

**- Sanitation for all -
an engine of economic growth for urban Africa**

About time to get the shit out of town?



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Executive summary

Today there are 1 billion people living in slums and other types of sub-standard housing without access to a toilet facility. Despite this, sanitation has been neglected by national and international decision-makers.

Improved sanitation not only facilitates improvements in human health, but enhances prospects for education and work, as well as personal security and dignity (particularly for women), and has a positive impact on the environment. In this way, sanitation has a pivotal role in achieving all eight Millennium Development Goals.

Human excreta can be viewed as waste or a resource. Traditional sanitation (sewage-based systems, pit latrines, etc) treats excreta as waste, whereas productive sanitation (also referred to as Eco-sanitation or EcoSan) treats human excreta as a resource, with natural fertilizer as an end-product.

If done right, productive sanitation can improve agricultural productivity, enhance food security and contribute to sustainable economic development. Productive sanitation provides an economic return on the reuse of nutrients.

Traditional sanitation in the form of sewage-based systems comes at a high cost, both in financial terms and for the environment. The high cost of investment leads to delays, which in turn leads to a range of negative impacts on health, education and work.

Developing productive sanitation, with lower up-front costs and reduced maintenance costs, as well as income-generating potential, would reduce the need for subsidies in the sanitation sector.

A market study from Uganda indicates that a complete sanitation system for 400,000 urban slum residents in Kampala can be run without subsidies by selling fertilizer and soil improvement products to commercial farmers and the flower industry.

More attention needs to be paid to the economic return on sanitation, particularly since traditional arguments about the health and social benefits of sanitation have failed to bring in adequate funding for long-term sanitation implementation and innovation.

Particular attention should be paid to the merits of productive sanitation solutions, which include considerable savings on initial investment and maintenance (compared to water-based systems) and a range of additional economic benefits.

Ways should be found to identify and "convert" the economic return on sanitation into new funding for research, development and innovation in the sanitation sector.

Expensive, non-viable water-based options should be taken off the table. Instead, efforts should be concentrated on innovation and low-cost quality productive sanitation solutions, with their multiple social, economic and environmental benefits, that have the potential to reach all.

Economic incentives that stimulate the expansion of sustainable sanitation should be developed. Innovative financing mechanisms for large-scale implementation should be explored.

Innovative mechanisms, including smart subsidies, should be put in place to ensure sanitation provision for the very poor. Above all, national decision-makers and the development community need to show leadership and innovation in order to secure sanitation for all.

**1.0
Introduction**

It is estimated that 2.6 billion people in the world, 38% of the world's population, lack access to improved sanitation.

One billion of these live in slums and other types of sub-standard housing. Geographically, the lowest sanitation coverage is in Sub-Saharan Africa, where only 31% of the population is estimated to have access to improved sanitation¹.

Yet, proper sanitation not only facilitates improvements in human health, but also enhances personal safety and dignity, and has a huge positive impact on the environment.

When the author of this paper started to investigate scalable solutions to the sanitation crisis in Uganda in 2007, the challenge was viewed in terms of incentives, design and economics rather than from a traditional NGO perspective².

There was clearly a need for innovation to generate results without the need for the huge, long-term subsidies that underpin conventional water-based systems³. Neither the willingness to pay nor the amount of water required to run the type of system that we often take for granted are present in an urban slum setting.

Large and respected institutions, such as the World Health Organization (WHO), the Water and Sanitation Program (WSP)⁴ and the United Nations Children's Fund (UNICEF), have pronounced that the best economic investment⁵ that can be made is in sanitation⁶.

The table below shows the return on investment of using a mix of technologies and approaches. A low investment cost per person and a large share of sustainable sanitation gives even higher returns.

Box 1: Urban development in urban Africa and Asia

Region	Cost-Benefit Ratio of Achieving the MDG Sanitation Target	Cost-Benefit Ratio of Achieving Universal Sanitation Access
Sub Saharan Africa	6.6	6.5
Arab States	5.3	12.7
East Asia & Pacific	12.5	13.8
South Asia	6.9	6.8
Latin America & Caribbean	37.8	39.2
Eastern Europe and CIS	27.9	29.9
Average for all non-OECD Countries	9.1	11.2

Source: [40].
doi:10.1371/journal.pmed.1000363.t002

Yet, local and national authorities, as well as international development agencies, including Norway⁷, continue to under invest in sanitation.

The absurdity of the conventional solution⁸, using a scarce resource – water - to throw away another resource - human excreta⁹ - verges on the immoral when one also considers that the sewage from conventional systems goes untreated into the nearest river or lake.

An alternative is to use the excreta as raw material to create a safe, high quality, soil improvement product and fertilizer that is needed locally. Cheap and robust technologies exist to ensure that urine and feces can be used safely in agriculture, but funds to bring about the necessary innovation and scaling up are not yet available.

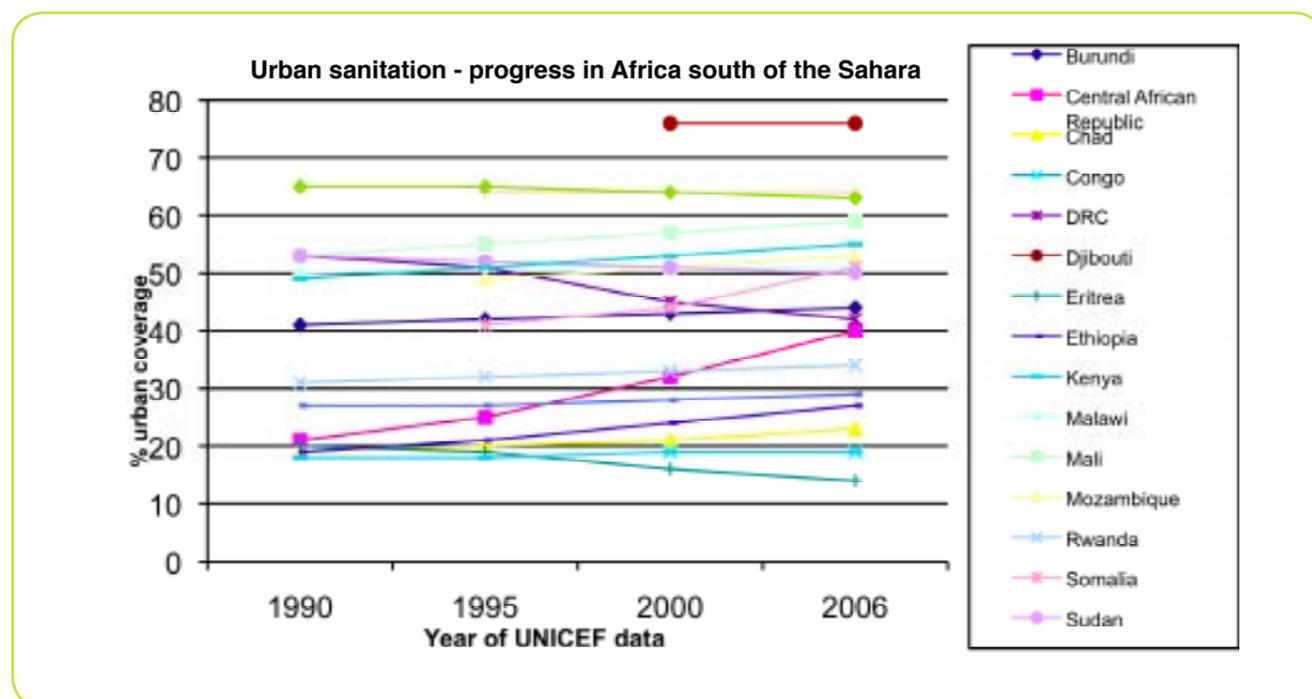
By reviewing the potential of productive sanitation, the international community can create an engine of economic growth for African and Asian economies that is sustainable and gives dignity to urban living.

2.0 International context

Despite sanitation's pivotal importance to human health and dignity, it has been neglected by international development. Around 6,000 people, mostly infants and young children, die every day due to lack of sanitation, resulting in poor hygiene and use of contaminated water.

As reported by the 2006 Human Development Report (UNDP), no act of war, terrorism or disease generates devastation on the scale of the crisis in sanitation and water. Yet, global achievements in terms of reaching sanitation targets have been far from impressive.

The table below shows the lack of progress in increasing urban sanitation in Sub-Saharan Africa. Nor has there been any significant progress since 2006, so the flat trend has continued.



In 2000, at the Millennium Summit at the United Nations in New York, sanitation was not even included as a Millennium Development Goal (MDG). It was only after intense political pressure that sanitation was added to the MDG on environmental sustainability (MDG7) after the Earth Summit in Johannesburg 2002.

From being "the last taboo" (Black 2008) of the previous decade, sanitation has slowly gained more attention. 2008 was the International Year of Sanitation, while a recent poll conducted by the British Medical Journal voted sanitation the greatest medical advance of the past 166 years¹⁰.

However, even with all this documentation and knowledge, political leaders in Africa and Asia and the international community, continue to ignore the issue that is the greatest killer of our time.

Some very important institutions still believe that urban sanitation in Africa and Asia can be solved by water-based investments.

The investment cost of pipes, installation, treatment and maintenance¹¹ is prohibitively high and renders this approach largely unviable¹².

By holding on to this false idea that water-based solutions will one day arrive, national and international decision-makers are given the opportunity to do nothing.

3.0 Aims and objectives

The aim of this paper is to show how increased focus and innovation is needed to change the direction of how the world community invests in human development.

Sanitation is not only a human right, but also important for the dignity and health of the individual. If done right, productive sanitation can improve food security and ensure progress towards sustainable economic development for the community.

Since our era is focused on the economic development of countries and regions, this paper will present how sanitation can be viewed as an efficient engine of economic growth for cities across Africa and Asia.

Unfortunately, this perspective was not included in the 2006 report from UN-HABITAT on the increasing role of growing cities in the development of national economies¹³.

People are moving into cities at an unprecedented rate across the developing world. Even if slum upgrade systems have lifted millions of people out of slum-like living conditions during the last decade, we still have an increase in the number of people living in slums today compared to the year 2000¹⁴ (see box).

This paper will seek to shed light on the following questions:

- *Can solutions to the sanitation crisis be presented in an alternative way, bringing about significant change in policy and investment strategy so that innovation and results can reach the 2.6 billion without access to sanitation?*
- *What kind of incentives need to be put in place to be able to "go to scale", using the entrepreneurial spirit that we find in African and Asian cities?*

4.0

Sanitation – an overview

4.1

The impacts of poor sanitation

Sickness and disease

Inadequate management and storage of human excreta lead to increased risk of infection from bacteria, viruses, and parasites that are found in faecal matter.

Diarrheal disease, which causes about 1.8 million deaths annually, mostly among children under five, is primarily spread through food and water contamination, often the result of poor sanitation and hygiene.

Lack of improved sanitation also contributes to parasitic infections such as schistosomiasis, affecting about 160 million people, and intestinal worms, which infect about one in ten people in developing countries.

Due to the difficulty of isolating causal effects of sanitation, which has many indirect effects and works in tandem with other factors such as water and hygiene, there have been limited comprehensive studies on the particular effects on health of sanitation alone.

A 1991 review of existing studies (Esrey et al.) Examined the impact of improved water supply and sanitation facilities on a variety of widespread infectious diseases. Using data from five out of 18 studies on sanitation that were considered "rigorous", the authors estimated that the expected reduction in diarrheal disease morbidity from sanitation improvements alone was 36%.

A more recent meta-analysis, published in 2005¹⁵, found only two studies with usable data on sanitation, the pooled results from which suggested a 32% decreased risk of illness due to sanitation interventions.

Analysis of merged DHS¹⁶ data across 70 low- and middle-income countries also found a protective effect, of improved sanitation against diarrhoea. The available data clearly suggests that increasing access to improved sanitation has the potential to improve health outcomes significantly.

The greatest benefits from improved sanitation could be expected in low-income countries, where infectious diseases, such as diarrhoea, are prevalent and child mortality rates are still high.

Diarrhoea is the second most important cause of under-5 deaths¹⁷, with the World Health Organization attributing 1.9 million deaths in 2004 to unimproved water supply and unimproved sanitation.

The vast majority of these deaths is attributed to diarrheal diseases and affects children under the age of 5.

The costs of treating diarrheal disease drain national budgets and family finances.

In Sub-Saharan Africa, where, on a typical day, half the hospital beds are occupied by people afflicted with faecal borne diseases, treating preventable infectious diarrhoea consumes 12 percent of health budgets.

Avoiding these costs would free up resources for other development objectives. In terms of productive years lost, the reduction in premature death would yield an annual economic value of US\$1.7 billion.

Economic impacts

Workdays are lost due to diarrheal disease, either when the worker is ill or when she/he is caring for a sick child. When workplaces have no toilets, women may lose workdays during menstruation. Halving the number of people in the world without access to basic sanitation would add more than 5 billion working days a year worldwide, and increase incomes accordingly. Universal coverage would add 20 billion working days.

Water resources are an important productive asset. Agriculture, fish production, energy production, large-scale industrial processes, small-scale industry, transport, and recreation all suffer economic harm from increased treatment and other costs due to water pollution by faecal contamination. Ground water pollution also increases the cost of water for urban households.



Box 2: Poor sanitation costs Lao PDR 5.6 % of GDP¹⁸

In 2006, the Lao People's Democratic Republic lost an estimated 5.6 percent of gross domestic product, or US\$193 million, due to poor sanitation and hygiene, according to a report published by the Water and Sanitation Program in 2009.

Of the impacts evaluated in the report entitled "Economic Impacts of Sanitation in Lao PDR"¹⁹, poor health accounts for 60 percent of the estimated economic costs.

The cost of households buying clean water supplies (due to water pollution) accounts for 18 percent, additional time spent accessing unimproved sanitation 13 percent, and tourism losses for 9 percent.

Poor sanitation, including hygiene, causes at least three million incidents of disease and 6,000 premature deaths annually. The resulting economic impact is more than US\$115 million per year, based on 2006 data, the report says.

Loss of education

Investment in primary education has been well supported by national governments and international donors, with impressive results in increased access.

Halving the number of people without access to improved sanitation, and thereby reducing incidents of diarrhoea, would add almost 200 million days of school attendance per year.

Girls are reluctant to attend schools, and parents are disinclined to send them, if there are no safe, private toilets for them to use. This is particularly true once menstruation has begun.

More girls in school mean higher rates of female literacy. In a typical developing country, each 1 percent increase in female secondary schooling results in a 0.3 percent increase in economic growth.

Healthy children learn more than children suffering from worm infections, which sap nutrients and calories and lead to listlessness and trouble concentrating. Up to two thirds of all schoolchildren in some African countries are infected with parasitic worms.

Environmental degradation

Degradation of waterways and pollution of groundwater resources are among the problems. This increases the spread of pathogens and degrades the natural capital of the country.

4.2 Improved sanitation

The WHO/UNICEF Joint Monitoring Programme (JMP) for Water Supply and Sanitation defines "improved sanitation" as a facility that "ensures hygienic separation of human excreta from human contact"²⁰.

This facility should:

1. Isolate faeces from the individual.
2. Prevent flies and small animals from coming into contact with faeces to prevent contagion.
3. Inactivate pathogens (viruses, bacteria, worms and parasites dangerous to humans) in faeces before they are returned to nature.

The JMP considers use of the following facilities as "improved sanitation"²¹:

- Flush/pour flush to:
 - piped sewer system
 - septic tank
 - pit latrine
- Ventilated improved pit (VIP) latrine
- Pit latrine with slab
- Composting toilet

The JMP definition of "improved sanitation" is used to measure progress towards achievement of the Millennium Development Goal (MDG) on sanitation (halving the proportion of people without sustainable access to basic sanitation).

There are acceptable solutions that are not part of this definition and there are environmentally unacceptable solutions that count as improved sanitation provision. For example, an improved pit latrine that pollutes groundwater for the entire village can be counted towards the MDG as the criteria relates to the building of the toilet, not how it functions for the surroundings or whether indeed it is functional.

High quality public toilets that give people all year access do not count for the MDG. This is a weakness since this would be the most cost effective way to assure 100% coverage for poor communities that lack the purchasing power for individual units for their household.

Shared or public sanitation facilities, even of an acceptable type, are not considered improved sanitation for the purposes of JMP monitoring of access to sanitation.

Unimproved sanitation facilities are those that do not ensure "hygienic separation of human excreta from human contact", including pit latrines without a slab and bucket latrines.

4.3

The role of sanitation in reaching the MDGs

The international community established the Millennium Development Goals (MDGs) in order to better coordinate development activities and ensure that the most important issues in terms of health, education, poverty and sustainable development were given priority in national and international donor budget decisions. The 8 goals, including reducing extreme poverty by half and providing universal primary education, had a target date of 2015.

While progress has been made to halve the number of people without access to safe drinking water, progress on the sanitation side has been deplorable.

The sanitation target (halving the proportion of people without sustainable access to basic sanitation by 2015) is, at the current rate of progress, due to be missed by a billion people and there is no indication that the international community will increase spending on scalable implementation strategies to achieve the target²².

Yet sanitation has a key role to play in achieving all 8 of the MDGs. The table below explains the link between sanitation and achievement of the MDGs.



	MDG	The role of sanitation
Goal 1	Eradicate extreme poverty and hunger	verty reduction through health improvements and shift in spending from medicines to other items. Productive sanitation, with the safe reuse of human excreta for fertilizer/soil improvement will increase production capacity and limit soil degradation in urban and rural agriculture.
Goal 2	Achieve universal primary education	Sanitation is important for retention rates – for girls, in particular. Clean and functional toilets in schools will increase their status in the community and dropout rates will fall. Productive sanitation can supplement school gardens with natural fertilizer and valuable knowledge about the ecosystem.
Goal 3	Promote gender equality and empower women	The threat of sexual violence or harassment when defecating in the open creates a strong sense of insecurity. Improved sanitation will reduce infections and loss of income due to limited mobility for women in urban areas.
Goal 4	Reduce child mortality	This goal cannot be achieved without massive investment in sanitation across Africa and Asia. Sanitation is the most important single factor in reducing child mortality.
Goal 5	Improve maternal health	Improved hygiene and reduction in open defecation would reduce the number of perinatal infections.
Goal 6	Combat HIV/AIDS, malaria and other diseases	Most water borne diseases are from poor sanitation and groundwater contaminated by faecal matter. Safe productive sanitation will decrease the health burden and strengthen immune systems, improving general health status.
Goal 7	Ensure environmental sustainability	When correctly handled, human excreta can be a resource; when incorrectly handled, it can degrade the environment and living areas.
Goal 8	Develop a Global Partnership for Development	Global partnerships that courageously promote sustainable sanitation are necessary to reach the MDGs.

4.4 The economics of sanitation

Human excreta can be viewed in two dramatically different ways: as waste or as a resource. Today, almost all nutrients from human excreta are left in the community as waste. The lack of collection is a burden to families across the developing world and detrimental to food security and the environment.

However a growing number of people have rediscovered the value of human excreta: urine as a potential natural fertilizer and faecal matter as a potential soil improvement product that nurtures the soil and improves ability to retain water. If applied correctly, it can improve the microorganisms needed to sustain agricultural productivity of the soil.

Accordingly, there are alternatives in terms of products available to governments and decision-makers. From an economic perspective, there are systems that:

1. View human excreta as waste
 - a. Sewage based systems (water, flush, pipes/tank, supposed treatment)
 - b. Pit latrines/VIPs ²³ (stand-alone units with a hole in the ground/some versions above ground)
 - c. Open defecation (in streets, parks, fields, etc.)
 - d. Flying toilets (defecating in a plastic bag which is thrown onto rooftops or trash heaps)

2. View human excreta as a resource
 - a. Composting toilet systems (reuse of excreta with reduction of pathogen levels)
 - b. Urine diverting dry toilets (UDDTs) with urea treatment (reuse with treatment to assure pathogen-free excreta)

The table below shows the investment cost²⁴ of different systems as well as what can be expected in terms of a return on investment in social and economic terms.

Sanitation solution	Investment cost Per person (USD)	Operational cost per year per person (USD)	Income potential from the system	Rating of environmental impact
Sewer connection	204 - 279	77 - 105	Large negative	Very poor
Ventilated Improved Pit Latrine	46 - 52	16 - 18	0	Poor (less flies)
Composting + UDDT's	32 - 92	11 - 32	5 USD per year per person ²⁵	Good / Very good
Pit Latrine (non-ventilated)	24 - 55	8 - 19	0	Very poor
Complete home-to-farm urban sanitation system	20 - 30	Covered by user fee 5 - 10 USD per year	Income to owner, community savings no need to invest & maintain home unit	Very good

Operational expenditures are important for the overall financial and economic performance of productive sanitation, but up-front capital costs are the most critical aspect. The lower the capital costs, the higher the monetary benefits of productive sanitation²⁶. This is a key argument for investing in low cost-high productivity sanitation solutions.

An economic return on sanitation can also be seen by reviewing the benefits that take place in other sectors²⁷. The fact that results show up in other sectors is one of the great challenges for sanitation. Results are seen in terms of reduced health costs, improved school attendance rates, lower family spending on medications, reductions in lost working days, less pollution of groundwater supplies and so on, rather than in terms of sanitation.

Understanding this could lead decision-makers to introduce incentives for sanitation providers and innovators to create results in urban and rural areas.

One could imagine a system in which sanitation providers are paid a fixed amount for each ton of excrement brought out of urban areas for safe treatment.

This would provide incentives for sanitation businesses to help solve the problem that governments, NGOs and UN agencies have not been able to solve.



4.5

Sewage based systems: a case of "triple loss"

High water consumption, loss of nutrients and massive pollution of waterways are the three major consequences of flush toilets in Africa and much of the developing world. Massive investments²⁸ have been made to provide flush toilets for urban elites. However, in most cities of the developing world, flush toilets are not connected to a functional treatment plant, so the sewage goes untreated into local waterways used by the poor²⁹, or directly into the sea.

As in the developed world, urban centers in the developing nations use drinking water to run toilets and transport human excreta through sewage pipes. Piped drinking water is also required and its distribution will have to increase to serve the unconnected poor.

However, a large share of current capacity is used to ensure functioning toilets rather than ensuring access to water for all. In Nairobi³⁰, as in many slums, water prices are much higher for the poor than for the upper and middle classes that are connected to the urban distribution network.

Large sections of the population are kept without their necessary allocation of water.

In urban areas, drinking water is a small component of total water consumption, compared to sewage and other waste disposal needs.

The expectation of sewage connections for our cities comes at a very high political and health cost, as investments are postponed and child mortality rates and other burdens on residents remain high.

The political economy of defecation is such that no democratic government will accept the hard fact that it cannot "afford" to invest in modern sewage systems for its citizens. Instead, governments and international donors continue to subsidize the users of these systems - often in the name of the poor who cannot afford these systems in the first place.

The cost of building sewage treatment plants is externalized through donor-driven environmental programmes.

The logical policy would be to accept the real cost and then impose differential pricing so that while the rich pay for the cost of the capital and resource-intensive sewage and waste disposal technology, the poor pay for the cost of their own separate disposal system, which is invariably unconnected to the sewerage system and hence low-cost.

By showing the real cost of flush toilet sanitation, there would be a drive to invest in alternatives that are comparable in terms of user quality, but have a very different environmental impact.

Sewage systems are built to protect public health, but badly managed sewers are becoming a serious health hazard. Serious outbreaks of waterborne diseases can result from:

- River pollution³¹ because of sewage not being treated³²
- Groundwater contamination because of leaky sewer lines³³
- Contamination of piped water supply systems because of leaky sewer lines leading to Infiltration of pathogens into drinking water pipelines, especially when they do not have water. This is the case in many cities in developing countries that cannot provide water round the clock.
- Sewage back flows because of badly maintained and blocked sewers or because of increasing use of non-biodegradable materials like plastic bags – often after heavy rainfalls in urban slums³⁴.

The functional, but high maintenance sewage systems of developed nations have taken away our understanding of nature's nutrient cycle, in which nutrients collected from the land should be returned to the land. With the use of sewers, this "waste" gets dumped into our aquatic systems as pollution.

Thus, while nutrients in food come from agricultural lands, sewage systems dump the nutrients contained in human excreta into water bodies where the nutrients are not needed.

Over time, our agricultural lands get depleted of nutrients and the conventional response to this is artificial fertilizers and not questions of how to redirect the wasted nutrients into productive use.

Artificial fertilizer use does not assure the soils of micronutrients and thus becomes a limiting factor in plant productivity, putting pressure on local food production and increasing poverty with decreasing yields.

Box 3. Agriculture in Africa – a perspective

Feeding over 6 billion people – and over 9 billion by 2050 – will require a wide range of creative, sustainable agricultural systems, which not only provide food, but also factor in the economic value of nature-based services, such as forests, wetlands and soil organisms that underpin agriculture.

Simply applying the "industrial" agricultural models of the twentieth century as a single, global solution will not serve Africa well. Sustainable agriculture and holistic production systems based on active agro-ecosystem management rather than on external fossil based inputs³⁵ are needed to solve the upcoming food security situation. Both traditional and scientific knowledge will need to be used to create a viable and sustainable production of our food.

The evidence presented in a 2008 study from UNCTAD/UNEP³⁶ supports the argument that organic agriculture can be more conducive to food security in Africa than most conventional production systems, and that it is more likely to be sustainable in the long term.

One of the prerequisites for this sustainable strategy is assuring availability of large volumes of natural nutrients safe for food production. Today enormous amounts of biological materials are burnt or dumped outside the field without any effort to bring the nutrients back to productive use in agriculture.

The conventional wisdom is that, in order to double food supply, efforts need to be redoubled to modernize agriculture. Such a strategy has been successful in the past. But there are doubts about the capacity of such systems to reduce food poverty. The great technological progress in the past half-century has not led to major reductions in hunger and poverty in developing countries.

Arguably, the most sustainable choice for agricultural development and food security is therefore to increase total farm productivity in situ, in the developing countries that are most in need of greater food supplies. Attention must focus on the following:

- 1. the extent to which farmers can improve food production and raise incomes with low-cost, locally-available technologies and inputs;*
- 2. whether African farmers can do this without causing further environmental damage;*
- 3. the extent of farmers' ability to trade on local, regional and international level.*

Agricultural production techniques have the potential to both influence and address the factors that contribute to food insecurity. Organic agriculture relies on five capital assets for success: natural, social, human, physical and financial.

Sustainable agricultural techniques contribute to and builds up stocks of these natural, social and economic resources over time. To reduce many of the factors that lead to food insecurity. Industrial high energy input agriculture, depending on outside imports of fertilizer, seeds and energy, will not add to farmers' ability to secure long-term productivity.

The vast majority of the case studies in the UNCTAD/UNEP research showed improvements to the natural capital base – their local natural environment, with 93 per cent of the case studies reporting benefits to soil fertility, water supply, flood control and biodiversity.

Organic farming leads to many improvements to the natural environment, including increased water retention in soils; improvements in the water table (with more drinking water in the dry season); reduced soil erosion, combined with improved organic matter in soils, leading to better carbon sequestration; and increased agro-biodiversity. As a result, soils are healthier; are better able to hold water and are more stable; can sustain plant growth better; and have a higher nutrient content. All this enables farmers to grow crops for longer periods, with higher yields and in marginal conditions. This, of course, can make a major impact on reducing the food insecurity of a region.

Conservation or zero tillage farming also is another innovation that can be of great benefit for African agriculture. The basis ingredients are: No ploughing/zero tillage, direct sowing, use of mulch (cover) to protect the soil from soil erosion, accept the use of mineral fertilizer, acceptance of integrated pest management, improved crop rotations and use of trees to enhance productivity. Tries to mimic a natural ecosystem

The formation of farmers' groups and cooperatives and less formal community collaboration has lowered the costs of working, led to increased knowledge transfer amongst farmers, reduced the costs of organic certification and contributed to greater food security.

This is in contradiction to the high profile involvement of the Norwegian government alongside private capital to give financial and moral support to industrial fertilizer infrastructure to Africa produced with fossil fuels.

5.0 An alternative way forward

5.1 Community-Led Total Sanitation

In recent years, new innovations such as Community-Led Total Sanitation (CLTS) have attracted significant attention.

At the heart of CLTS lies the recognition that merely providing toilets does not guarantee their use, nor result in improved sanitation and hygiene.

Earlier approaches to sanitation prescribed high standards and offered subsidies as an incentive. But this often led to uneven adoption, problems with long-term sustainability and only partial use. It also created a culture of dependence on subsidies. Open defecation and the cycle of faecal–oral contamination continued to spread disease.

In contrast, CLTS focuses on the behavioural change needed to ensure real and sustainable improvements – investing in community mobilization instead of hardware, and shifting the focus from toilet construction for individual households to the creation of “open defecation-free” villages. By raising awareness that, as long as even a minority continues to defecate in the open, everyone is at risk of disease, CLTS triggers the community’s desire for change, propels them into action and encourages innovation, mutual support and appropriate local solutions, thus leading to greater ownership and sustainability.

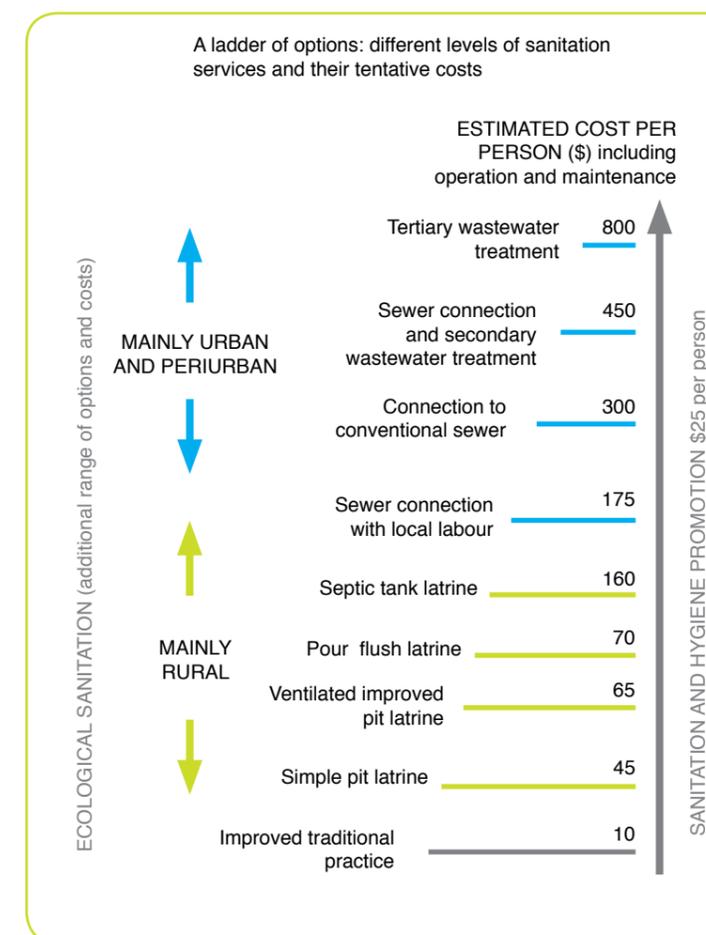
CLTS was pioneered by Kamal Kar in a village in the Rajshahi district of Bangladesh, while he was evaluating a traditionally subsidized sanitation program. Kar, who had years of experience in participatory approaches in a range of development projects, succeeded in persuading the local NGO to stop top-down subsidized toilet construction. He advocated change in institutional attitudes and the need to draw on intense local mobilization and facilitation to enable villagers to analyse their sanitation and waste situation and bring about collective decision-making to stop open defecation.

CLTS spread fast within Bangladesh where informal institutions and NGOs are key. Both Bangladeshi and international NGOs adopted the approach. The Water and Sanitation Program (WSP) of the World Bank played an important role in spreading the approach to neighbouring India and then subsequently to Indonesia and parts of Africa. Today, CLTS is in more than 20 countries in Asia, Africa, Latin America and the Middle East.

In addition to creating a culture of good sanitation, CLTS can also be an effective point for other livelihood activities. It mobilizes community members towards collective action and empowers them to take further action in the future. CLTS outcomes illustrate what communities can achieve by undertaking further initiatives for their own development.

5.2 Productive sanitation

Productive sanitation views urine and faecal matter, separated at source³⁷, as a resource for agriculture, productive school gardens and water protection. To create these benefits, we have to think beyond the WSP sanitation ladder that places the flush toilet on top. The idea of providing flush systems for all has hindered innovation and locked 2.6 billion people into the current situation. It also brings false expectations to users who may reject sustainable options, based on a perception of status underlined by the WSP sanitation ladder³⁸.



This illustrates how far decision-makers are from the realities of developing nations. For urban high density areas, there are no high quality/low cost sanitation systems with good logistics that are above ground with the goal of preserving the nutritional value of the human excreta. Investment and operational costs that exceed the average income of large portions of the population in developing countries underlines the need to innovate and think outside the flush toilet logic developed in industrialized parts of the world.

5.3

Sanitation for food security – a design criteria

Apart from the obvious design criteria of comfort and isolation of faecal matter, today's water-based sanitation systems are designed for resource use and waste creation, instead of low inputs and safeguarding the nutrients present in human excreta. The quality of the service provided by the toilet itself is not determined by the wastefulness or usefulness of its capacity to safeguard nutrients.

"Flush and forget" is ingrained in the habits of the privileged and, since decision-makers take this for granted, the sanitation community needs to explain how the future of sanitation should look.

Since 40% of the world's population is still without a toilet, it is time for a new era of sustainability and resource conservation to take the front seat in the design and innovation process. Designers and trans-disciplinary teams should be encouraged to bring forward solutions suited to an amalgam of cultural settings and situations in which people live.

Taking into account water shortages, energy price volatility and the need to move away from fossil fuel- based inputs in agriculture, more local production and distribution systems of nutrients are needed. The local food movement should welcome a future "local natural fertilizer" movement that is just as important for the CO2 footprint of our food.

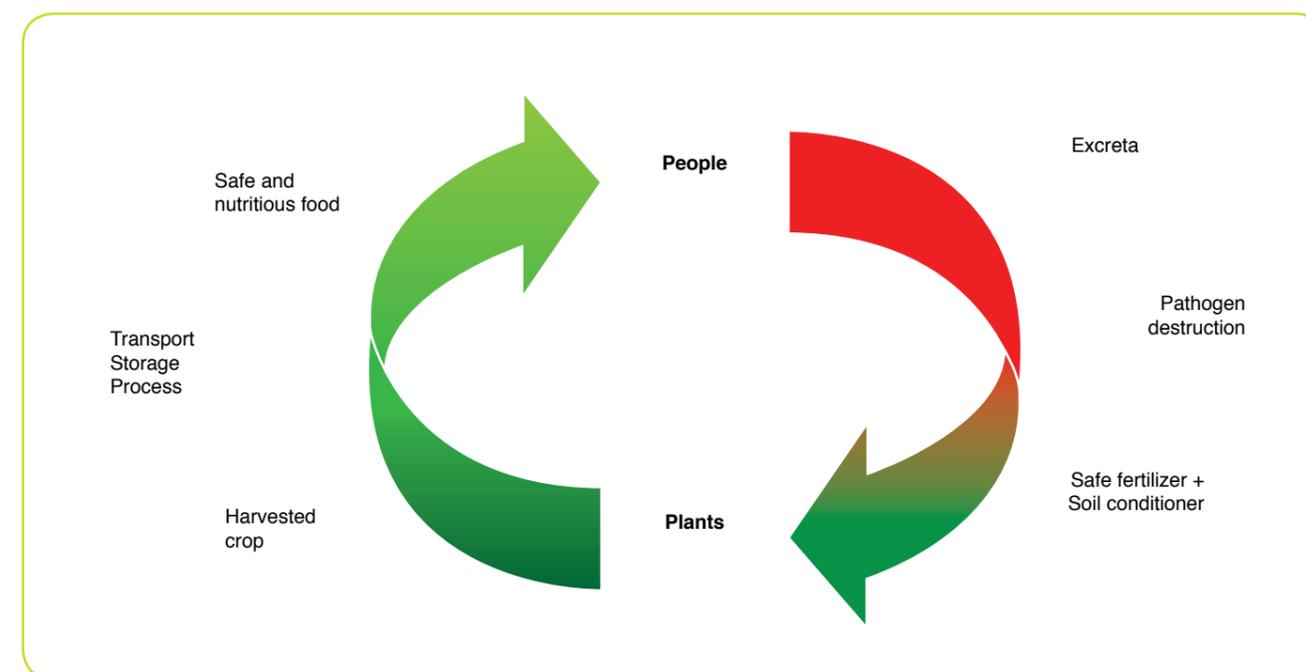
5.4

Ecological Sanitation (EcoSan)

Within productive sanitation, there are a wide range of so-called EcoSan technologies. In this paper, we focus on those that have the greatest potential for economic returns through the reuse of nutrients in agriculture. Urine can be used as a fertilizer for organic crops that provide a good return in areas with the transport infrastructure for export.

The promotion of Urine Diverting Dry Toilets (UDDTs), a form of sanitation that involves the separation of urine from faeces at the toilet itself, maintains the qualities of both urine and faeces. Excreta separation facilitates the reuse of nutrients contained in urine and faeces, which can contribute to increased crop yields in local agriculture.

UDDTs will be a challenge to introduce to a large public at the current stage of development. This is in particular true for the low cost products now available. Product designers and users need to communicate with the industrial environments so local quality UDDT are made available. A more systematic approach to how UDDTs link to logistical systems is needed to provide clean transport of nutrients for treatment before sale to commercial agriculture.



EcoSan options include:

- Composting dry toilets
- Urine diverting dry toilets (UDDTs)
- Arborloo³⁹
- Low flush systems with decentralized biological treatment and reuse

The role of human excreta in agriculture:

- Urine is the everyday food for plant growth and can be applied with water every week or every second week depending on crop.
- Treated or composted solids are for the long-term benefit and maintenance of soil quality. Depending on current soil quality, this should be done every planting cycle or once a year.

5.5 Composting dry toilets

A composting toilet is an aerobic processing system that treats excreta, typically with no water or small volumes of flush water, via composting or managed aerobic decomposition.

Composting toilets should be viewed as an alternative to central wastewater treatment plants or septic systems. Typically they are chosen:

- to alleviate the need for water to flush toilets
- to avoid discharging nutrients and pathogens into peoples' living spaces or the environment
- to capture nutrients in human excreta

Unfortunately many sanitation projects carried out are implemented without forethought as to how the human excreta will be treated and reused. Safe sanitation of high user quality can be achieved and, if explained, the process of transforming human waste through composting to soil conditioner can provide an additional incentive.

Composting toilets should be used at a household level and in communities close to agricultural production. Low-cost composting methods for households in both rural and peri-urban areas can be connected to experimental gardens to demonstrate the agricultural impact of the compost.

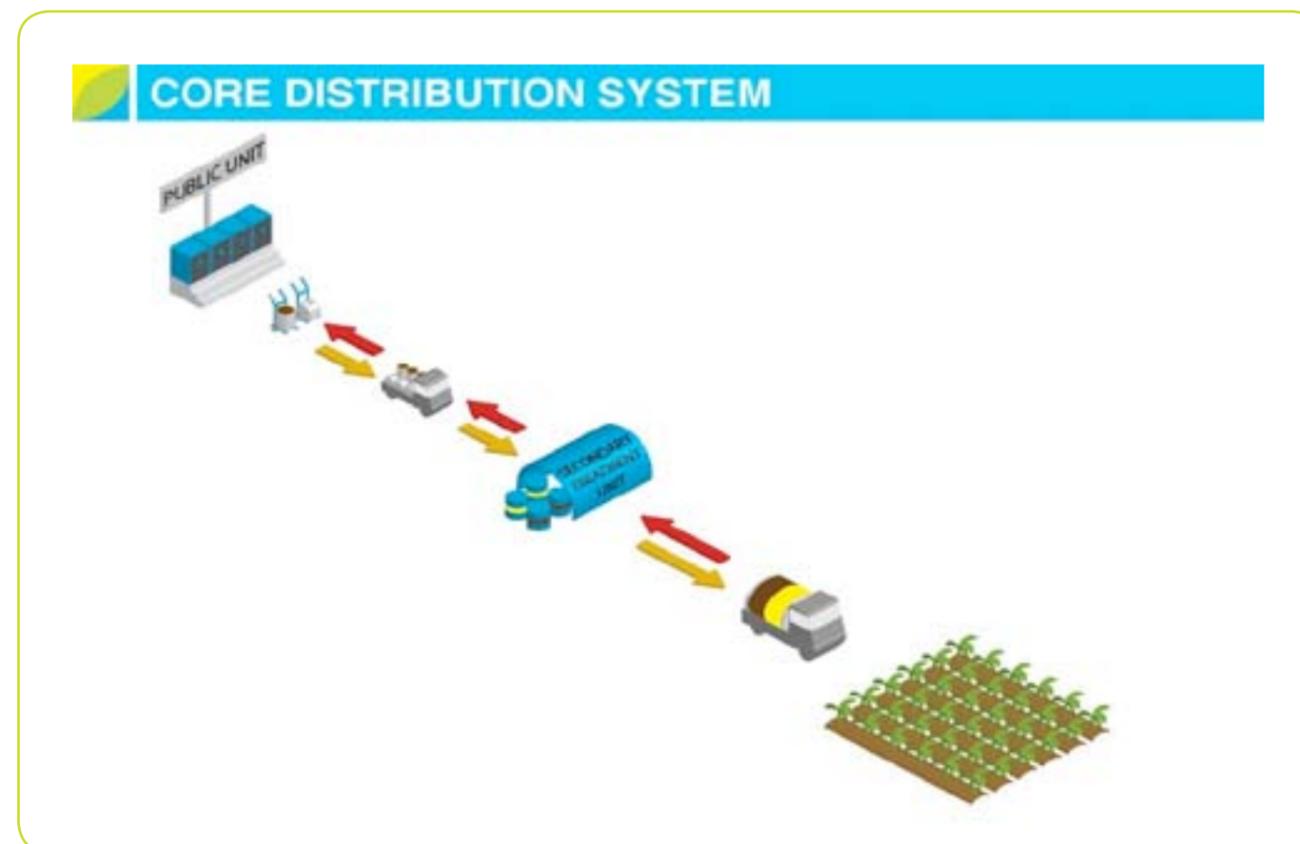
Urban public units have been piloted in many places around the world, with the treatment of human waste that can later go to use in agricultural production.

The challenge is to encourage the learning necessary for the management of such networks for the system to be scalable. By addressing this issue, local government, municipalities and NGOs can serve the population safely in the future and effectively treat human excreta alongside organic waste from residents.

By creating a value chain, multiple households using separating toilets can share a waste collection and transport system - an ecological waste treatment facility. This system can also include garden waste and vegetable market waste from the city for aerobic composting into a high quality agricultural fertilizer.

The fertilizer will have to be tested to ensure that it meets public health standards before it is sold to local farmers, replacing imported chemical fertilizers.

In order to expand projects in developing countries that tie sanitation to other types of recycling and reuse of organic waste, there is a need to adapt current knowledge with the help of local designers and universities so that low-cost methods are made available locally.



(Chart: Value chain for local fertilizer production and food security)

5.6

UDDTs with Urea Treatment— a solution of the future in urban areas

Urea is the most common fertilizer in the world. In Africa it is widely distributed across the continent in towns and often sold by the bag or kilo in shops in rural areas. Due to high transportation costs and inefficient distribution, the price of imported urea for small-scale farmers can be 2-3 times the world market price.

For sanitation purposes, urea can be used as a catalyst for a process that makes the faeces safe to reuse as a soil improvement product. Since it is the pathogens in faeces that kill, there are strong incentives to assure that faecal matter is brought into a well-thought through handling and treatment regime. By isolating faecal matter in urban areas before treatment, this process could save lives by limiting the spread of disease.

Using urea for safe reuse will also be a positive contribution to food security since the nutritious "waste" is enhanced and transformed into a safe agricultural input. When the urea comes into contact with faeces, an enzymatic breakdown into ammonia and carbonate takes place, driven by enzymes which naturally occur in faeces. As the urea is broken down, the pH value of the material increases and hygienisation begins. Disease-producing pathogens which are found in faeces are rendered inactivate within 2–6 weeks depending on the surrounding temperature⁴⁰.

Diarrhoea accounts for 1.8 million deaths per year worldwide, of which viruses are responsible for about 43 %⁴¹. Several viruses, such as Adenovirus, are tolerant to extreme pH-values and can survive for a long time in the environment.

Urea treatment is found to inactivate even Adenovirus to acceptable concentrations much faster than any other suitable treatment method. *Ascaris*⁴² has a high prevalence rate in developing countries, and may affect as much as 80% of the population in some areas⁴³, but is very resistant to alkaline treatment and composting.

However, fast reduction of *Ascaris* levels has been achieved with urea treatment⁴⁴. *Salmonella*, *E.coli*, *Cryptosporidium* and *Giardia* are responsible for most food-borne disease transmission, and are all rapidly inactivated to insignificant levels with 4 % urea treatment⁴⁵.

Untreated or composted faeces, by comparison, is not hygienized until after 1–2 years. Urea treatment is the simplest and most efficient treatment available. The beauty of the process is that, when done in Africa, the Caribbean, South-East Asia or other countries with a tropical climate, there is no energy added to the process, as night time temperatures are often higher than 20°C.

Adding urea to the faecal matter is not a wasted input; it is a product that brings value to the production of food and fodder. When treated with 4% urea, 1,000 kg of faecal matter (produced by approximately 3,000 people) costs 40 USD to treat, or 1.3 US cents per person. The intention is that the soil improvement product, when sold to commercial farmers, recuperates this cost and, if possible, makes a profit to run the sanitation systems needed for collection.

Urine is, in its natural form, considered safe when exiting the human body. The risk of contamination is mainly from contact with faecal matter. This brings about the importance of separating urine from faecal matter with urine diverting toilets. The best way to produce large amounts of safe urine is from urinals for men and, if well designed, also from women⁴⁶.

This simple measure limits the risk of cross-contamination. The hygienization of the urine occurs more quickly and is done without adding urea since the same active substances to start up the hygienisation process are already present in urine.

This type of value chain development is an economic perspective that is very distant from the traditional NGO approach to sanitation. If new funding is not available, funding should be transferred to innovation in order to create scalable solutions. See Case studies 1 and 2 for more information about value chain development.



Box 4: Production of banana with natural fertilizer

73% of farmers produce some banana for cooking (matooke) since this is the staple food in Uganda.

The farmers indicated some knowledge about the effects of urine, not so much as a fertilizer, but more as a fungicide against Banana Wilt disease, or Panama disease. But they also expressed fear that people (family members and consumers) might have a negative attitude to it and refuse to buy the products.

Matooke production 2,1 tons per hectare - The average matooke yield is about 30 percent higher when manure is applied to matooke. 54% of households have plots with agricultural production in Kampala – 76 % of them are in connection to their living space. Urban agricultural activities can mediate the association between urban poverty and household food insecurity.

Therefore, urban agricultural activities should be promoted as a strategy to strengthen household food security

On matooke, the results indicate a strong association between matooke yield and manure application. Matooke yield is 36 percent higher when manure is applied.

Average in Uganda only 8,3 % of farmers use natural fertilizer (manure)

Safe soil improvement product from human faecal matter could replace reliance on using local wastewater that in addition to some nutritional value have great risks of being laced with industrial pollution from chemicals and untreated pathogens that thrive in the local climate.

200 kg of human soil improvement product = 4kg of urea in N content.

With current prices of the banana in Kampala the farmer would increase production with 30 % if sufficient soil improvement/natural fertilizer is used. This represents 150 UDS per hectare.



Case studies

Case study 1: An emerging market for treated human excreta - Ouagadougou

Since March 2009, there has been a "human fertilizer" market in Ouagadougou, the capital of Burkina Faso. Human urine and dried faeces are collected and taken to "eco-stations", where they are sold on to farmers as fertilizer after adequate storage. In this way they increase sanitation coverage, create jobs in the private sector and provide urban farmers with complete and efficient natural fertilizers.

The situation in Ouagadougou

In Ouagadougou, only 19 per cent of the population has access to improved sanitation, such as connections to sewers or septic tanks and improved pit latrines. The commonest pit latrines in Ouagadougou have several problems.

In addition to the risks of groundwater pollution and nutrient loss from infiltration, there are also flies, odours, the risk of collapse and difficulties in emptying the pits. There is not yet a system for sludge treatment in Ouagadougou, which means that the sludge is informally dumped in and around the city.

To provide an alternative, a project implemented by the Regional Centre for Low-Cost Water and Sanitation (CREPA) and other institutions have promoted the use of Urine Diverting Dry Toilets (UDDTs). When urine and faeces are kept separate, there are generally fewer problems with odours and flies; the treatment is relatively easy; and nutrient losses are prevented.

The toilets are built above the ground to protect the groundwater and enhance the dehydration of the faecal matter. Households were able to choose from a range of models, with single or double vaults in different materials, was available for the households to choose from ⁴⁷.

Use of sanitized human excreta

Even before construction of the toilets began in 2006, efforts were being made to sensitize urban farmers with respect to the value of urine as a fertilizer. This was necessary because, if there was no interest in the end product, the whole chain would be sure to fail. The promotion was based on participative experimentation, using urine as a fertilizer in four different urban sectors. The urine had been collected with mobile urinals during a film festival.

In the first phase, 70 urban farmers applied urine to their land and compared it with urea on test plots, and with the industrial fertilizer NPK_{48,49}. Yields of the plots using NPK and urine were higher, proving that both industrial fertilizer and urine increase agricultural production. Urine was dosed, based on its nitrogen content, which was around 5 g/l in Ouagadougou.

Since then, 600 urban farmers have been trained on the use of urine as a fast-acting nitrogen fertilizer, and, to a certain extent, also on the use of sanitized dry faeces as base fertilizer. The training is based on practical knowledge concerning dosages for different plants, and also on safety measures for the plants, farmers and consumers.

In March 2009 an evaluation workshop was held with urban farmers from the four sectors to decide on the transition from "free" human fertilizers to a fertilizer market.

The price of liquid and solid fertilizers was based on the NPK content compared to the cost of an equivalent amount of nutrients in chemical fertilizer. Based on earlier calculations by Dagerskog (2007), the work of Jönsson et al. (2004), and considerations that human fertilizers contain organic material and trace elements, but also demand more work both in transport and application compared to chemical fertilizers, a reasonable price was set at USD 0.20 per jerry can of hygienized urine and USD 0.10 per kg of hygienized faeces (sold in 25 and 50 kg bags).

Interest in buying natural fertilizer depends largely on the price of the chemical fertilizers, but there are those who are already convinced of the benefits:

Dera Mouni, urban farmer for the past 25 years:

In the beginning, I was a bit sceptical, but after the training first at CREPA and then here in our own fields, I was convinced. The liquid fertilizer gives very good yields. For the last crop cycle I bought the liquid fertilizer for my cabbage, but this cycle I will grow peppers as well. Peppers respond very well to liquid fertilizer. It is true that I have to invest some more when using the liquid fertilizer. For one plot of 40 m², I usually apply manure and then 2 kg of urea. The urea costs me around USD 1.

With the urine I use around 10 jerry cans, which cost me USD 2 and is also heavier to apply. In return I have fewer problems with insect attacks, and the yields have been great. What I harvest from one plot I can usually sell for USD 50. Of the 16 farmers who participated in the fertilizer tests on this site, I am the only one as far as I know who now buys the liquid fertilizers.

Many farmers don't see tomorrow. I think this system has a future, because the chemical fertilizers kill the soil in the long term, and we know that. The liquid fertilizer is new for us. Regarding the solid fertilizer from human faeces it will be easy to sell. The treated faeces looks like the manure we are used to.

Collection, treatment and income generation

In each sector, a collection system managed by a local non-profit association was set up. The association collects and transports urine and dried faeces from households to "eco-stations", where it is stored for further sanitization. The associations managing the collection and treatment would ideally cover their own running costs by selling the fertilizers to farmers, as the theoretical cost/benefit analysis shows.

The income depends on the amount of urine and faeces that enters the system and is then sold to farmers. The following calculation is based on the estimation that 40 per cent of the urine and 75 per cent of the faeces produced by a household actually enters the system. The cost for transport and treatment is about USD 2.30 per household per month. Income of USD 2 per household per month can be obtained from selling the excreta and USD 0.3 per household per month from a household collection fee (the fee is USD 0.6 per household per month, but the cost for collecting it is USD 0.3 per household per month). The costs referred to are only operating costs for collection and treatment⁵⁰.

Thus, theoretically the associations involved can cover their operating costs, but this requires that the following operating criteria be fulfilled. In the actual situation, after a year of functioning, none of these criteria were completely fulfilled as of yet.

1. Excreta quantity entering the system:

For the system to be self-sustaining, the households need to supply at least the quantity of human excreta estimated above. The challenge in rural or peri-urban settings is to get the volume and logistical elements to be cost-efficient.

2. Fees:

The households have to pay the collection fee. However, about 50 per cent of households do not pay the fee. How can the poor have access to this service without it becoming a burden on their low income? Cross-subsidy structures have to be put in place within the community.

3. Scale:

The collection system has to operate at full capacity to be cost-efficient. This example is from small-scale implementation and the economics could be improved by higher penetration rates and more participating households.

4. Storage:

There has to be sufficient storage capacity at the eco-stations to handle the volume generated per household in the system. This element creates high initial investment so there is a need for outside funding during the start-up phase.

5. Reuse demand:

There must be a demand for all the excreta entering the system. Some farmers have bought large quantities, but the urban farmers' willingness to pay has not been up to expectations, partly because of the transport cost from eco-stations to farms.

Discussion

The project has succeeded in raising awareness on urban excreta and nutrient management in Ouagadougou. If the collection system continues to grow, it will be necessary to establish how much excreta urban farmers potentially can use. Sawadogo (2008) therefore made an inventory of urban farming within the Ouagadougou city limits and found, in total, 201 hectares, 93 percent of which is dedicated to vegetable farming and 7 percent to horticulture.

This means that, if the authorities decide to adopt ECOSAN on a large-scale, agricultural production using sanitized excreta needs to be made a priority in and around the city to avoid high transportation costs. All together, the population of Ouagadougou generates around 525,000 m³ of urine per year. As it stands now, external funding is necessary to support part of the operating costs of the fertilizer production system. Instead of paying the associations directly, the subsidy might be more efficient if targeted to the end of the chain, linking it to each jerry can or bag of fertilizer sold and applied in farming. The incentive to sell the fertilizers would then become even greater, and the associations would be stimulated to improve their marketing. It will also be important to have a municipal strategy for what to do when demand does not meet supply, and how to use the excreta elsewhere.

The new EcoSan system in Ouagadougou is by no means ideal, but it has taken some innovative steps in urban nutrient management. The experiences show that the operating costs of collection and treatment can almost be recovered by the sale of treated excreta, if the distances to be covered are relatively short. Public funding is needed for investments in and control of the system, and to a certain extent for running costs, at least in the short term.

It is always difficult to mobilize scarce public funds, but if the gains in health and environmental protection could be valued, in addition to the agricultural benefits, it would probably prove to be an economically sound public investment.

Case study 2: The potential of productive sanitation for urban economic growth – experiences from Kampala, Uganda

In late 2009 a study was conducted to investigate possible ways to dispose of human excreta from slum areas in Kampala⁵¹. The main objectives of the study were to design a logistics system that connects the areas of human excreta production with urban agriculture. The logistics of human excreta investigated in this study are to be carried out by a private sector company in order to maximize efficiency and improve the system's economic sustainability.

During the study additional information from peer-reviewed literature presented aspects as to why sanitation can be considered a driver for economic development and how this can improve the overall viability and sustainability of future projects.

The situation in Kampala

About 430,000 people live in the slum settlements of Kampala. The growth rate in the city's population during the past five years was 4.4%, with 4.8% projected for the next five years, compared to a global average of 1.9%⁵².

The sanitation situation in the slum areas of Kampala is unacceptable. The reasons for the situation include low lying topography that easily gets inundated from heavy tropical rainfalls; the level of income of residents and their inability or reluctance to pay for improved sanitation (either investing in proper facilities or arranging proper emptying of existing facilities); and lack of planning and law enforcement from the local authorities.

Where no centralized sewage line network exists, it is assumed that it is an individual responsibility to implement a safe and suitable on-site sanitation facility. Kampala City Council's (KCC) duty is to monitor this individual responsibility and ensure law enforcement.

An estimated 60% of toilets in Kampala's slums are shared pit latrines that have been constructed above the ground due to the high groundwater table and in order to prevent flooding after heavy rainfalls.

In higher elevated areas, where a deeper groundwater table can be expected, conventional pit latrines without lining are dug into the ground and used instead. An estimated 30% of people living in slums use public toilets funded by NGOs, official authorities such as KCC and the Directorate of Water Development (DWD) or by official development assistance (ODA).

There are quite a number of public toilets that are operated on a commercial basis where the users pay a fee of 0.04 EUR per visit. From this income, the operator gets paid and expenses for water, cleaning materials and emptying costs are recovered. Since the slum areas are places with high economic activity, the public toilets are additionally frequented by informal traders from outside Kampala that visit the markets to conduct business during the day.

The remaining 10% of slum dwellers, who are likely to belong to the poorest section of the community, have to rely on "alternative" means, meaning the use of polyethylene bags for defecation (referred to as "flying toilets") or open defecation which considerably spoil the environment and contribute to various health problems, such as cholera outbreaks, diarrhea and different parasitic infections.

But not only "alternative" sanitation practices have increased the risk of the outbreak of disease; the commonly applied emptying practices of the shared, above-ground pit latrines are contributing to the precarious situation.

One popular way of dealing with the faecal sludge from toilets is to empty the contents into the surrounding environment by way of a drainage channel. This usually happens during the rainy season when a cork which is positioned close to the level ground of the pit is opened and the faecal sludge is released.

Another popular option is to empty the pits manually with a bucket. In this case again, the environment in the direct vicinity receives the faecal sludge. The basic version of the conventional underground pit is usually not emptied properly either, but just left for decomposition while a new pit has to be dug somewhere else on the compound.

If enough money for a proper emptying can be allocated, KCC or the Private Emptier Association (PEA) get contracted and provide the emptying service with suction trucks.

However, due to a scarcity of money and often unsuitable toilets without lined pits and bad road accessibility, this option is rarely chosen. Instead, the public units get emptied by trucks which are financed by the income generated by obligatory user fees. If a 10,000 litre truck provides the service, the costs for one emptying trip can easily add up to 64 EUR.

Sustainable sanitation in Kampala slums

The history of sustainable sanitation in the slums of Kampala can be regarded as one with varying success, dependence on outside funds and little sustainability.

In the past, several projects have promoted and implemented the use of Urine Diverting Dry Toilets (UDDTs), since this technology is commonly considered a feasible option when it comes to implementation in low-cost environments. Besides the advantages of saving water used for flushing, improving the environmental situation of the surroundings and the health situation of the inhabitants, the technology also provides users with a valuable fertilizer for agriculture.

But exactly this has been identified as a stumbling block for more successful implementation. People did not know what to do with the generated excreta and additionally showed a strong reluctance to handle it. Another reason for the limited success was a lack of ownership by toilet users and hence the operation and maintenance was deficient.

As already mentioned, a logistics system has been designed as a possible solution to past problems. The system consists of various components. It can roughly be divided into three levels: slum, private company and farmer. The excreta is collected in the slums and delivered manually to collection points by the toilet owners themselves, informal collectors or small collection enterprises.

Incentives are handed out at the collection points for the delivery of every single container. From the collection points, the excreta is picked up on a regular basis by a private company and delivered to a treatment facility within the city using tanker-trucks. After a certain period of treatment the sanitized excreta is delivered to farmers around the city.

The outcome of the study presented the logistics of human excreta to be a profitable business, with a return on sales of 21.7% in the most optimistic scenario. At the same time it also revealed a variety of constraints and restrictions, such as socio-cultural taboos related to excreta handling (amongst slum dwellers), high handling and management cost (private company and farmers) and high vulnerability of the supply chain.

Beneficiaries and benefits

In a comprehensive set of studies by Hutton et al. (2007) and Haller et al. (2007) diarrhoea has been chosen as a suitable indicator for cost-benefit analysis. In their studies, the effects of different water supply and sanitation interventions have been modelled and presented in terms of a reduction in diarrhoea incidences.

This effect in turn is transformed into monetary sums, underlining information from reviewed literature and own assumptions (cf. Hutton et al., 2007).

The positive impact of the logistics system in reducing diarrhoea cases in slums and possible impacts on the targeted area with respect to economic growth are presented below. The economic impacts for the company, the institution in charge of compliance with sanitation regulations (the Kampala City Council) and the farmers are also described.

The benefits for slum dwellers include the following:

- Less cases of diarrhoea are generally seen in all age groups.
- People are able to work more and improve their productivity⁵³. It is estimated that an average of two days are lost per case of diarrhoea. The gross national income (GNI) per capita per day can be used for a valuation in monetary terms.
- A reduced number of diarrhoea cases in children over 5 years old and under 15 decreases the number of days they are absent from school. On average, three days are lost per case of diarrhoea and, even though school is not productive work, the GNI per capita and day is used for valuation. This assumption is motivated by the generally accepted "[...] importance of proper schooling for future productivity as well as the overall welfare of society [...]"⁵⁴. A reduction in expenditure on medical expenses and related costs, such as transport.
- Less cases of diarrhoea also lead to a reduction in the number of days children under 5 years old need special attention from their care takers. An average of five days is attributed to that purpose and 50% of the per capita per day GNI is used for the purposes of valuation.
- Potential for income generation either through incentives for the delivery of human excreta containers to collection points, or through the profit generated from operating collection points or public units.
- Benefits resulting from fewer deaths. For the purposes of valuation, income lost as a result of a fatality is calculated based upon the number of productive years lost.
- Less time spent getting to sanitation facilities. An average 30 minutes per day and person are allocated for that.
- Improved quality of life (privacy, dignity, convenience, status, safety, higher environmental quality).

The company in charge of service delivery generates income. Schroeder (2010) concludes that a maximum of a 21.7% return on sales can be achieved, taking into consideration the constraints and restrictions mentioned in the study.

People living in urban slums in Kampala do not get assistance to fulfil sanitation requirements. As mentioned above, if no centralized sewage network exists; on-site sanitation has to be put in place by the individuals themselves. Compared to water based sanitation Kampala City Council can therefore likely reduce its expenses by increasing efforts and support to dry toilet solutions with less investment needed.

The farmers benefit from receiving an efficient organic fertilizer for a competitive price. Depending on the design details of the system, the delivery scheme can even include an introduction service, acquitting the farmer from all soil and nutrient management related activities.

Depending on the local farm production and the fertilizer market Corporate Social Responsibility (CSR) issues might play a significant role. In the case of Uganda with an increased flower production for export the international companies involved can include sanitation in their CSR portfolio.

For this sector social responsibility and more environmental production can be achieved by changing to natural fertilizer. Sanitation Value chains need buyers of the fertilizer and with the public sceptical to human excreta use in food production the flower industry is perfectly placed to use natural fertilizer.

Another economic benefit can accrue from marketing agricultural products that have been fertilized with human excreta as "certified organic", realizing higher prices for the end product.

Discussion

A general overview of the potential of economic growth caused by improvements in sanitation facilities was presented by the studies of Hutton et al. (2007) and Haller et al. (2007). A more detailed insight was created by connecting the studies with the results obtained from the study of the logistics of human excreta.

All stakeholders involved in the proposed scheme generate a beneficial outcome, ranging from direct effects, such as fewer incidents of death or higher productivity, to indirect effects, such as profits from selling organically produced goods for a higher price than their "non-organic" counterparts.

Sanitation appears to be an underestimated and at the same time effective driver to improve the health of a society and simultaneously contribute to economic growth. These effects should be seen as synergies since a better health status alone does not seem to be a sufficient trigger for investing in improved sanitation. Economic development seems well-suited to support a wide reaching strategy assure sanitation for all and contribute to economic growth.

This table shows how urban sanitation systems can have an impact on agricultural production and the environment:

Urban slum Population	Number of public units	Urine collection	Faeces collection	Urea fertilizer equivalents	CO2 emissions saved	= Number of km with car 140g/km	Market value USD	Income per liter from fertilizer ⁵⁵
100 000	150 units	2400 m3	600 tons	35 tons	209 tons	1,5 million	35.000	233 USD

The figures are based on a urine market study conducted in Uganda by using 50% collection rates for an urban population of 100,000 people in Kampala. It is estimated in the Kampala study that the urban slum sanitation system will not need heavy subsidies when running close to full capacity.

Recommendations

More attention needs to be paid to the economic return on sanitation, particularly since traditional arguments about the health and social benefits of sanitation have failed to bring in adequate funding for long-term sanitation implementation and innovation.

The economic benefits include reduced health costs to society, higher levels of school attendance, higher productivity (through a reduction in lost working days), reduced environmental costs (through reduced pollution), and an increase in GDP.

Particular attention should be paid to the merits of productive sanitation solutions, which include considerable savings on initial investment and maintenance (compared to water-based systems) and a range of additional economic benefits:

1. Production of natural fertilizer for both organic and conventional agriculture, with monetary benefits for households and schools through sale of fertilizer and increased production in household/school plots
2. Increased earnings in urban agriculture due to access to locally-produced natural fertilizer (rather than imported products), increased yields and increases in the export of organic goods
3. Increased employment and earnings within the city through service delivery and the development of competent micro-enterprises running toilets for the community.
4. Reduction in environmental and social costs through the restoration of soil productivity using a safe soil improvement product

Ways should be found to identify and "convert" the economic return on sanitation into new funding for research, development and innovation in the sanitation sector. The identification of sanitation-induced savings in areas such as health should motivate municipal and national governments to invest in sanitation for all inhabitants.

Expensive, non-viable water-based options should be taken off the table. Instead, efforts should be concentrated on innovation and low-cost quality productive sanitation solutions, with their multiple social, economic and environmental benefits, that have the potential to reach all.

Economic incentives that stimulate the expansion of sustainable sanitation should be developed. Innovative financing mechanisms for large-scale implementation of sanitation should be explored. One example might be the approach used with vaccines, with pre-financing in capital markets based on future savings.

Innovative mechanisms, including smart subsidies, should be put in place to ensure sanitation provision for the very poor.

Above all, national decision-makers and the development community need to show leadership and innovation in order to secure sanitation for all.

Appendix A: "Economic Impact of Sanitation in Asia" ⁵⁶

Poor sanitation is one reason why many tourists choose not to go to certain places or decide that they will not go back for a second visit. For tourist economies in Asia, this has been quantified to enormous losses of potential income. In developing countries, such as Cambodia, the Philippines, Vietnam and Indonesia, this has been estimated at a loss of over 350 million USD a year.

This estimate is based on sanitation representing 5-10% of total decision-making factors affecting tourism in this region. There is no doubt that sewage and open defecation, with human excrement littered across cities, play a role in how a country is perceived as a destination for tourism.

Major finding 1: Poor sanitation causes approximately US\$9 billion in annual economic losses in the four countries: an average of 2% of annual GDP. A greater share of the socioeconomic burden of poor sanitation falls on the population without improved sanitation – especially women, children, the elderly and the poor – increasing inequities in society. By improving sanitation, a significant proportion of these socioeconomic impacts can be mitigated.

Recommendation 1: Decision-makers are advised to act now. Sanitation should be given increased political importance and budget allocations. Governments should give priority to the populations with no latrines.

Major finding 2: The health- and water-related impacts of poor sanitation have the greatest economic toll on society. The WB – WSP study confirms that the most tangible impact of poor sanitation is an increased risk of infectious disease and premature death, which result in high economic costs.

A high proportion of human excreta and wastewater eventually finds its way to water bodies and causes significant pollution and related economic costs.

Recommendation 2: Governments should focus on the easily achieved health benefits of improved sanitation - by educating children and promoting safe but simple low cost latrine designs, improved excreta isolation measures and improved hygiene practices such as hand washing with soap.

Governments should urgently implement sanitation standards that reduce the release of waste matter into water resources. Focus should not be just on human excreta, but also solid waste, household and agricultural waste that can use some of the same reuse value creation systems.

Major finding 3: Sanitation has a major role in sustainable development, due to its multiple impacts and links with other development goals (MDGs). Sanitation plays a key but largely unrecognizable role in population welfare and poverty reduction. Impacts not fully explored - in particular tourism and the investment climate - are potentially major arguments for improving sanitation.

Recommendation 3: Sanitation cannot be the task of a single sector or ministry. Advocacy is needed at the highest levels to ensure political support and resource allocations for sanitation, but also at implementation levels where population demand for sanitation is key for its success.

Major finding 4: The socioeconomic impact of poor sanitation varies between different countries. Given the lack of sanitation-related information in official reporting systems and surveys, several impacts of poor sanitation could not be evaluated, or assessed at the local level.

Recommendation 4: To convince local decision-makers local studies would be more credible in showing the real impacts of sanitation affecting their population, and obtained improvements in population welfare. Further research studies could fill important knowledge gaps about the economic and welfare effects of improving or not improving sanitation.

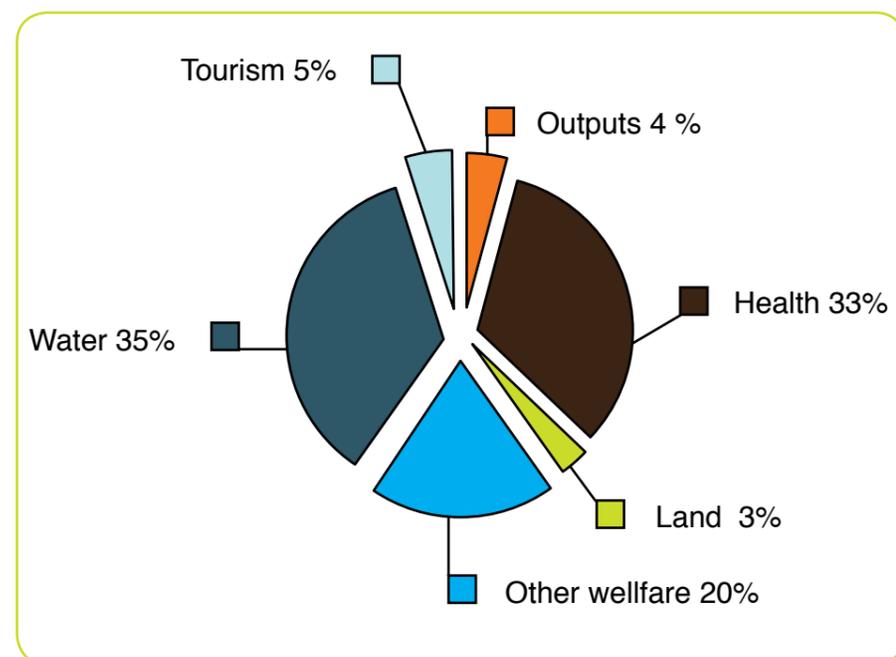


Figure: Distribution of economic gains from improved sanitation, by impact.

Improved sanitation yields an estimated US\$6.6 billion in economic gains. There is some uncertainty in these estimates, given the difficulty of predicting which costs are mitigated and which are not, and over what time period. The water losses mitigated, which contribute to 35% of the overall gains, are dependent on other factors such as changes in water treatment practices. Because many economic losses were not quantified in this study, the economic gains could be considered conservative.

Cambodia, Indonesia, Vietnam and the Philippines lose an estimated US\$9 billion a year because of poor sanitation (based on 2005 prices). That is approximately 2% of their combined Gross Domestic Product (GDP), varying from 1.3% in the Philippines and Vietnam, to 2.3% in Indonesia and 7.2% in Cambodia.

The annual economic impact is approximately US\$6.3 billion in Indonesia, US\$1.4 billion in the Philippines, US\$780 million in Vietnam and US\$450 million in Cambodia. With the universal implementation of improved sanitation and hygiene, it is assumed that all the attributed impacts are mitigated, except health, for which 45% of the losses are mitigated.

Universal sanitation would lead to an annual gain of US\$6.3 billion in the four countries, as shown in the figure below. The implementation of ecological sanitation approaches (fertilizer and biogas) would be worth an estimated US\$270 million annually.

Poor sanitation also contributes significantly to water pollution – adding to the cost of safe freshwater for households, and reducing the production of fish in rivers and lakes. The associated economic costs of polluted water attributed to poor sanitation exceed US\$2.3 billion per year, divided between US\$1.5 billion in Indonesia, US\$320 million in the Philippines, US\$290 million in Vietnam and US\$150 million in Cambodia.

Poor sanitation also contributes to US\$220 million in environmental losses (loss of productive land) in Indonesia and Vietnam, US\$1.3 billion in other welfare losses (time to access unimproved sanitation), and US\$350 million in tourism losses.

	Per capita USD million	Per capita	%
Cambodia	448	32.4	100 %
Health	187.1	13.6	42 %
Water	149	10.8	33 %
Other well fare	38.2	2.8	9 %
Tourism	73.7	5.3	16 %
Indonesia	6344	28.6	100 %
Health	3350	15.1	53 %
Water	1512	6.8	24 %
Environment	96	0.4	2 %
Other well fare	1220	5.5	19 %
Tourism	166	0.7	3 %
Philippines	1412.1	16.8	100 %
Health	1011.1	12.0	72 %
Water	323.3	3.8	23 %
Other well fare	37.6	0.4	3 %
Tourism	40.1	0.5	3 %
Vietnam	780.1	9.3	100 %
Health	262.4	3.1	34 %
Water	287.3	3.4	37 %
Other well fare	118.9	1.4	15 %
Environment	42.9	0.5	6 %
Tourism	68.6	0.8	9 %
Total	32.4	22.2	100 %

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Footnotes

- 1 Sanitation report, Water and Sanitation Program (WSP) – Guidance Note 2009 for Urban Africa. http://www.wsp.org/wsp/sites/wsp.org/files/publications/Main_Global_Guidance_Note.pdf
- 2 Based on experience from Uganda and other parts of Africa, traditional in this context implies funding of small stand-alone projects that help a family, school or group within a city, without looking at scaling-up to allow universal access.
- 3 Water-based flush sanitation for the minority/elite is today subsidized by donor funding and loans from, amongst others, the World Bank
- 4 A multi-donor partnership administered by the World Bank
- 5 www.wsscc.org
- 6 Mara D, Lane J, Scott B, Trouba D (2010) Sanitation and Health. PLoS Med 7(11): e1000363. doi:10.1371/journal.pmed.1000363
- 7 Norwegian aid to the water and sanitation sector has continued to decline as a proportion of total development assistance. Norwegian funding of water supply and sanitation was around 250 million Norwegian crowns in 2009 - less than 1.4 % of total Norwegian bilateral development Assistance
- 8 Water-based flush toilets that in Africa have no treatment and go directly into lakes, rivers or the sea as pollution
- 9 The nutrients should be the basis for natural fertilizer production and transformed into a safe soil improvement product
- 10 Mahatma Gandhi said in 1923 in reference to health: "sanitation is more important than independence"
- 11 During a presentation at NORAD in January 2011, the executive director of WSSCC in Geneva, Jon Lane, underlined that not a single treatment plant north of South Africa was functional. All sewage from flush toilets goes directly into rivers, lakes or the sea.
- 12 Investment and operational cost of flush toilets exceed the average income of the population in developing countries
- 13 Enhancing Resource Allocation to Urban Development in Africa , Report of African Regional Seminar on Enhancing Resource Allocation to Cities to Strengthen their Role as Engines of Economic Growth and Development, UN-HABITAT 2006, <http://www.unhabitat.org/pmss/listItemDetails.aspx?publicationID=2292>
- 14 Figures from UN-HABITAT
- 15 Fewtrell L, Kaufmann RB, Kay D, et al. Water, sanitation, and hygiene interventions to reduce diarrhoea in less developed countries: asystematic review and meta-analysis. The Lancet Infectious Diseases. 2005;5(1):42-52.
- 16 Demographic and Health Survey (WHO)
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- 18 Gross domestic product
- 19 http://www.wsp.org/wsp/sites/wsp.org/files/publications/ESI_Laos_english.pdf
- 20 <http://www.wssinfo.org/definitions-methods/introduction/>
- 21 <http://www.wssinfo.org/definitions-methods/watsan-ladder/>
- 22 Dr. Yong-Ee Cho, president of the South Korea based World Toilet Association - <http://www.worldtoilet.org/>
- 23 In a ventilated improved pit latrine (VIP), ventilation dries faecal matter, reducing odor and flies faster
- 24 WHO figures based on cost in many countries
- 25 Urine from EcoSan can be used to replace industrial fertilizer. One person urinates 500 liters per year, which is the equivalent of 5-8 kg of industrial fertilizer, with a value of 4-8 USD. Motivation to deliver should be created by collection services, free handouts of "peepoo bags" or free access to the urban unit.
- 26 See chapter 8.2 for more on productive sanitation
- 27 See table on page 2 on cost benefit ratio
- 28 In terms of investment per user and compared to investment in low cost alternatives for the poor
- 29 Poor segments of the population do not have tap water and are more likely to use surface or river water that is polluted by untreated sewage from the rich sections of town with flush toilets.
- 30 <http://www.irinnews.org/Report.aspx?ReportID=91021>

- 31 More than 3,000 million liters of untreated sewage are discharged daily into the Ganga basin, according to Mamata Tomar, director of J M Enviro, a company that has completed over 60 pilot projects over the past five years in India. www.downtoearth.org.in/node/734
- 32 Haiti Cholera outbreak was caused by UN Peace Keepers dumping sewage into a river. Investigation news report from Al Jazeera: <http://www.youtube.com/watch?v=gk-2HyQHUZ0> + <http://www.rnw.nl/english/bulletin/haiti-cholera-outbreak-came-un-camp>
- 33 "The affected students could have taken contaminated water from boreholes in their institutions or water pans back at home. Many locals have been admitted with the same ailment." <http://www.irinnews.org/Report.aspx?ReportID=88577>
- 34 Urban slums visited by author 2010 in Nairobi, Kampala and Maputo has reported this happening regularly after rainfall.
- 35 Production of 1 kg of nitrogen based industrial fertilizer will give emissions of 6 kg CO2 during production. (EU average)
- 36 United Nations Conference on Trade and Development + United Nations Environment Program report "Organic Agriculture and Food Security in Africa" http://www.unctad.org/en/docs/ditcted200715_en.pdf
- 37 Systems that do not separate urine and solids can also be reused in a safe way, but treatment costs can be higher since the safe part of human excreta (urine) is contaminated by the pathogens in the solids.
- 38 Source of Sanitation Ladder: United National Environmental Program (UNEP)
- 39 A pit latrine in rural areas on soil that prevents contamination of groundwater – reuse takes place by planting a tree when latrine is full. This is not suitable in an urban context, in areas with a high water table or areas prone to flooding.
- 40 SuSan Design has, in collaboration with researchers at the Swedish University of Agricultural Science, developed the first large scale prototype for this process that will store faecal matter for 4 weeks at a minimum temperature of 20°C (68° F), ensuring pathogen reduction to insignificant concentrations.
- 41 Ramani & Kang 2009
- 42 *Ascaris lumbricoides* is the giant roundworm of humans. An ascarid nematode, it is responsible for the disease ascariasis in humans, and it is the largest and most common parasitic worm in humans.
- 43 Brooker et al. 2009
- 44 Nordin et al. 2009a
- 45 Jenkins et al. 1998; Nordin et al. 2009b
- 46 SuSan Design has tested a home unit urinal for women and their families in an urban slum of Nairobi in 2010
- 47 The European Union financed the ECOSAN project that was implemented from 2006-2009 by CREPA (Regional Centre for Low-cost Water and Sanitation), GTZ (German Technical Cooperation) and ONEA (National Water and Sanitation Authority). The project is active in four of Ouagadougou's thirty urban sectors, where many urban agriculture activities take place.
- 48 NPK is the chemical abbreviation for Nitrogen Phosphorous and Potassium based fertilizer.
- 49 See Bonzi, 2008, for results
- 50 Costs do not include investment and depreciation costs for equipment, especially urine storage tanks. These costs need external funding.
- 51 Schroeder, 2010 (Urine market study by GTZ in cooperation with SuSan Design)
- 52 UNHABITAT, 2010
- 53 Rosemarin et al., 2008
- 54 Hutton et al. 2007
- 55 The units will also have income from user fees and sale of hygiene products, airtime and other suitable products making it a viable business.
- 56 Economic Impact of Sanitation in Asia – Summary of a four-country study conducted in Cambodia, Indonesia, the Philippines and Vietnam under the Economics of Sanitation Initiative (ESI), November 2007

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