeholders with some farmland on their plot, the toilets of 28 households were estimated to be less than 20 meters from the farmland. The previous toilets of the stakeholders had predominantly been pit latrines that had filled up or collapsed. Of those cases, in 14 the old pit was simply covered and a new was dug. Only one household mentioned that they had planted a tree on the old pit in order to make use of available nutrients.

When it comes to the more practical aspects of sanitation, a little more than half of the respondents reported using toilet paper for anal cleansing and 18 were using only water, while the rest are using both ways. The vast majority of the toilets are squatting toilets, but when asked for their preferences in this regard, slightly over half of those who provided an answer preferred a sitting toilet.

About three fourths of the stakeholders did not report any way disposing of their toilet waste other than covering a full pit latrine up and digging a new one. The choice not to collect the toilet waste had more to do with the cost of collection than any other reason.

Nearly half of the mentions given by respondents on organic waste concerned using at least some of it as composted fertilizer in their fields and gardens, while eleven mentioned using it as fodder for farm animals and the same amount reported burning their organic waste. Nine respondents said that they

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dump the organic waste in a storage pit or a container without further specifying later handling of the waste.

On the question whether there are any forms of eco-sanitation already in use in the study area, the answer is almost unanimously negative. When asked if they in any way reuse their toilet waste, as much as 49 of the 61 stakeholders stated that they do not. Of the reasons for these, 60 separate mentions were given. 17 out of these cited cultural reasons, along the lines of it simply not being the local custom, without giving more thought to the underlying reasons for this. These thoughts can be complemented with answers stating that it is 'considered dirty' or 'not good' and that it is thought of as 'generally unacceptable'. Together these cultural reasons merited 30 mentions, half of the total. More practical reasons that were often mentioned were a lack of knowledge or skills, challenges in collecting the waste (11 mentions in total) and lack of sufficient technology. Together, these technological reasons amount to 26 out of the 60 mentions on why not to reuse toilet waste. The rest of the mentions were attributed to there being enough rain for agricultural production (in quite a contrast to worries of water accessibility expressed by many stakeholders during the fieldwork), there being enough organic waste available for manure, the bad smell of toilet waste and a concern of the waste ending up in important water sources.

While almost no current reuse of toilet waste was reported, reuse of other organic waste is, not very surprisingly, quite commonplace as 43 stakeholder of the 50 that were in a position to give an answer reported using at least manure and most often also organic household waste for composting and soil conditioning.

In understanding the practical preferences regarding sanitation solutions of people, a good starting point was built by investigating the level of satisfaction and reasons for that regarding present toilets, in this case through the simple interview question: 'Are you happy with your toilet?', followed up by enquiries into the reasons for the answers. In the coding stage of the qualitative content analysis pros and cons of the present toilets were established. All in all, 32 out of the 64, exactly half, mentions were positive. When examined more closely, however, 15 of the total 32 positive mentions only described the toilet as satisfying without giving any further reasons, which hints towards the feature of the toilet as something inevitable, with the single purpose of satisfying a certain bodily need, a primal urge. Other positive sides of present toilets were a sufficient level of hygiene, the small use of water, proper construction, novelty, in the few cases the fact that it's a flush toilet and in one case a sense of ownership and the following pride in cleanliness and hygiene.

The negative sides with present toilets were dominated with simple comments that in the present circumstances it is the only option, without further elaboration on what improvement are wished for. The problem of improper construction also merited many comments, with preferences for a seat, proper ventilation and flush also mentioned.

When asking for further elaboration on how to improve local toilets, 24 out of 86 mentions were connected to the quality of construction. The elusive goal of sufficient water availability which was mentioned 12 times and complemented by the direct wish of having a flush toilet that was expressed 7 times. Of special interest for this study is that the need for a system of removing and/or reusing the toilet waste was mentioned by the stakeholders without first being mentioned by the interviewer only five times. On one of these occasions it was stated that the responsibility should be carried by the authorities, the rest thought of it as the responsibility of each stakeholder.

A list of priorities was constructed based on the interview question 'What is most important in a good toilet?' The list is presented in table 1.

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TOILET FEATURE PRIORITIES	Lower Mwatate	Upper Mwatate	Wundanyi	TOTAL
Cleanliness	15	8	11	34
Proper construction	4	8	8	20
Water availability	5	3	3	11
Ventilation	3	3	2	8
Flush	3	2	0	5
Running water	3	0	0	3
Maintainance	1	1	1	3
Means of collecting waste	0	3	0	3
Privacy	0	1	2	3
Disinfectants, antiseptics	1	0	1	2
Comfortability	1	1	0	2
Safety	0	2	0	2
Water saving	0	1	0	1
Paper	1	0	0	1
No smell	1	0	0	1
Capacity	0	0	1	1
Sufficient distance from house	0	1	0	1
Inside	0	0	1	1

Table 1. Priorities for what constitutes a 'good toilet.' Each participant in the stakeholder interviews was given the chance to freely mention one or two most important features.

On communal issues in sanitation and waste management, six distinct needs can be singled out from the expert interviews: need for more awareness, training, appreciation of waste management, clear household-level benefits, comprehensive planning of waste management and proper application of those plans. Whereas a sense of responsibility among the population towards waste management and environmental protection was cited, among the experts interviewed there was also some recognition of a NIMBY (Not In My Back Yard) effect regarding waste management infrastructure. A theme of special interest as a new, 'fresh', approach to waste management was the potential role of the informal sector as well as for instance youth or women's groups in collecting and reusing non-organic waste.

Specifically on toilets, one expert emphasized a set of priorities not very different from those found in the literature review: cultural acceptability, affordability, efficiency, sustainability, accessibility, and comfortability. To these, hygiene, simplicity and stakeholder involvement in design were added by another expert. The prevalence of pit latrines was explained with the fact that those should actually be

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seen as progress from ‘what was before’ and that the security from disease they provide is seen as an imperative priority.

Whether regarding waste management or toilet systems, no cultural taboos were identified in the expert discussions that would restrict future solutions.

When asked for certain features in their surroundings that should be given priority in protection from pollution, the largest share of the 79 mentions, 18, had to do with local water bodies and concern over runoff pollution, mirroring the general concern over water availability. A combined 12 mentions were attributed to agricultural production, in the form of farming areas and house gardens.

The participants in the expert interviews and group discussions were asked to reflect upon and discuss the cultural meanings attributed to human waste and the possibility of reusing human excreta. Those meanings are summarized and divided into positive and negative associations in table 2. In addition, the prerequisites of training and availability of appropriate technology were once more emphasized and it was judged that attitudes in the community are changeable if clear benefits of it can be pointed out.

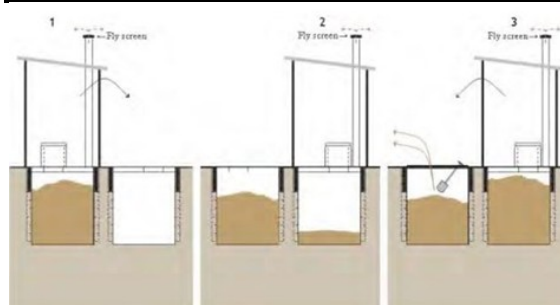
Table 2. Positive and negative cultural associations with human excreta and the possibility to reuse human excreta for agricultural use among the expert interview and group discussion participants.

POSITIVE ASSOCIATIONS	NEGATIVE ASSOCIATIONS
No taboos	Considered unclean
Potential benefits	Connection to diseases
Use of animal manure	Mentality, attitude
Was used before, known as a nutritious resource	Use of animal manure
Is used elsewhere	Suspicion of outsiders
Educated community	Superstition
Problems with chemicals	
Urine easier	

Table 3 shows the final league table generated from the 21 separate ranking exercises done with the participants of the expert interviews and group discussions. The fossa alterna (alternating pit, fig.15) and the biogas reactor were deemed the ecological sanitation solutions comprehensively most appropriate in the Taita Hills with a clear margin before the composting toilet, the arborloo and the urine-diversion dehydration toilet (UDDT). In the comparison the Pit Latrine or the VIP Latrine was ranked clearly last, perhaps due to the discussions on ecological sanitation that had taken place during the interviews before the actual ranking exercise. The most important factors that were mentioned in the discussions and can be seen as essential reasons for the ranking are discussed

Table 3. The final league table resulting from the participatory ranking exercise.

Rank	Alternative	Score
1	Alternating pit	19
2	Biogas reactor	20
3	Composting toilet	33
4	Arborloo	36
5	UDDT	38
6	Pit Latrine / Vip Latrine	52



below, with a total collection of all the pros, cons and other comments attributed to the six different alternatives is presented in appendix 1.

In the popularity of the alternating pit (Fig 4), the simplicity seemed the most important factor along with the fact that it requires minimum training to work since it is essentially a pit latrine that enables the reuse of the toilet waste. It also requires little labour to work properly, and gathered many comments on its sociocultural acceptability, local applicability and great replicability. As the downsides, the participants mentioned the challenges of constructing durable yet movable structures and that it takes time for the system to produce the benefits of treating the waste.

Figure 4. The fossa alterna (alternating pit) ecological toilet.

On the biogas reactor, the greatest benefits perceived by the participants were connected to its ability to provide both manure and cooking gas. This was often mentioned together with the rising prices of firewood and the connected deforestation of the hills. It was also said to be especially suitable to schools that generate high amounts of waste, to generate long-term and continuous benefits and to be of use in preventing environmental degradation. As reasons for the biogas reactor losing in popularity were given the fear of smell in the gas, doubts over whether a single household will produce enough waste for gas generation, the high initial costs of building one and the need for training in using it. As mentioned earlier, the solid waste that is left after the generation of gas is still in need of secondary treatment, which has to be added to the list of downsides.

Conclusions, discussion and proposals

It is quite clear that agriculture is the main livelihood in the study area, and that a considerable share of the local population is dependent on successful yields for their food security. Many of the stakeholders interviewed for this study are also keeping livestock of different kinds and the usage of manure from these animals as soil conditioner is deeply rooted in the local manners and practices. Using industrial fertilizers, by contrast, is not as widespread and is most importantly prohibited by its costs. These aspects of the local livelihoods point to the conclusion that on-site ecological sanitation solutions could, when properly adapted, contribute to the livelihoods on the grass-roots level by incorporating them with existing practices. It is also clear that fertilizer produced through treating human excreta, or “humanure”, could compete with the usage of industrial fertilizers.

Problems with water accessibility were a recurring theme during the fieldwork and have been documented in the study area also in previous research. This also motivates the use of ecological sanitation, as the solutions can be easily adapted to water scarce circumstances while still providing healthy and environmentally sound sanitation as well as protecting existing water sources.

The level of satisfaction with the pit latrines in use now together with the results from the participatory ranking exercise point to the conclusion that any ecological sanitation solutions designed in the area are most likely to be successfully adapted if the end user experience is as simple and as similar as possible to using a pit latrine.

As was to be expected as a premise of the study, reuse of human excreta is virtually nonexistent in the study area. Sociocultural reasons and local custom seem to be the most important reasons for this, but a lack of technology and skills was widely acknowledged as well. However, the mentioning of technology and skills itself as well as more direct results of the qualitative content analysis give the strong impression that sociocultural obstacles for reusing human excreta are existent but not overwhelming and the general conclusion can be drawn that they can well be overcome through awareness-raising and provision of skills and technology.

The readiness of the participants to discuss the issue and results of the QCA enforce the impression that whereas reuse of human waste is not traditionally acceptable (as represented in the interview answers by references to local custom), it can also not be described as a taboo per se. Composting of

organic waste is a widespread practice, which would suggest that training in composting of human excreta would not bring overwhelming challenges.

These findings suggests that simple solutions based on composting of waste are feasible in the Taita Hills and that a widespread readiness to reuse human waste in agriculture in the Taita Hills is in place. The challenges to this have to do mostly with culture, customs and awareness. As one participant put it, the culture is not static and none of the obstacles is impossible to overcome with training interventions and the most promising eco-sanitation solutions are not crucially inapplicable in the Taita Hills.

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Appendices

Appendix 1: The pros, cons and further comment on all the specific ecological sanitation solutions presented in the participatory ranking exercise, as formulated by the participants.

	Pros	Cons	Other comments
Pit Latrine/VIP Latrine	Currently most popular Water saving	No reuse of waste Crude first solution Disgust	Price: 18000- 20000 KSh Needs training
Composting Toilet	Enables reuse of waste Permanent Provides fertlizer 'Good alternative' Should be tried Simple	Maybe culturally sensitive Brings costs Smells Disgust Perceived water need Expenses	Price: up to 40000 KSh In institutions Different religious views matter Sharing Similarities already exist No shortage of fertilizer in Wundanyi

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	<p>As cheap as a pit latrine No water needed</p> <p>Good on farmland away from home</p>	<p>Not very popular Stigma of using compost Needs training</p> <p>Needs maintenance No solid waste Acceptability doubtful</p>	<p>Fertilizer needed in Taveta</p>
Urine Diversion Deydration Toilet (UDDT)	<p>Should be tried</p> <p>People will adapt Takes little space</p> <p>Environmentally friendly Quick benefits Comprehensively applicable</p> <p>Even more potential Best where water table is high Reduces smell Urea maybe easier to accept 'I would recommend'</p>	<p>Needs more training</p> <p>Harder Smell of urine Waste will be mixed because not everyone has skills New things difficult</p> <p>Not very popular</p> <p>Hard to use</p> <p>Needs designing More expensive</p>	<p>Price: up to 51000 KSh</p> <p>Usefulness of urine Toilet paper Automatic spread of urine On trial Depends on soil texture Has to be leak-proof</p>
Biogas reactor	<p>Complete system</p> <p>Price of firewood is high Produces both gas & manure</p> <p>Useful in schools</p> <p>Could be used more Preventing environmental degradation</p> <p>Gaining popularity Long-term benefits Communal cooperation possible</p>	<p>Fear of smells Many households not producing enough waste</p> <p>Needs training</p> <p>Slurry easily contaminated</p> <p>Needs secondary treatment</p> <p>Expensive to start</p>	<p>Price: over 400000 KSh</p> <p>Pathogens Could be used more Has to be demonstrated Needs social marketing</p> <p>'Exorbitant' price Proportioning to waste amounts</p>

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	<p>Very good when planned</p> <p>Already in use</p> <p>Good with animals</p> <p>Permanent</p> <p>Many should use</p> <p>Gas great benefit</p>		
<p>Fossa Alternativa</p> <p>(Alternating Pit)</p>	<p>Simple</p> <p>Pit latrine with reuse</p> <p>Small labor need</p> <p>Advancing 'what is now'</p> <p>Possibility to use precast slab</p> <p>Could be tried</p> <p>Plastic/Movable slabs available</p> <p>Applicable</p> <p>Acceptable</p> <p>Continuity</p> <p>Replicability</p> <p>'Like an upgraded pit latrine'</p>	<p>Takes time</p> <p>Slow benefits</p> <p>Timber structures not durable</p> <p>People like stone toilets</p>	<p>Price: up to 30000 KSh</p> <p>Needs movable superstructure</p>
<p>Arborloo</p>	<p>Easy to adapt</p> <p>Already in use/Most common now</p> <p>Acceptable</p> <p>Increases in fruit yields</p> <p>Done 'by mistake' already</p>	<p>Needs space with time</p> <p>Not feasible in urban areas</p> <p>Poor handling, erosion, degradation, pollution</p> <p>Timber structures not durable</p> <p>People like stone toilets</p> <p>Takes space, slopy area</p>	<p>Up to 15000 KSh</p> <p>Depth of pit important question</p> <p>Land tenure & security needed</p> <p>Vast land needed</p> <p>Needs movable superstructure</p>