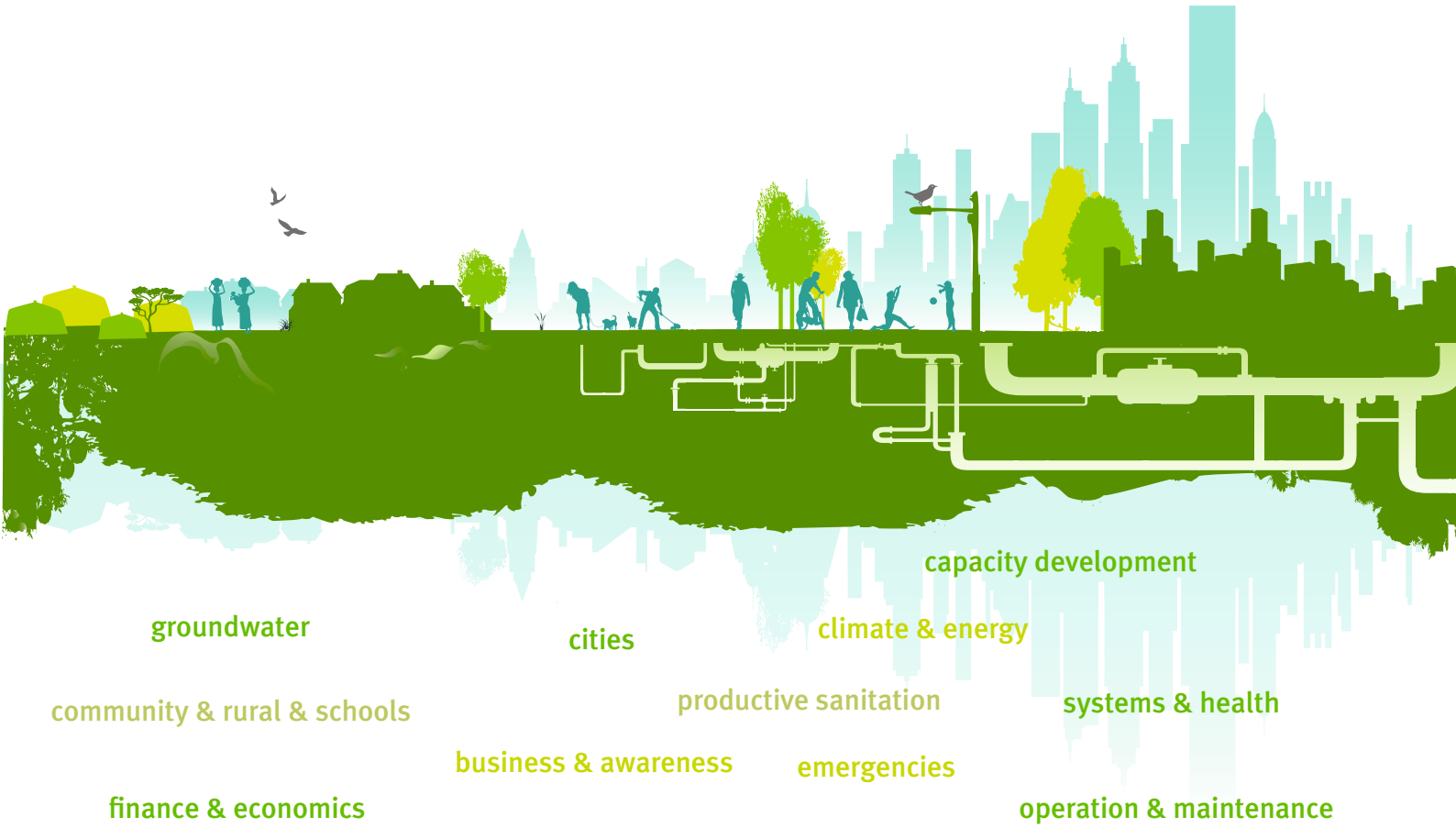

capacity development

groundwater

cities

climate & energy

community & rural & schools

productive sanitation

systems & health

business & awareness

emergencies

finance & economics

operation & maintenance

sustainable sanitation alliance

Compilation of 13 factsheets on key sustainable sanitation topics

sustainable sanitation alliance

Imprint

Published by:
Sustainable Sanitation Alliance
c/o Deutsche Gesellschaft für
Internationale Zusammenarbeit (GIZ) GmbH
Sustainable sanitation ecosan program
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Place and date of publication:
Eschborn, April 2012

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Design cover and schematic on page 9:
creative republic
Thomas Maxeiner Kommunikationsdesign, Frankfurt am Main
www.creativerepublic.net
(inspired by earlier design ideas by Rahul Ingle and Klaus Sattler)

Photos on back cover:
© Robert Gensch (Philippines), Peter Morgan (Zimbabwe), Laura Kraft (Kenya), Steffen Blume (Kenya)

Foreword

Sanitation remains one of the most pressing challenges that we need to tackle in order to allow humankind to live in dignity and free of threats from a contaminated environment. For this reason, I together with my colleagues of the UN Secretary General's Advisory Board on Water and Sanitation (UNSGAB) and many other partners and friends are continually lobbying for sanitation to receive higher visibility at the international level as well as more determined actions on the national and local level. We already know that we will not reach our goal at a global level to halve the proportion of those who do not have access to sanitation by 2015. Nevertheless, we need to keep trying. For this purpose, the UN Secretary General has launched the Sanitation Drive to 2015, which calls on all stakeholders, state or non-state, private or public to speed up, to double efforts and to end open defecation in order to solve the sanitation crisis for as many people as possible until the 2015 deadline.

What we need is a clear political commitment together with investments from public as well as private sources. But probably most importantly, we need creative ideas. We have seen over the past years that there are no "one-size-fits-all approaches" for designing sanitation systems for those most in need, for spreading and scaling-up good ideas, and for developing truly sustainable sanitation solutions, that look at the full sanitation chain and cater to human and environmental health alike.

This is where SuSanA comes in. For me, SuSanA represents a wonderful source of ideas and solutions for sustainable sanitation; as a unique network of experts from around the world, SuSanA is poised to develop, disseminate and implement those solutions to make sanitation access achievable, socially acceptable and affordable.

The core of SuSanA are its working groups, where experts get together on specific issues pertinent to sanitation ranging from technical questions around sanitation, such as sanitation systems, operation and maintenance, via governance aspects, such as planning, community involvement, to interconnected issues, such as renewable energy, climate change and food security.

I find SuSanA's holistic approach particularly appealing: looking not only at sanitation at the household level, but asking what does this mean for wastewater management; how are sanitation and food security interlinked? What benefits can be reaped from improved sanitation for developing a green economy, promoted as one of the outcomes of the Rio Plus 20 Conference? SuSanA's work shows that sanitation has a great potential to not only help realise the human right to sanitation and to bring dignity to billions of people, but to be so much more.

The wealth of this knowledge is contained in the factsheets prepared by the expert working groups and published in a compiled form for the first time. I congratulate SuSanA on this important publication and hope that the factsheets will contribute to making this important knowledge widely available.

Dr. Uschi Eid
Vice Chair – UN Secretary General's Advisory Board on Water and Sanitation (UNSGAB)

Preface and acknowledgements

This factsheet book is a compilation of 13 thematic factsheets which were produced by the eleven SuSanA working groups. What makes these factsheets special is that they are multi-authored by people from different organisations and by free-lance consultants. The factsheets were developed in a long process involving many discussions and review loops which were mostly carried out in public, e.g. at working group meetings, with the working group mailing lists or, since July 2011, also in the open SuSanA discussion forum.
http://forum.susana.org/forum/categories/6-susana-working-groups

The SuSanA working groups were established in 2007 in order to cover a variety of different thematic aspects of sanitation and to increase the understanding and knowledge exchange about these aspects. They are a platform for experts and interested individuals to share and exchange their knowledge on specific aspects of sanitation. We invite you to join the pool of experts and contribute to the discussions by joining some of the SuSanA working groups.
www.susana.org/working-groups

We thank all the authors and contributors to these factsheets who have often volunteered their own private time, outside of their normal work commitments, to work on this. Their names are given on the following pages.

I also wish to thank my team at the SuSanA secretariat – which is hosted by GIZ in Germany – who were part of this factsheet compilation process since July 2011 and who have helped to raise the quality of the factsheets to a consistently high standard, in terms of content as well as layout: Enno Schröder, Martina Winker, Philipp Feiereisen, Christian Rieck, Doreen Mbalo and Bismark Yeboah. Special thanks are due to Leonie Kappauf and Rahul Ingle from my team who worked on numerous factsheets and the layout, as well as to Trevor Surridge who proof-read the entire compilation and gave detailed critical feedback on each factsheet. We are also grateful to Sunder Subramanian, a SuSanA member from India, for writing the first version of the executive summary.

If you spot any errors or omissions in this factsheet book please e-mail us at *susana@giz.de*. The individual factsheets and this book are available on the SuSanA website. *www.susana.org/library*

Dr. Elisabeth von Münch

On behalf of the SuSanA secretariat
Located at GIZ, Eschborn, Germany
Eschborn, April 2012

partner of
sustainable
sanitation
alliance

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WG 10: Operation and maintenance of sustainable sanitation systems

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WG 11: Sustainable sanitation and groundwater protection

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Executive summary

The target audience for this document includes a wide range of readers who are interested in aspects of sustainable sanitation and their links with other environmental and development topics. Possible readers include practitioners, programme managers, engineers, students, researchers, lecturers, journalists, local government staff members, policy makers and their advisers or entrepreneurs. The emphasis of this document is on developing countries and countries in transition.

The Sustainable Sanitation Alliance (SuSanA) is a loose, informal network of organisations such as NGOs, private companies, governmental and research institutions as well as multilateral organisations that aim to contribute towards achieving the Millennium Development Goals (MDGs) by promoting sustainable sanitation.

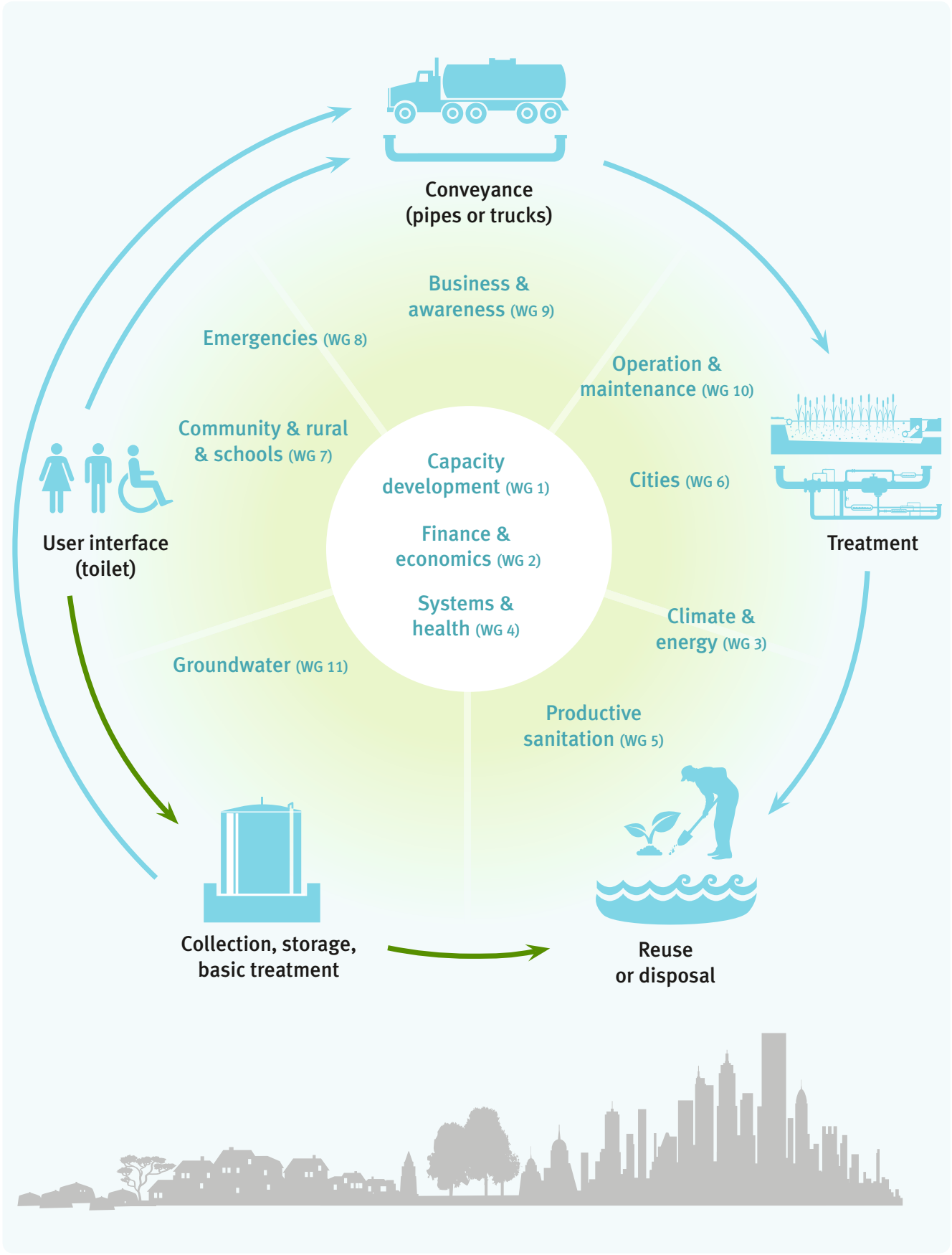
Sanitation generally refers to the provision of facilities and services for the safe disposal of human excreta and domestic wastewater. Personal hygiene practices like hand washing with soap are also part of sanitation. Sanitation also includes solid waste management and drainage but these two aspects are not the focus of this publication. In order for a sanitation system to be sustainable, it has to be economically viable, socially acceptable, technically and institutionally appropriate, and protect the environment and natural resources.

SuSanA contributes to the policy dialogue towards sustainable sanitation through its resource materials and a lively debate amongst the members during meetings, in the working groups, bilaterally, through joint publications and via various communication tools like the open online discussion forum. This publication showcases the broad knowledge base and state of discussions on relevant topics of sustainable sanitation. All of the working groups have published one or two factsheets providing a broad guidance relating to their specific thematic area.

The 11 working groups of SuSanA have the following titles:

WG 1 Capacity development
WG 2 Finance and economics
WG 3 Renewable energies and climate change
WG 4 Sanitation systems, technology, hygiene and health
WG 5 Food security and productive sanitation systems
WG 6 Sustainable sanitation for cities and planning
WG 7 Community, rural and schools (with gender and social aspects)
WG 8 Emergency and reconstruction situations
WG 9 Sanitation as a business and public awareness
WG 10 Operation and maintenance
WG 11 Groundwater protection

Due to the inter-relationships between the working groups, the factsheets are inter-related and where appropriate, are cross-referenced. The factsheets relate to different parts of the "sanitation chain", which consists of user interface, conveyance, collection/storage, treatment, reuse or disposal. We have attempted to visualise the linkages between the different working groups and the sanitation chain in *the following schematic*. There are some working groups which are dealing with overarching themes and these have been placed in the centre of the schematic.



Schematic to indicate how the 11 working groups of SuSanA relate to the sanitation chain and to each other.
In brackets are the numbers of the respective working groups.

Key messages of each factsheet are provided below:
Factsheet of WG 1 on "Capacity development for sustainable sanitation" provides an overview on basic principles of capacity development and addresses current challenges and gaps in capacity development for sustainable sanitation, as well as possible strategies and instruments to address those. Furthermore it contains a list of examples and contact details of capacity development initiatives from the sector. The key messages are:

- Capacity development for sustainable sanitation requires cross-sectoral cooperation with individuals and within organisations from health, infrastructure, water, environment, agriculture, education, economic development etc.
- It considers the complexity of sanitation systems and takes place along the sanitation chain, considering all technical, financial, social and institutional aspects.
- It includes a variety of methods: education, professional training, support for documentation of appropriate local infrastructure and sharing knowledge in print, online and multi-media.

Factsheet of WG 2 on "Financial and economic analysis" introduces concepts of costs and economics in connection with sustainable sanitation, and describes the application of and differences between financial and economic analyses. It provides an overview of analytical approaches for comparing sanitation interventions, and illustrates these approaches using evidence from existing studies. The main focus is to provide a basis for financial decisions concerning the scaling up of sanitation services. The data generated by financial and economic analyses have major implications for the programming and design of sanitation projects.

Factsheet of WG 3 on "Links between sanitation, climate change and renewable energies" argues that sustainable sanitation projects can contribute to both climate change mitigation (through energy or nutrient recovery) and to climate change adaptation (through innovative sanitation systems and wastewater management). Measures for renewable energy production consist of either biogas production from wastewater or biomass production through the use of wastewater to grow short rotation plantations for firewood. Measures of nutrient recovery are primarily based on nitrogen reuse. Adaptation measures in the area of sanitation aim at coping with increasing water scarcity or flooding.

Factsheet of WG 4 on "Sanitation systems and technology options" highlights the fact that with so many innovations and existing technologies for different settings, difficulties with knowledge dissemination hinder informed decision making and the integration of all sanitation elements with each other and the water and nutrient cycle. This factsheet makes a plea for a sanitation system approach where technologies are categorised based on their "product-process" characteristics and then linked into logical systems using a "flowstream" concept. This method for organising and defining sanitation systems helps facilitate informed decision making and consideration of an integrated approach. By using the sanitation system and its technology configurations other aspects can be further highlighted such as the inherent implications for operation and management, business and management models, service and supply chains, possible involved stakeholders, and finally the associated health risks by exposure of different groups of people to waste products.

Factsheet of WG 5 on "Productive sanitation and the link to food security" provides information on the link between sanitation and agriculture as well as related implications on health, economy and the environment. It shows examples of treating and using treated excreta and wastewater in food production and describes the potential for urban agriculture and resource recovery in rural areas thereby contributing to food security and helping to reduce malnutrition. Institutional and legal aspects, business opportunities and how to manage associated health risks are also discussed. Productive sanitation is the term used for the variety of sanitation systems that make productive use of the nutrient, organic matter, water ansedd energy content of human excreta and wastewater in agricultural production and aquaculture. The implementation and scaling-up of productive sanitation systems is inhibited by weak, non-existing and sometimes prohibiting legislation. It is therefore necessary to develop relevant legislation along the sanitation chain taking into consideration the type of crops, occupational health, food hygiene and other preventive and risk management measures.

Factsheet of WG 6 on "Planning of sustainable sanitation for cities" deals with the planning of sustainable sanitation for urban and peri-urban areas to achieve comprehensive and inclusive sanitation coverage in cities. It elaborates on the shortcomings of supply-driven planning and presents three demand-led approaches which recog-

nise that stakeholder involvement is a prerequisite to effective planning. Guiding principles for better sanitation planning in cities of developing countries are proposed. The key messages of this factsheet are:

- Recent innovations in sanitation planning include a more integrated planning approach; a greater emphasis on the actual needs and financial capacity of the users, close consultation with all stakeholders and a systems approach to sanitation, integrating all domains of the city.
- Improving sanitation coverage especially for the urban poor means tackling vested interests and corrupt practices of regulatory authorities, the private sector and politicians. Planning must openly deal with these issues and seek to increase incentives for anti-corrupt behaviours and to achieve greater transparency at community and city levels.

Factsheet of WG 7a on "Sustainable sanitation for schools" emphasises that schools should educate children and provide a healthy environment but are often unable to fulfil these obligations. This is mostly due to the lack of motivation and attention to sanitation and hygiene. Behaviour is typically formed during childhood and therefore education and learning life-skills on health and hygiene in schools are vital to improving conditions of people's lives from childhood to adulthood. The guiding principles for successful and sustainable school sanitation are:

- Creating demand through stakeholder involvement (demand-driven approaches) and identification of suitable sanitation technologies for local conditions including reuse options in school gardens.
- Monitoring outcomes, impacts and processes, including health and hygiene assessments, school attendance and usage of facilities.
- Establishment of an enabling environment with relevant government ministries through the development of guidelines and standards, legislation and enforcement and sufficient budget provision.

Factsheet of WG 7b on "Integrating a gender perspective in sustainable sanitation" is based on the premise that access to safe sanitation is a basic human right for all women, men and children. Integrating gender in sanitation requires comprehensive information about the gender specific local context provided by assessments such as socio-economic analyses and impact assessments of policies and programmes on females. Key messages from this factsheet are:

- Gender equality is an integral part of sustainable sanitation meaning that the sanitation system should consider the differing needs and should be suitable for women, men and children. Females are often involved in water, hygiene and sanitation but lack support to deal with these issues.
- There is a widespread lack of suitable sanitation facilities compounded by a lack of privacy. This increases female vulnerability to violence and impacts their health, well-being and dignity.
- The special needs of menstruating females need to be considered in appropriate sanitation programme designs by providing adequate female hygiene materials, discreet disposal and washing facilities.

Factsheet of WG 8 on "Sustainable sanitation for emergencies and reconstruction situations" emphasises that to reduce the risk and potential effects of disasters, sanitation solutions need to be robust to buffer against certain challenging environments. In emergency situations, groups with specific needs need to be considered (i.e. children, women, elderly, injured and people with disabilities) and appropriate emergency relief measures for each stage of an emergency situation need to be selected. The factsheet recommends the following to the actors in the emergency and reconstruction sectors:

- When implementing immediate sanitation solutions, apply those which can be adapted in later phases to become more sustainable.
- In between emergencies incorporate risk reducing measures in local and urban planning which will prevent and reduce the need for response efforts.
- Engage in learning activities, and experiment together with other professionals to increase innovation of options.

Factsheet of WG 9a on "Sanitation as a business" illustrates activities that can create revenues for investors and local entrepreneurs and also highlights some of the challenges in delivering sustainable sanitation services to the poor. The key messages of this factsheet are:

- Sanitation can be a viable business opportunity and has the potential to provide multiple benefits to the poor. Market-based approaches seek to address the challenges of financial sustainability and to strengthen the role of the private business sector while empowering local communities and individuals to make their own informed decisions about obtaining sanitation products and services.
- The challenge is still to identify effective, scalable, and sustainable sanitation solutions with economic potential and to allocate investment capital and funding to implement these solutions on a large scale.

Factsheet of WG 9b on "Public awareness raising and sanitation marketing" highlights the importance of public awareness raising and sanitation marketing to increase the efficiency and sustainability of sanitation improvements. Four key approaches to awareness raising include (i) raising overall public awareness, (ii) professional marketing of sanitation to those lacking access, (iii) stimulating private sector interest in the sanitation market, and (iv) advocating to decision makers in the public, private and civil sectors. The twin fields of awareness raising and sanitation marketing lay the groundwork for successful advocacy and highlight business opportunities in sanitation. These approaches, moreover, make it possible to scale-up and increase the efficiency of current efforts towards improved sanitation for all.

Factsheet of WG 10 on "Operation and maintenance of sustainable sanitation systems" is based on the understanding that effective and efficient operation and maintenance (O&M) is crucial for the sustainable implementation and long-term functioning of sanitation systems. However, issues related to O&M services are often neglected in the design and set-up of sanitation systems and thus non-functioning O&M services are a widespread challenge. The guiding principles for the design of sustainable O&M services are:

- The level of O&M is closely linked to ownership of a facility and the basic understanding of the technology and its functions.
- Clearly defined roles and accountabilities as well as appropriate support and training are essential for the management of O&M services.
- Institutional responsibilities as well as effective mechanisms for cost recovery are needed to ensure sustainable O&M.

Factsheet of WG 11 on "Sustainable sanitation and groundwater protection" stresses that groundwater quality and sanitation are often linked. Pollution of groundwater from unsafe sanitation systems can include pollution by nutrients, pathogens and organic micro-pollutants (including emerging contaminants). Key messages of this factsheet are:

- Land-use planning plays an important role in protecting areas that are vulnerable by restricting the use of these areas.
- Accessible and safe sanitation and good groundwater quality are critical elements for sustained growth in developing countries that require policy and legal support systems to remain effective. This includes developing educational curricula (focussing on groundwater and sanitation) as well as institutional capacity building programmes at all political levels of government.

sustainable sanitation alliance

SuSanA factsheet

Capacity development for sustainable sanitation

April 2012

1 Summary

This factsheet provides an overview on basic principles of capacity development and addresses current challenges and gaps in capacity development for sustainable sanitation, as well as possible strategies and instruments to address those. Furthermore it contains a list of examples and contact details of capacity development initiatives from the sector. The factsheet is intended for individuals who require or are engaged with capacity development for sustainable sanitation.

The key messages are:

- Capacity is knowledge, information, and attitude.
- Capacity development is the process of unleashing, strengthening, creating, adapting and maintaining capacity over time. It takes place on three levels: individual, organisational and enabling environment. An enabling environment encourages sustainable sanitation thinking and action at local and national levels, which is necessary for policy development.
- Capacity development for sustainable sanitation requires cross-sectoral cooperation with individuals and within organisations from health, infrastructure, water, environment, agriculture, education, economic development etc.
- It considers the complexity of sanitation systems along the sanitation chain (from the user interface, collection, treatment, reuse and safe disposal of sanitation products), considering all technical, financial, social and institutional aspects.
- It is an internal process of change led by communities and nations.
- It insists on knowledge sharing and management and involves development, transfer and use of both explicit and tacit (undocumented) knowledge.
- It includes a variety of methods: education, professional training, support for documentation of appropriate local infrastructure and sharing knowledge in print, online and multi-media.

2 Background

The Millennium Development Goals (MDGs) aim to achieve poverty reduction and sustainable development. The target for water supply and sanitation services is to halve the proportion of people without access to safe drinking water and basic sanitation by 2015. Although extending safe sanitation facilities is neither prohibitively expensive nor technologically unattainable, progress on sanitation actually slowed according to the 2010 report of the Joint Monitoring Programme of UNICEF and WHO.

Sanitation protects and promotes human health by maintaining a clean environment and breaking the cycle of diseases. Sustainable sanitation is far more than toilet availability. Toilets are part of a system that should be economically viable, socially acceptable, and technically and institutionally appropriate. Moreover, sustainable sanitation should also protect the environment and natural resources. This definition results in five key criteria for sustainable sanitation (SuSanA, 2008): a) protection of human health; b) protection of the environment and natural resources (including water resources, ecosystems, fuel wood, etc.); c) viable technologies and operations; d) financial and economic sustainability; and e) socio-cultural acceptability and institutional appropriateness.

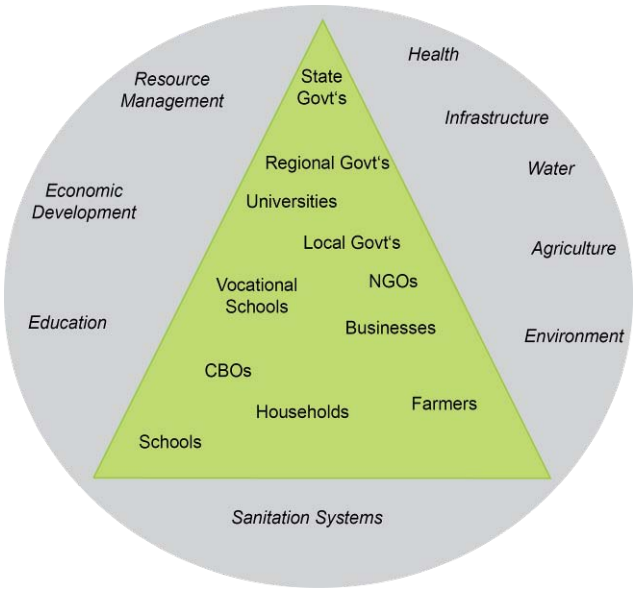


Figure 1: Capacity building takes place at individual, organisational and at the level of an enabling environment. It requires a trans-sectoral approach to health, infrastructure and water, environment, agriculture, and education (source: seecon GmbH).

The Sustainable Sanitation Alliance (SuSanA) is a network of organisations that share a common vision on sustainable sanitation. Since 2007, SuSanA has served as a platform for exchange, coordination and policy dialogue and a catalyst for sustainable sanitation. SuSanA Working Group 1 concentrates on capacity development, which is widely recognised as a prerequisite for the achievement of the MDGs (Bos, 2006; Morgan, 2005).

In the field of sustainable sanitation, capacity development is particularly important due to system complexity and the various sectors and authority levels involved. Governments and decision makers need to be aware of the importance of sanitation and the benefits of sustainable sanitation in order to show leadership and allocate the resources necessary. Leadership involves coordinating different governmental and non-governmental institutions to create an enabling environment across sectors - health, infrastructure, water, environment, agriculture, and education. Institutions and organisations, local governments, planners and the private sector need technical and managerial capacities in order to implement sustainable sanitation within allocated resources. At the same time, the civil society needs to show a demand for sustainable sanitation to ensure that sanitation is put on the local political agenda and to activate the private sector to respond to this demand.

3 What is capacity development?

Although capacity building is promoted as central to development, people everywhere struggle to explain exactly what it is (Bos, 2006; Morgan, 2005). The past decade has witnessed a resurgence of interest in capacity development and with it the redefinition of the concept. Whilst the traditional view of capacity development was based on technical training and foreign expertise, today's approach captures the concept in its complexity and entirety.

For the SuSanA Working Group 1, capacity is the collective actions of groups of individuals, organisations and societies that possess as a whole a collection of specific abilities, which enable them to manage their affairs successfully (Bos, 2006; OECD, 2006).

In a more practical sense, capacities can also be described as knowledge, information, and attitudes (Bos, 2006). Capacity development is the process in which these groups unleash, strengthen, create, adapt and maintain their capacity over time (OECD, 2006). This implies that (Morgan, 2005):

- Individuals have personal abilities, attributes, or competencies that contribute to the performance of an organisation or a system;
- Organisations or broader entities have capabilities to do something (the building blocks of an organisation's overall capacity to perform);
- Organisations or entities try to connect these competencies and capabilities into a coherent combination or system that allows them to perform.

Inside the boundaries of an organisation or a network of organisations, capacity is shaped and influenced by the context: capacity development takes place in a broader, dynamic institutional and socio-economic context. Both planning and implementation of capacity building interventions need to take account of external influences on the context within which organisations operate. Capacity obviously depends not only on the individuals and the organisations in which people work but also on the broader environment of these organisations including the institutional framework and the structures of power and influence (OECD, 2006).

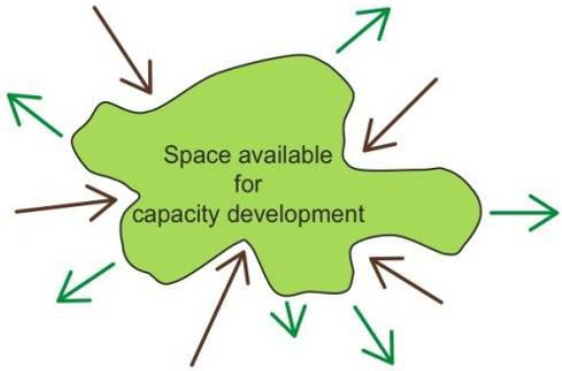


Figure 2: It is important to identify factors that enable capacity development (green outward arrows) and factors which block it (black inward arrows).

According to the above described spheres of capacity development, there are three levels on which to pursue capacity development objectives (OECD, 2006):

1) The individual level: people having abilities and competencies.
2) Organisational or institutional level: individuals make up organisations and institutions; the sharing of skills, knowledge, experience and values amongst the individuals will translate into the organisation's capacity, consisting of procedures, systems, policies and culture.
3) The enabling environment: incentives, policies and governance influence the behaviour of organisations or institutions and individuals.

These three levels of capacity development are equally important and interdependent. This implies that capacity development interventions at one level are likely to have an impact on other levels as well. Successful efforts to promote capacity development lead to:

- Increases in the knowledge and skills of individuals - the "micro" perspective (Baser and Morgan 2008);
- Enhancement of the quality of the organisations in which they work (organisational procedures);
- Creation of an enabling environment (e.g. the incentives, policies and governance influencing the behaviour of the organisations – the "macro" perspective).

4 Principles of capacity development in sustainable sanitation

Without developed capacity there is limited exchange and transfer of knowledge; inefficient use of available resources; poor service delivery, second-rate performance; inadequate infrastructure, that is poorly adapted to the local context and insufficient maintenance.

There are five key requirements for capacity development for sustainable sanitation:

- A multi-disciplinary approach with attention to the various social, political and institutional, environmental, technical and financial dimensions.
- A trans-sectoral approach.

- Attention along the entire sanitation chain – from the user interface, collection, treatment, reuse and safe disposal of sanitation products.
- Action at all three analytical levels: individual, organisational and enabling environment.
- Inclusion of local and national actors from civil society, the private sector and the government.

a) Capacity development at individual and the institutional levels

Local governments need capable sanitation engineers, health extension workers, policy makers, managers, and operators to plan and manage technical infrastructure and to adapt projects and programmes to the local context. A sound understanding of the whole sanitation system is crucial so that collaborating experts in health, infrastructure, resource management, agriculture and economic development can work effectively together.

Professionals form most of their ideas during their training. Education and training programmes in universities, technical schools and research institutes need to include sustainable sanitation in their curricula, develop appropriate materials, and serve as regional resource centres. Similarly NGOs, CBOs and local, regional and national governments can compile information on sustainable sanitation, share it with staff and organise workshops for professionals.

At the same time, understanding of local perceptions, needs and preferences facilitates efficient social marketing and demand creation. Information of end-users together with the practical training and access to financing opportunities for small businesses can activate the local private sector. User demand also helps integrate sustainable sanitation in local agendas.

b) Creating an enabling environment

Sanitation often lacks an “institutional home” because of its multi-disciplinary and trans-sectoral character. Governments commonly deal with different aspects of sanitation systems in several ministries; this hampers coordination, strategic planning and financing of capacity development.

Sustainable sanitation has to be integrated in key national policies, technical guidelines, sub-national guidelines and thematic strategies to stimulate good governance and political leadership. This will lead to ownership, participation and allocation of financial means. Thereby, the preparation of strategies and guidelines has to be part of an internal process of change (OECD, 2006). Furthermore, incentives for regional governments and private sector organisations can help to create an enabling environment. Information of the benefits of sustainable sanitation in the local language fosters the process of creating an enabling environment and supports the national government to do a good job. Thus busy government officials working with tight budgets can be provided with key arguments for sustainable sanitation. Local drivers for sustainable sanitation such as health or food security can be identified and included in the information.

5 Strategies and Approaches

Capacity building is neither an output nor project but a continuous process (Bos, 2006). It is important to develop strategies according to the specific level (individual, organisational, enabling environment) and the domain (knowledge and information, skills, and attitudes) of the capacity being built.

Organisations may have the following strategies and approaches:

- Assess gaps in capacity within a country and support planning, implementation and monitoring of performance for capacity development within the country.
- Consider a country-led approach and build on internal processes by identifying local drivers for sustainable sanitation (e.g. groundwater pollution, food security, etc).
- Adapt language and means of communication to the local context.
- Create strategic partnerships between different actors e.g. businesses, local governments and institutions that are actually implementing capacity development such as knowledge sharing and training.
- Focus on relationships between the enabling environment and other levels to align training and development of individual skills with organisational reforms and institutional changes.
- Increase awareness of sustainable sanitation through the media and special events, such as the World Toilet Day on 19 November each year.

6 Instruments

Education: Educational institutions need to acknowledge the importance of sustainable sanitation and incorporate this interdisciplinary topic into teaching curricula.

Training: Professional engineers, policy makers, managers and operators working in the field can be trained in special courses, workshops, seminars, and on the job training.

Research and documentation: It is important to document research, pilot projects and examples of scaling-up in the ongoing process of capacity development.

Knowledge and information management and sharing: The transfer and exchange of knowledge is a precondition of capacity development. Different users respond to different types of information and channels. New media on the internet make it possible to share and exchange knowledge much more easily. Academic books and journal articles require purchase but usually information is more carefully reviewed than that freely available online. Compiling and making relevant information accessible fosters capacity development. Universities and schools should be equipped with the skills to enable them to share and manage knowledge. Institutions that manage knowledge consistently are better poised to meet the ever-changing management and development challenges. Networks and learning alliances play a major role in improving knowledge sharing and management.

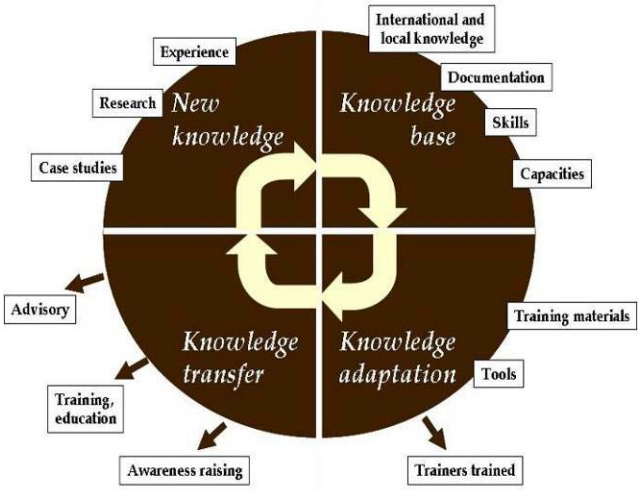


Figure 3: Knowledge management is the continuous process of generating new knowledge or repackaging old knowledge; of creating a knowledge base; of knowledge adaptation; and of knowledge transfer (source: Cap-Net, 2004).

Box 1: Knowledge management nodes funded by SEI

In 2006 the Swedish Development Cooperation (SIDA) and the Stockholm Environment Institute (SEI) launched Phase 2 of their EcoSanRes Programme (2006-2011). The main intention of the initiative was to promote pro-poor sustainable sanitation through capacity building and knowledge management. The programme therefore facilitated the establishment and development of "nodes of expertise" ("knowledge nodes") that have conducted regional projects dealing with awareness raising, training, policy and regulation reform, R&D, testing and development, demonstration and social marketing. The programme has established eight knowledge nodes; one in the Philippines, China, Nepal, Southern Africa, Uganda, Burkina Faso, Central America and Bolivia. The nodes have been hosted by renowned research and knowledge management institutions and set the programme content and priorities for their respective regions individually. The knowledge dissemination and capacity development activities in the knowledge nodes have so far resulted in national policy changes in the Philippines, Honduras, El Salvador, Bolivia and Uganda and at a regional policy level the Manila Declaration was initiated. Although the funding for the nodes only lasted for about two years and stopped in mid 2011, SEI is still collaborating with all nodes and is planning to continue to support the node structure. Also, the nodes have brought and continue to bring financing and capacity to their hosts.

Further information: www.ecosanres.org

7 SuSanA partners in capacity building

Conventional capacity building and North-South knowledge transfer have proven inadequate for scaling up sanitation innovation. A number of SuSanA partners, however, have acted strategically and pioneered a variety of promising approaches. The list of examples that follows is not complete. A similar list, which is continuously updated, is available on the SuSanA website: www.susana.org.
The SuSanA secretariat welcomes corrections or additions to this list (info@susana.org or susana@giz.de).

a) Reference centres and knowledge nodes

Water Research Commission (WRC), (www.wrc.org.za/Pages/KnowledgeHub.aspx): South African knowledge hub offers research reports, technical and policy briefs, and magazine articles on water resource management, including agricultural water use, drinking water, wastewater, and water for mining, and sanitation. Formerly hosted the SADC Node for Sustainable Sanitation (SAKNSS) (www.afrisan.org); which offered learning events and study visits, a stakeholder database, case studies and publishes regional *Sanitation Matters* magazine.
Contact: Ditshego Magoro (ditshegom@win-sa.org.za)

African Regional Centre for Water and Sanitation (CREPA), (www.reseaucrepa.org): Intergovernmental organisation with 18 member states in West and Central Africa; training courses and practical experience in various technologies and reuse.
Contact: reseaucrepa@reseaucrepa.org)

NETWAS, (www.netwas.org): Hosts former Ugandan knowledge node; organises training and field demonstration of ecological sanitation (ecosan) installations; has influenced national sanitation strategy.
Contact: Cate Nimanya (netwasuganda@gmail.com)

ENPHO (Environment and Public Health Organization) (www.enpho.org/resource-center.html): Resource centre in Nepal; collects, stores and disseminates information for education and advocacy on the environment and public health; offers consultancy services.
Contact: Bushan Tuladhar (bushan.tuladhar@gmail.org)

Centre for Advanced Philippines Studies (CAPS), (www.caps.ph): Knowledge node of SIDA-founded EcoSanRes programme; secretariat of the Academic Consortium for Sustainable Sanitation (ACSuSan); offers formal and non-formal courses; has physical library and web database.
Contact: Dan Lapid (danlapid@caps.ph)

Asociación Centro Ejecutor de Proyectos Económicos y de Salud (ACEPESA), (www.acepesa.org): One of the first established knowledge nodes for Central America; based in Costa Rica; supports implementation of integral solid waste management systems based on models of communal micro-enterprises; offers online courses.
Contact: Victoria Rudin (vrudin@acepesa.org)

Regional Water and Sanitation Network of Central America (RRASCA) and the National Water and Sanitation Networks of El Salvador, Guatemala, Honduras and Nicaragua; have contributed to national guidelines for sustainable sanitation and to streamlining of gender equity in projects; helped introduce sustainability criteria in water and sanitation development plans in Honduras and Nicaragua.
Contact: Gloria de Avila (gavila.rases@gmail.com)

Netherlands Development Organization (**SNV**): La Paz office hosts Bolivia knowledge node directed by the national sanitation collaboration platform for local, regional, and national government entities (DINESBVI, sites.google.com/site/dinesbvibolivia/); recently contributed to national guidelines on ecological sanitation and gender equality in water and sanitation; introduced ecological sanitation into the university curriculum; supports eight demonstration projects.
Contact: Eduardo Quiroz (equiroz@snvbo.org)

b) Research institutions or degrees at universities

Xavier University (XU) Sustainable Sanitation (SUSAN) Center; in the Philippines, (www.susancenter.xu.edu.ph): Targets local governments, NGOs, practitioners and academia; research, training, and consultancy services for Southeast and South Asia. Sustainable sanitation is part of engineering curricula; research agendas and includes the use of urine as fertiliser, public health implications of dry sanitation and treatment methods including terra preta sanitation. Also offers training modules, based on the Sustainable Sanitation and Water Management (SSWM) Toolbox; courses in agricultural reuse of urine and faeces; low-cost dry toilet construction; development of urban sustainable sanitation plans; awareness raising and behaviour change strategies; and terra preta sanitation.
Contact: Annaliza Miso (annamiso1980@googlemail.com)

University of Science and Technology in Beijing, China, (www.en.ustb.edu.cn): Offers MSc in Environmental Sanitation; established the Centre for Sustainable and Ecological Sanitation (www.susanchina.cn) for PhD and Master students. Jointly hosts the China Node for Sustainable Sanitation (CNSS) together with the Clean Water Alliance.
Contact: Prof. Li Zifu (zifulee@yahoo.com.cn)

National Agricultural University in Peru, (www.agricolaunalm.edu.pe): Diploma course in "Department of Land Management and Sustainable Development" for sanitation and health professionals.
Contact: Rosa Miglin (rmiglio@lamolina.edu.pe)

CINARA: Research and development institution based at the Faculty of Engineering at Universidad del Valle in Colombia, (cinara.univalle.edu.co); recognized throughout Latin America in the water supply and environmental sanitation sector. Formerly hosted the Columbian knowledge management node.
Contact: (cinarauv@correounivalle.edu.co)

UNESCO-IHE Institute for Water Education (Delft, The Netherlands), (www.unesco-ihe.org): Annual online ecosan course for mid-career professionals from developing countries; addresses ecosan topics in engineering, architecture, planning, financing, and health; scholarships available through the Bill and Melinda Gates Foundation. An MSc degree in Sanitary Engineering and an additional online course in Faecal Sludge Management with the taught part completely carried out through online courses. An additional online course in Faecal Sludge Management are planned to be introduced in the near future.
Contact: Mariska Ronteltap, (m.ronteltap@unesco-ihe.org)

Sandec - the Department of Water and Sanitation in Developing Countries at Eawag: Internationally recognised competence centre with 30 years research in low- and middle-income countries; develops concepts and technologies using Eawag's multidisciplinary knowledge; main activities are applied research, teaching and training, and knowledge management; conducts courses at universities in Europe and the global South (e.g. 2iE in Burkina Faso, Makerere University in Uganda and AIT in Thailand); offers downloadable training tools also available on CD-Rom: (www.sandec.ch).

The Norwegian University of Life Sciences (UMB) is converting sanitary systems on the campus to source separating/recycling systems; offers a joint MSc programme in "Sustainable water and sanitation, health and development" together wth the **Tribhuvan University** in Nepal and **COMSATS University** in Pakistan; prepares a web based course: "Introduction to sustainable water and sanitation" (ready in August 2012). To apply see: www.umb.no/study-options for Norway; www.ioe.edu.np for Nepal and www.comsats.edu.pk for Pakistan.
Contact UMB: Prof. Petter D. Jenssen, (petter.jenssen@umb.no)

Tampere University of Technology (TUT), (www.tut.fi/en): Organises International Dry Toilet Conference every three years with Tampere University of Applied Sciences, the University of Tampere and Global Dry Toilet Organisation of Finland; offers an annual online course about sustainable sanitation with selected lectures from pre-conference workshops.
Contact: Tuula Tuhkanen (tuula.tuhkanen@tut.fi)

Vienna University of Natural Resources and Life Sciences (BOKU), Centre of Development Research (CDR) (www.boku.ac.at): Multidisciplinary network of scientists from various BOKU departments; conducts applied research and training in sustainable natural resource management; collaborates with partners in Africa, Asia and Latin America.

Kristianstad University in Sweden, (www.hkr.se/templates/Programme 5898.aspx): One year MSc in Sustainable Water Management; explores sustainable alternatives to flush-and-discharge approaches, decentralisation, nutrient recycling, and biogas production.
Contact: Lena Vought (lena.vought@hkr.se)

Linköping University, Swedish Institute of Infectious Disease Control, and Swedish University of Agricultural Sciences have developed the sourcebook "Sustainable Sanitation for the 21st Century" (http://www.sustainablesanitation.info): Intended for university training programmes for lecturers' use as well as for self-study; provides powerpoints commented in attached pdf files which can be combined with the trainer's own material.

Figure 4: Participants of SSWM Experts Training Course at the CHRDU Training Centre in Nagarkot, Bhaktapur, Nepal in 2010 interacting in group work (source: seecon GmbH).

c) Training courses for professionals

Sarar Transformación SC, (www.sarar-t.org): Multi-disciplinary Mexico-based consulting group; supports organisations in the region in sustainable sanitation; influences policy dialogue through strategic alliances with governmental organisations; offers regular training courses in sustainable development and participatory approaches. Contact: Ron Sawyer (rsawyer@sarar-t.org)

Sustainable Sanitation and Water Management (SSWM) Toolbox, (www.sswm.info): Open-source and quality-approved online capacity building tools that link up water management, sanitation and agriculture at the local level; can be used as teaching support as well as self-learning tool; designed as process and planning tool for planners; implementation tool for NGOs and practitioners; resource for leaders and decision makers; or learning tool for students; offers guided exercises to assess local problems, factsheets on hardware (technical solutions) and software (behavioural change), and project planning and implementation tools; includes supplementary readings, links, a library, glossary, ready-made PowerPoint and "train-the-trainers" materials; developed with support of SuSanA partners (www.sswm.info/content/partners) under the aegis of seecon.
Contact: (sswm@seecon.ch)

seecon International, (www.seecon.ch): Offers courses and training in sustainable sanitation and water management based on the **SSWM** Toolbox (www.sswm.info) acts globally; the portfolio includes basic to expert courses, hands-on training and training of trainers; innovative participatory learning in partnership with international and regional organisations.
Contact: (sswm@seecon.ch)

Linköping University, Swedish Institute of Infectious Disease Control, and Swedish University of Agricultural Sciences (see previous Section b.).

Ecosan Services Foundation, (www.ecosanservices.org): Based in Pune, India; provides training activities based on the Sustainable Sanitation and Water Management (SSWM) Toolbox; open source knowledge provider that works with a pool of private sector experts, NGOs, and research organisations; immense experience in developing urban sustainable sanitation plans; offers consulting services, including design of decentralised wastewater treatment systems.
Contact: (sreevidya.satish@ecosanservices.org)

Figure 5: Hands-on training in secondary composting at SIDA's International Training Programme in 2005 (source: SEI).

For further information on training courses see this SuSanA webpage (www.susana.org). For course materials from various courses see: www.susana.org/lang-en/conference-and-training-materials/materials-of-trainings.

d) Web-based libraries and Open Source Publications

SuSanA Library, (http://www.susana.org/lang-en/library): Has a large collection of materials on sustainable sanitation; SuSanA also provides a DVD with a large portion of library contents to those with slow internet connections.
Contact: (info@susana.org or susana@giz.de)

The **Sustainable Sanitation and Water Management (SSWM) Toolbox,** (www.sswm.info): Gives an overview of approaches and technologies in the water management and sustainable sanitation sector including both planning and implementation.
Contact: (sswm@seecon.ch)

International Water and Sanitation Centre (IRC), (www.irc.nl): Independent non-profit organisation based in the Netherlands that conducts research in areas where existing information is insufficient; works collaboratively with partners on literature reviews, advocacy meetings, publications and information sharing workshops, documents 40 years of sector progress, analysis and tools; provides direct access to ever-increasing number of documents; the database also contains externally-produced documents on sanitation at (www.irc.nl/page/116). Sanitation searches at online library: (www.washdoc.info/page/53887).

Water, Engineering and Development Centre (WEDC), (www.wedc.lboro.ac.uk/knowledge/know.html): Knowledge base maintained by Loughborough University, United Kingdom. Database of WEDC's own and other selected publications; available for registered users to download free of charge are WEDC's own resources, including 150 books, over 1700 conference papers and other key documents in pdf format.

Other Online Resources:

- www.giz.de/ecosan (with quarterly electronic newsletter in English and French)
- www.ecosanres.org
- www.sustainablesanitation.info/meny.html
- www.library.eawag-empa.ch and http://www.eawag.ch/forschung/sandec/training_tool/
- www.akvo.org and www.akvopedia.org/
- www.cap-net.org
- www.gwptoolbox.org
- www.grassrootswiki.org
- www.iwawaterwiki.org
- www.practicalaction.org/practicalanswers/
- www.genderandwater.org
- www.ecosan.at

e) E-mail discussion group, online forums, blogs, and newsletters

SuSanA Forum (www.forum.susana.org): Open discussion platform launched by the Sustainable Sanitation Alliance in July 2011; all postings are readable by everyone and searchable by search engines like Google; participants can create new topics, post queries, users may subscribe to receive email alerts.

Figure 6: Participants at the 13th SuSanA meeting in Kigali in July 2011 (source: SuSanA).

EcoSanRes email discussion group: Started by Stockholm Environment Institute (SEI) in 2001; registered members discuss technical questions, contacts, information on ongoing projects, funding opportunities and more (www.ecosanres.org/discussion_group.htm). Join the 800 member group via ecosanres website (www.ecosanres.org/discussion_group.htm) or directly via yahoo: tech.groups.yahoo.com/group/ecosanres/

Sanitation Updates: News feed jointly maintained by the International Water and Sanitation Centre (IRC) and USAID's WASHplus project; provides news, information and resources in support of the goal of sanitation for all (www.sanitationupdates.wordpress.com/).

IRC E-Source: WASH news and features in English, French and Spanish with an emphasis on rural and peri-urban areas in developing countries (www.source.irc.nl/).

Other web-based news and discussion:

- www.watersanitationhygiene.org (forum on water, sanitation and hygiene)
- www.assemblyonline.info (news service from Nigeria)

f) Learning alliances, communities of practice and networks

Sustainable Sanitation Alliance (SuSanA), (www.susana.org): Informal network of partner organisations sharing a common vision on sustainable sanitation; has served since 2007 as a coordination platform, a work space, a sounding board, and a catalyst; contributes to policy dialogue, conferences and events. Offers for example an extensive online library, a case study collection, and a partial copy of website on DVD; available are a vision document, a joint road map and factsheets authored by eleven thematic working groups and a discussion forum.
Contact: (info@susana.org or susana@giz.de)

Global Community of Practice for Sanitation and Hygiene: Initiative of the Water Supply and Sanitation Collaborative Council (WSSCC) launched in 2011 in response to sector demand for collaborative learning; global space for honest debate on sanitation and hygiene; platform for national-international and South-South exchange of successes, failures and lessons learned.

Cap-Net (Capacity Building for Sustainable Water Management), (www.capnet.org): UNDP programme that supports capacity development in water management towards achievement of the MDGs; global network made up of professional networks at country and regional levels and international partners; works with networks worldwide; seeks to expand reach, achieve on-the-ground impact and embed new knowledge into existing capacity building institutions.
Contact: (nick.tandi@cap-net.org).

Ecosanlac, (www.ecosanlac.org): Regional Latin America network of professionals and academics interested in ecological sanitation. Shares news of learning opportunities and organises events and conferences.
Contacts: Paula Paulo (ppaulo.ufms@gmail.com) and Ricardo Franci (franci@npd.ufes.br)

g) Video clips

New forms of digital media distribution allow widespread access to quality educational material. Educational films on sustainable sanitation worldwide are available on the SuSanA website: (www.susana.org/lang-en/videos-and-photos/resource-material-video) or on Youtube: (www.youtube.com/user/susanavideos).

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Acknowledgements are given to the following persons for their valuable contributions:
Philipp Feiereisen (GIZ, Germany), Halidou Koanda (WaterAid, Burkina Faso), Mariska Ronteltap (UNESCO-IHE, The Netherlands), Elisabeth von Muench (GIZ, Germany), Themba Gumbo (Cap-Net, South Africa), Nick Tandi (Cap-Net, South Africa), Sreevidya Satish (ESF, India), Christoph Luethi (Eawag/Sandec, Switzerland), Robert Gensch (Germany), Annaliza Miso (XU SUSAN, The Philippines), Bipin Dangol and Bushan Tudalhar (ENPHO, Nepal), Guenter Langergraber (BOKU, Austria), Tuula Tuhkanen (TUT, Finland), Katharina Conradin (Mountain Wilderness, Switzerland)

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sustainable sanitation alliance

SuSanA factsheet

Financial and economic analysis

April 2012

1 Summary

This factsheet introduces financial and economic costs and benefits in relation to sanitation systems. It provides an overview of analytical approaches for comparing sanitation interventions using financial and economic analyses and illustrates these using results from various studies. The target group of this factsheet includes sanitation practitioners, researchers, policy makers and their advisers. The main focus is to provide a basis for informed choice based on financial decisions concerning the scaling up of sanitation services.

Financial and economic analyses are a crucial part of feasibility studies assessing the benefits of improved sanitation and thus feed into policy decisions, sanitation programming and project design. The data generated by financial and economic analyses have major implications for the programming and design of sanitation projects, and are therefore crucial for the planning and delivery of affordable and sustainable sanitation services.

In order to assess the relative sustainability of sanitation options, a range if comparative studies need to be conducted to show the real costs and benefits of moving from unimproved to improved and more sustainable sanitation options.

A comparison of costs and benefits of different sanitation options using economic and financial analyses provides a justification for investments in sanitation in the first instance and enables decision makers to allocate limited resources more efficiently. Financial analyses only measure the costs and benefits that have direct and measurable financial implications, whereas economic analyses include all broader costs and benefits, including those that do not have financial implications. For instance the costs for premature mortality are economic rather than financial.

Capital expenditure (CAPEX), operational expenditure (OPEX) and capital maintenance expenditure (CapManEx) are the key parameters for both the financial and economic assessment of sanitation options. Important tools for financial and economic analysis include the cost-effectiveness ratio, Benefit-Cost Ratio (BCR), Net Present Value (NPV), or Internal Rate of Return (IRR). Key indicators for setting tariff structures and the assurance of affordability include: i) Full cost of sanitation per capita as a percentage of per capita GDP, ii) Cost of access to sanitation as a percentage of household income, iii) Annual cost of sanitation as a percentage of household income, iv) Long run marginal cost and cost of sanitation services as a percentage of water tariffs. Economic analysis can also be used to assess the cost benefit of investments in sanitation in relation to other types of development interventions.

2 Background

Financial investment costs are often stated as one of the major barriers to increasing sanitation coverage – next to the lack of political will. Therefore, it is important to know what cash sum is affordable for the beneficiaries (households, communities, schools) and which share has to be financed either by the government, through grants (subsidies), loans from banks, or in-kind contributions (Mehta, 2005).

Although improvements in sanitation are known to result in large economic benefit for society as a whole, the priorities of those who are responsible for investment, whether at the household, municipal or national government level, tend to set investment priorities differently, based on financial constraints and self-interest.

Figure 1: Excavations for a biogas digester in Livingstone, Zambia at a project of the Devolution Trust Fund (DTF) (source: P. Feiereisen, 2011)

Financial and economic analyses are key policy tools, which provide practical guidance on sanitation options, and can be used alongside other decision making frameworks such as multi-criteria analyses. These analyses enable assessment of intervention efficiency for different sanitation options and assist decision makers in maximising the return on limited financial resources available to sanitation programmes. Outputs of economic analysis can show the overall costs and benefits of improved sanitation compared to no or unimproved sanitation.

Financial and economic evaluation seek to provide further insight into the relative cost efficiency of different options –

not just one or two standard options, but the locally adapted range of feasible options – as a basis for an informed choice. The inclusion of all feasible options is of key importance to the process of informing decision makers and planners of the potential range of sanitation options in a single context.

Hence, financial and economic analyses need to provide the decision maker with specific information that helps to judge the real costs and sustainability of different technologies. This means not just knowing the purchase price or capital costs but also operation and maintenance (O&M) costs, and the associated additional (direct or indirect) benefits to the user such as health, comfort and protection of the local environment.

An assessment of the benefits of improved sanitation may be applied to the following activities:

a) Policy decisions

Results from an economic analysis can play an important role in influencing political decisions about the need to invest in improving sanitation (cost benefit analysis). Analyses of economic benefits can support sanitation advocacy efforts, with the aim of increasing political support and potentially household and community knowledge, leading to greater prioritisation of sanitation and hygiene.

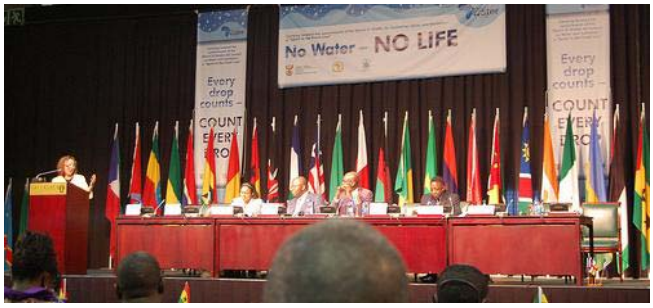

Figure 2: Uschi Eid (UNSAGB) giving a speech on the importance of sanitation in the plenary session of the Second Africa Water Week in South Africa (source: A. Panesar, 2009).

b) Sanitation programming

Economic analysis may also be required to justify the rationale for a project or programme in the first instance. On the basis that there is economic justification, financial analysis is used to compare long term costs of different alternative solutions (cost effectiveness) taking into account capital investment (CAPEX), operational and maintenance expenditures (OPEX) and capital maintenance expenditures (CapManEx).

c) Project design

Sound financial analysis is fundamental for good project design. To be able to appropriately cost a project within a given budget, engineers need to base estimates on accurate unit costs and have a clear understanding of the uncertainties surrounding data sets.

Clearly, financial and economic evidence has value for a range of target groups – groups that have different roles and levels of influence in decisions on choice of sanitation technology or programme implementation:

- *For those controlling budgets* for allocation to sanitation programmes the primary concern is for overall programme efficiency; including household, community and external benefits of improved sanitation. Also important to policy makers are the overall financing needs for different programme components and the different sources from which to finance these programmes.
- *For implementing agencies* concern will be not only the overall gains, but also the equitable distribution of the programme gains, and targeting of subsidies to poor and vulnerable groups.
- *For the ultimate beneficiaries* – the households – the interest will be on private benefits and the investment and running costs that must be covered by the household.

3 Financial analysis: elements and indicators

Financial analysis focuses on expenditures and revenue streams and considers subsets of data that are identifiable as financial transactions. Financial assessment of sanitation options considers capital expenditure (CAPEX), operational expenditure (OPEX) and capital maintenance expenditure (CapManEx).

To ensure sustainability, investors of sanitation systems such as utilities or local authorities need to consider the recurring costs for the operation and maintenance to ensure sustainability and not only the initial investment costs. In addition, there is a need to take into consideration service charges and other sources of revenue such as from the sale of by-products (e.g. treated wastewater for irrigation, compost or digested sludge, or electricity derived from biogas).The capital cost of different sanitation options is a very important variable for the decision whether to invest or not, and for the choice of technology. Households, in particular poor ones, are highly sensitive to price in their purchase decisions, especially for sanitation which is not usually a priority item.

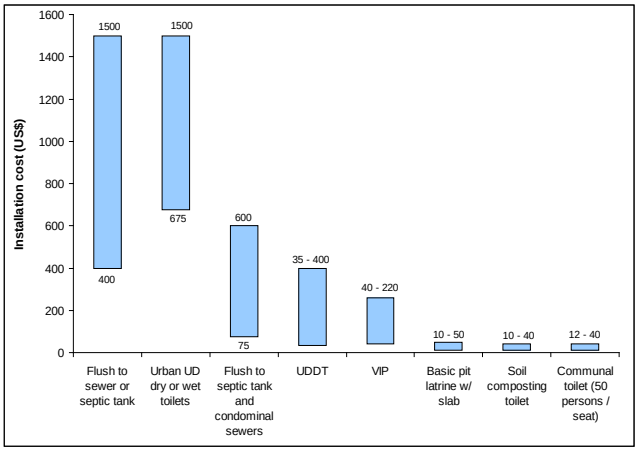

Figure 3: Example capital cost range for different sanitation options, per unit (source: Rosemarin et al., 2005). Note that most of these options do not cover the whole sanitation chain.

As shown in Figure 3, capital costs vary between different sanitation options, the project scale and even within one technology type **CAPEX** includes both hardware for

household and shared toilet facilities as well as costs for waste collection, transport and treatment facilities. CAPEX also includes labour and management overheads for planning, construction and works supervision.

OPEX costs are those that are required to sustain the operation and maintenance of a system or facility. These include day to day costs such as labour, fuel, cleaning materials, and costs for repairs OPEX costs include for example pit or vault emptying, a fee for the treatment costs of faecal sludge and for software components.

Software components targeting community acceptance and behaviour change are essential for the uptake, compliance and long-term sustainability of all sanitation systems. Therefore, costs for sanitation promotion and advocacy are important costs that also need to be included in the analysis. Costs of "software" include sanitation promotion and demand creation (e.g. social marketing), awareness and educational campaigns to promote improved hygiene and system use, and capacity development of stakeholders (such as training of artisans, operators and sanitation suppliers). These costs should be planned and fully budgeted for implementation of programmes on a larger scale; these costs should also be considered in the project design and in the OPEX.

CapManEx[1] are costs that cover all expenditures to reduce the chances of asset failure and ensure the same level of service delivery as existed after construction. This includes the renewing, replacement, rehabilitation or refurbishing of broken system such as replacement of pumps.

The decision about which data to include in the financial analysis depends upon the boundary for the analysis which will be determined by the purpose of the analysis and the target group (see above). The most important boundary is between the private and public domains, which defines the costs and benefits to be allocated to the household and those to be allocated to the project respectively. The project expenses include costs that are not incurred by households directly but are incurred by agencies or institutions responsible for promoting and implementing sanitation projects and programmes.

Given the range of sanitation stakeholders, there may exist different interpretations of the word "cost" and the forms of cost presentation. Households are naturally interested in the costs of a single sanitation option as it relates to their particular household, including only the components they actually have to pay for. Therefore, a disaggregation of household and third party costs is useful to be able to account for these different perspectives:

- *Households* - at the time of investment (e.g. connection fee, toilet investment) and during operation (e.g. wastewater levy, cost of sludge removal); and
- *Third parties* - in the form of investment subsidies or recurrent subsidies sourced from donor funds, state budget or cross subsidies such as from water tariffs.

From a household perspective, the main consideration is the expenditure related to sanitation facilities. Household expenditures or costs may be subsidised with external financing in order to reduce the cost to the household. These subsidies are included as part of the total financial analysis, and are expressed as a project cost.

Figure 4: Hygiene promotion activities for Filipino children during Global Handwashing Day in 2008 (source: R. Gensch, 2008).

Financial costs to households can be reduced by encouraging in-kind contributions from household members, and hence not only increasing participation (which is likely to increase the use of and make it easier for the household to maintain and repair their sanitation facility) but also reducing the requirement for cash funds. Households, especially in rural areas, have access to materials such as sand, stone, wood or plant materials for latrine construction. Experience has shown that people are willing to contribute their time and effort as a substitute to local workmen who must be paid in cash[2]. Also, for toilets with reuse options, or simple pit emptying, there will be costs for the work involved, transportation and storage, whether covered through cash payments or in-kind contributions.
It is important to note that increasing the level of investment does not necessarily lead to increased level of service. The service delivery approach tries to shift the focus from the service delivery of physical hardware to the service itself and to differentiate between the different types of service. The IRC WASHCost project assumes that a cost-benefit decision can only be made relating to the level of service delivery (Moriarty et al. 2010).

The following indicators are relatively simple and can provide decision makers with information to support decisions about tariffs and affordability:

i) Full cost of sanitation per capita as a percentage of per capita GDP (gross domestic product): To allow for a comparison between different projects or different options within one region.

[1] See: IRC Briefing Note 1b: www.washcost.info/page/866. Further information on life-cycle cost approach on IRC WASHCost working papers: www.washcost.info/page/1293

[2] See for example SuSanA case study on UDDTS in rural Kenya: www.susana.org/lang-en/library?view=ccbktypeitem&type=2&id=129

ii) *Cost of access to or annual cost of sanitation as a percentage of household income:* If households are expected to make a significant up-front contribution without access to a credit mechanism, this single payment might constitute a serious barrier. This can be expressed as per capita access cost as a percentage of the per capita household income. However, average data such as household income should be treated with caution due the large income differences between poor and rich households.

iii) *Long run marginal costs (LRMC):* The cost for one additional unit with the best resource allocation. It is calculated in relation to per capita and year to compare different regions with different household income.

iv) *Cost of sanitation services as a percentage of water tariffs:* decision makers often *prefer the cost of sanitation r*elated to water sales. This allows correlating full costs to current sanitation tariffs.

Table 1 shows some examples for these cost indicators and illustrates considerable differences in the share of operation and maintenance costs as part of total costs, ranging from 0% in an Indian example of pour flush latrines to 42% in the case of a biological treatment plant in Turkey. Table 1 also shows total costs of sanitation options as a percentage of gross domestic product (GDP) per capita, and household costs as percent of income for some examples. However, the comparability of these examples is quite low as some options include wastewater conveyance and treatment while others do not.

Table 1: Total costs, average household costs and operation and maintenance (O&M) cost as a percentage of total costs, and software as a percentage of investment expenditure for some sanitation examples worldwide – just to give a rough indication of a possible cost analysis and ranges of figures.

Location and type of sanitation	Inhabitants served	Total LRMC[a] as % of GDP[b]	Annual costs of sanitation as % of household income	O&M[c] as % of full cost	Software cost as % of total investment	Source
Kuje, Nigeria Combined sewage and offline treatment	582 (rural)	1.14%	1.82%	N/A	N/A	Illesanmi (2006)
Berlin, Germany Conventional gravity based systems, wastewater treatment plant	4,891 (peri-urban)	0.86%	0.84%	15%		Oldenburg (2007)
Conventional gravity based systems, one stream, sequencing batch reactor (SBR)	4,891 (peri-urban)	0.64%	0.63%	10%	N/A	
Urine separation/storage, brownwater vacuum system and biogas reactor, greywater treatment SBR	4,891 (peri-urban)	0.69%	0.68%	5%	N/A	
Rajasthan, India Pour-flush and bathroom, on-site (mostly deep soak pit); no pit emptying included	1,050,000 (rural)	0.5%	N/A	(no cash)	11%	KfW (2008a)
Bahia, Brazil Mixed systems (ponds, anaerobic Imhoff tanks and gravel sand filters)	34,000 (rural)	0.6%	0.1 – 0.2%	27%	21%	KfW (2008b)
Haikou, China Centralised system, reuse of energy and nutrients (parts of the sewer already existed)	850,000 (urban)	0.7%	0.4%	31%	2.4%	KfW (2008c)
Fethiye, Turkey Mechanical-biological treatment, nutrient removal, disinfection	65,000 (urban + tourists)	0.7%	N/A	42%	5%	KfW (2008d)

[a] LRMC: Long run marginal costs; [b] GDP: Gross domestic product; [c] O&M: operation & maintenance

4 Economic analysis: elements and indicators

Economic analysis includes the financial costing as the core of the analysis and additionally takes a broader perspective, encompassing social and environmental costs and benefits that can be ascribed with a monetary value. Therefore input data will include not only the financial cash flows but also in-kind or external costs and benefits.

Economic benefits include those related to:

- Health benefits such as avoided deaths and avoided morbidity;
- Economies of time saved seeking sanitation facilities or waiting to use these facilities as well as fewer sick days which results in greater productivity
- Environmental benefits such as reduced water pollution
- Reuse of human excreta - fertiliser, biogas etc.
- Wider benefits for the economy related to increased attractiveness for tourism and the business community.

There are also other benefits such as perceived improvement of living quality through attainment of privacy, dignity, convenience and status, however these are difficult to quantify in economic terms.

Thus, economic analysis includes all costs and benefits of households – including the monetary value of in-kind contributions of materials and labour. The most common approach for "shadow price" valuation of own labour is the price of local non-qualified labour. Economic analysis also reflects the full opportunity cost of resources employed. This refers to the economic opportunity lost from using cash, in-kind labour and materials in sanitation that could be employed for another productive use.

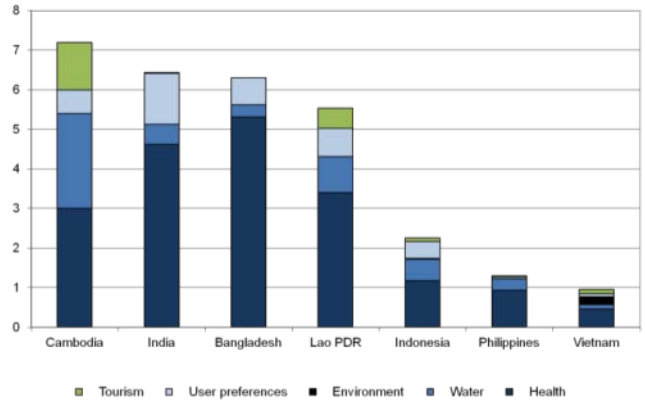

Figure 5: Economic losses resulting from poor sanitation and hygiene in seven countries of Southeast Asia, as a percentage of annual GDP (source: WSP, see Footnote 3).

Where reliable data are available, these economic benefits can be quantified and converted to monetary units to be included in full economic evaluation. A study conducted by WSP in South East Asia in 2007 found that poor sanitation and hygiene led to annual economic losses in the order of 1% (Philippines, Vietnam), 2.3% (Indonesia), 5.5% (Lao PDR) and as high as 7% (Cambodia) of GDP (Hutton et al., 2008).

A recent study by WSP found that eighteen African countries lose around USD 5.5 billion every year due to poor sanitation, with annual economic losses between 1% and 2.5% of GDP[3].

5 Economic benefits of resource-orientated sanitation

Different types of sanitation provide different levels of economic benefit in terms of mitigation of pollution impacts and environmental protection. Further financial or economic gains can be achieved with resource-oriented sanitation systems: reuse of treated wastewater, human excreta fertiliser and biogas. Human excreta (also in the form of sludge from central treatment plants) can be used as fertiliser and soil conditioner after composting. A detailed analysis of three ecological sanitation (ecosan) projects has been carried out by Schuen et al. (2008).

By reusing excreta, households can generate monetary benefits and increased crop production can have a positive impact on them financially. Evidently, poorer households seek to gain more in proportion to their household income (Schuen et al. 2008). The use of human excreta as fertiliser is especially relevant in land-locked countries where the cost of imported fertiliser is significantly higher. Given the increasing scarcity (and price) of phosphorus, the monetary reuse value of human excreta also increases (Gensch et al., 2012).

The value of excreta products which are produced and used on the person's own property can be estimated by comparing the value of the included nutrients at the shadow prices for synthetic fertiliser including transport costs minus the value of the additional personal labour required. If the nutrients are transferred to somebody else's farm, the effective payment (price) of the transaction can be included in the financial analysis.

In addition, biogas generation in sludge digesters of larger wastewater treatment plants and household or community biogas digesters produce biogas as well as fertiliser. A household biogas digester mainly relies on organic waste from animals, because human excreta can cover only 15-30% of a household's energy need for cooking (depending on climate and cooking habits). Similar to nutrient reuse, biogas for cooking can be valued at market prices of firewood or other locally used fuels for cooking. If faeces are converted to compost, the local price of compost can be used for economic estimates.

Other economic gains or cost savings which can be calculated:

- *Water savings* can be valued at the cost of provision of additional drinking water.
- *Treated wastewater or greywater* may be reused for irrigation or aquifer recharge. The market price for irrigation water from other sources can be used to value the benefit of reusing treated wastewater. The calculation

[3] See WSP Africa: Economics of Sanitation Initiative (2012) for more information: www.wsp.org/wsp/content/africa-economic-impacts-sanitation

would include the effective payment (market price) for water minus cost of transfer[4].
- *Households* who reuse their waste do not need to pay for pit emptying services or build a new pit when the old one is full.

Many of the argued (or predicted) benefits of reuse oriented sanitation are heavily related to context-specific programme conditions. For instance, the extent of the benefit will be closely related to the degree of community acceptance of excreta reuse, hygiene behaviour change and other factors that determine successful adoption of technologies.

Figure 6: A stove in a school kitchen running on biogas produced from human excreta in Rilima, Rwanda (source: P. Feiereisen, 2011). More photos on this school: www.flickr.com/photos/gtzecosan/sets/72157627230220319/with/6008002835/.

6 Tools for financial and economic analysis

Whole life-cycle analysis involves a long term perspective which takes into account all costs incurred and benefits received over the total duration of the planned project (including operation as well as construction), which is known as the planning horizon. Depending on the type of asset, the quality of construction and the chosen planning horizon, the design life for individual components of the sanitation system may be greater than or smaller than the planning horizon.

A concept similar to the accounting term of asset "depreciation" encourages long-term thinking and investment in technologies that are financially sustainable. For a comparison beyond specific requirements of programme implementers or national governments, some basic tools and ratios are helpful for comparing sanitation interventions with respect to monetary as well as non-monetary outcomes, and from several perspectives.

Costs can be annualised to aid judgments about affordability. Costs expressed in local currency and in real prices of the base year of the study (i.e. without inflation) are most appropriate for financial analyses where the results are to be used to support national or sub-national level decision-making. The discount rate used should reflect the opportunity costs of capital in a given national economy. If there is no accepted national discount rate, economists frequently use a discount rate of 5%.

While providing the results of financial and economic analyses to potential users, measures such as the cost-effectiveness ratio, Benefit-Cost Ratio (BCR), Net Present Value (NPV), or Internal Rate of Return (IRR) can be utilised. In each case, the tools are essentially the same for financial and economic analyses; but the input data will of course vary. Only larger programmes will justify research and full cost-benefit analysis. In these cases, the *ratio of total benefits divided by total costs* or the *internal rate of return* can provide additional information for policies and decisions.

a) Cost-effectiveness ratio

The cost-effectiveness ratio is a more specific tool that compares costs with a single outcome of sanitation improvement, expressed in physical (non-monetary) units such as inhabitants better served, health gain or reduction in pollution. It is generally used in public sector planning.

b) Benefit-Cost Ratio (BCR)

The benefit-cost ratio (BCR) is calculated by dividing the discounted benefits by the discounted costs of the sanitation intervention.[5] This indicator can be used to compare different sanitation improvement options and to compare a sanitation option with 'doing-nothing'. Two types of studies reporting BCRs can be distinguished: (i) those reporting the costs and benefits generally associated with improved sanitation on a regional or national level ('macro' studies); and (ii) those comparing the costs and benefits of alternative sanitation options in a single context on the household level('micro' studies).

c) Net Present Value (NPV)

Long-term outcomes of sanitation interventions can be measured either in monetary terms in cost-benefit analysis (CBA) or cost-effectiveness analysis (CEA). This is used to assess financial costs over a period of time and is particularly relevant where sanitation projects achieve similar or identical outcomes. The narrower CEA can be used if valuation of benefits is difficult; while CBA is a broader method that combines multiple impacts of improved sanitation in a single framework expressed in monetary units.

For both CEA and CBA, the NPV is a common parameter for comparing sanitation technologies, which can be expressed in financial and economic terms. The calculation of these two values is similar, but the input data and costing factors are different in each case.

The combined investment and recurrent costs are expressed as a NPV over the useful lifetime of major investment components, and can be subtracted from the NPV of

[4] Until now the cost saving that can be achieved with treated wastewater is still however close to zero in most countries, but the concept might have importance in the future.

[5] The discount is the difference between the present amount and the amount in the future. The discount rate is usually given at 5% per year.

financial benefits to estimate the financial net present value (FNPV). The economic analysis of selected factors (e.g. reuse of nutrients and energy) can use the long run household costs and benefits per person served per year, as a percentage of local or regional per capita household income to calculate the costs and benefits as a percentage of household income.

d) Internal Rate of Return

The ratio of the financial benefits to the costs is termed the financial internal rate of return (FIRR). This measure takes into account investment and recurrent costs and provides a measure of the annual equivalent return on investment in percentage terms, taking into account monetary cash-flows over the life span of the investment. It allows comparison between the efficiency of the intervention with other potential uses of funds.

Economic internal rates of return (EIRR) tend to be significantly higher than financial ones because it also includes non-monetary costs and benefits (health, environmental and reuse benefits of sustainable sanitation options) over the lifetime of the sanitation improvement. For example, a study of three African countries on integrated household biogas and sanitation showed a financial IRR of around 10% compared to an economic IRR of over 70% (Renwick et al., 2007).

7 Limitations of these analyses

Economic analysis requires the valuation of economic costs and benefits and is limited to the availability of reliable data. The large diversity of measures and settings make it hard to compare the results from studies in different locations. There is therefore a need for greater awareness of the analytical methods and indicators by researchers and practitioners and the application of standardised methodologies for data collection and analysis.

Many projects promoting excreta reuse as fertiliser or soil conditioner and biogas production involve use of the products by the same households or the institutions, such as a school or a prison, which has produced the excreta in the first place. But so far, little data exists to suggest the actual financial or economic value of these products. In the absence of in-depth research, a careful use of shadow prices is most appropriate to reflect the upper limit of economic value (i.e. equivalent fertiliser).

Available estimates of economic benefit of excreta reuse in the literature are challenging as they are largely based on hypothetical returns using expected excreta production, quality and prevailing market prices, as opposed to actual household economic impacts (Rockström et al., 2005; Oldenburg, 2007; Renwick et al., 2007). Established markets for trade in human excreta are not yet documented, and it is not clear whether the same nutrient or fuel volume/weight would receive the same prices as, say, synthetic fertiliser, conventionally produced compost or liquefied petroleum gas (LPG).

To date, although some data exists, there is still relatively limited published cost and economic evidence relating to different sanitation options, and all available evidence has not been systematically estimated and compiled[6]. Quantifying sanitation impacts and converting to monetary values to give accurate estimates of economic impact or benefit is a challenging task for various reasons:

- Firstly, improved sanitation is one of many ongoing development 'interventions' that affect socio-economic outcomes, such as health, education, agriculture and private sector development initiatives. Hence, robustly designed studies are needed which conduct data analyses adequately, accounting for a range of confounding variables.
- Secondly, the step of monetisation adds a further layer of uncertainty on the already uncertain physical/natural measurements of sanitation benefits. Prices can be highly variable, or markets may be imperfect thus distorting prices from the market equilibrium price level (which is the standard measure of welfare impact in economics).
- Additionally, prices may not exist at all, such as for some benefits of sanitation (e.g. comfort value, increased security for women or social impacts of improved sanitation) and thus need to be ascertained through proxy pricing or contingent valuation techniques. Hence, the analyst must compare the methods available, justify selection of a single method; and conduct sensitivity analysis to assess how uncertainty in price assumptions affects the overall benefit estimation.

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Acknowledgments are given to the following persons for their valuable contributions:
Madeleine Fogde (SEI, Sweden), Arne Panesar (GIZ, Germany), Markus Starkl (BOKU Vienna, Austria and IWA-SWMDC), Ayesha Irani (Luis Berger, Panama), Norbert Brunner (CEMDS, Austria), Valentin Post (WASTE, Netherlands), Alexander Krohs (RWTH, Germany), Annika Schöpe (formerly GIZ, Germany), Elisabeth von Münch (GIZ, Germany).

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sustainable sanitation alliance

SuSanA factsheet

Links between sanitation, climate change and renewable energies

April 2012

1 Summary

Sustainable sanitation projects can contribute to both climate change mitigation (through energy or nutrient recovery) and to climate change adaptation (through innovative sanitation systems and wastewater management).

Measures of renewable energy production consist basically of either biogas production from waste water or biomass production through the use of waste water to grow short rotation plantations for firewood. Biogas can also be used for heat generation while heat exchangers can recover heat energy from wastewater in sewers. Measures of nutrient recovery are primarily based on nitrogen reuse. Adaptation measures in the area of sanitation aim at coping with increasing water scarcity or flooding.

By using reuse-oriented sanitation systems with energy, nutrient or wastewater recovery and reuse, anthropogenic greenhouse gas emissions can be reduced (mitigation) as well as people's capacity to cope with climate change impacts can be increased (adaptation).

In cases where these measures for reduction of greenhouse gases are achieved in developing countries, the emission allowances can be sold on the international emissions trading market and thus can contribute additional financial benefits. In order to be financially viable, there is a minimum project scale due to fixed transaction costs, with project bundling the minimum scale can be achieved.

This factsheet emphasises the need for climate change mitigation and adaptation measures in the area of sanitation. In addition, it provides an overview of the possibilities of using sanitation systems for renewable energy production, nutrient recovery and it explains the financial benefits that emission trading can bring.

2 Introduction

2.1 Overview

UNFCCC[1] defines 'Climate change' as a "change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods". Some of the major climate change effects that have been predicted are the significant rise in temperature due to greenhouse gases, rising sea level and shifts in precipitation and evapotranspiration patterns (IPCC, 2007a). By 2050, the number of countries facing water stress or scarcity could rise from 48 to 54, with a combined population of four billion people i.e. about 40% of the projected global population of 9.4 billion[2].

Increasing water scarcity combined with increased food demand and water use for irrigation as a result of less precipitation are likely to be a driving force leading to water reuse. Areas with low sanitation coverage might be found to be practising more uncontrolled water reuse i.e. reuse performed using polluted water or even wastewater (Bates et al. 2008).

Sustainable sanitation has a strong link to climate change and renewable energy production. For example, sanitation systems can be designed in a way to produce renewable energy sources (biogas or biomass) which in turn may mitigate climate change by reducing greenhouse gas emissions. Sanitation systems may also serve to help people adapt to climate change by reusing energy, nutrients and treated wastewater and thus substituting the use of primary resources.

Figure 1: Urine Diversion Dehydration Toilets (UDDT) withstood the flood waters that resulted from a cyclone that struck southern Bangladesh in 2009 (source: A. Delepiere). More photos from this project: www.flickr.com/photos/gtzecosan/sets/72157626407064863/

Another example is dry toilets such as Urine Diversion Dehydrating Toilets (UDDT) with a raised platform and safe containment of excreta and which use no water for flushing (suitable for areas with increasing water scarcity) or which

[1] UNFCCC – United Nations Framework Convention on Climate Change, www.unfccc.int

[2] See: www.maps.grida.no/go/graphic/increased-global-water-stress

can still function during flooding events. UDDTs are potentially resilient to all expected negative climate change impacts while water born systems (flush toilets and sewers) are more vulnerable to different climate change scenarios (WHO and DFID 2009)[3].

2.2 Greenhouse effect and contributing gases

The greenhouse effect is the phenomenon where the presence of so-called greenhouse gases (GHG) cause warming of the earth's surface: GHG allow solar radiation to enter the earth's atmosphere but prevent heat from escaping back out to space. They absorb infrared radiation and reflect it back to the earth's surface leading to its warming.

Many human activities cause GHG emissions which drive the anthropogenic greenhouse effect. According to the Intergovernmental Panel on Climate Change (IPCC) the anthropogenic greenhouse effect will cause a rise in the mean global temperature of between 1.1 and 6.4°C by the end of the 21st century (IPCC, 2007a). Changes in rainfall patterns, rising sea level and weakening of sea currents will also have additional impacts on the global temperature distribution. In order to limit climate change to tolerable levels, global temperature rise should be limited to 2°C (IPCC, 2007b). To achieve this, GHG emissions would have to be reduced by 50% by 2050 compared to the level in 1990 (IPCC, 2007c).

2.3 Relevant greenhouse gases

In the field of sanitation, the following GHG are climate relevant:

- *Methane* (CH_4) is a potent greenhouse gas with a global warming potential 25 times higher than that of carbon dioxide (CO_2) in a 100 year perspective (IPCC/TEAP, 2005). In anaerobic processes, organic matter contained in domestic waste and wastewater is decomposed and biogas is formed which contains 60-70% methane.
  In soak pits, anaerobic ponds, septic tanks and other anaerobic treatment systems or even at the discharge of untreated wastewater into water bodies, anaerobic processes take place to different extents and methane is released to the atmosphere.
  While combustion of biogas produces CO_2, a greenhouse gas (see below), the carbon in biogas comes from solid or liquid biomass that has fixed carbon from atmospheric CO_2. Thus, biogas usage is carbon-neutral and does not add to greenhouse gas emissions.
- *Carbon dioxide* (CO_2) is produced as a result of combustion of any fossil or biomass fuel. However, CO_2 from biomass combustion does not contribute to global warming as it originates from the atmosphere; it is a step in the organic carbon cycle. In sanitation, CO_2 emissions occur whenever fossil energy is used, as fossil fuel-based electricity. The treatment of wastewater for removal of organic matter and nutrients in wastewater treatment plants requires energy. The same holds true for the production of mineral fertilisers which is a very energy intensive process.
- *Nitrous oxide* (N_2O) is a strong greenhouse gas with a global warming potential 298 times higher than that of CO_2 in a 100 year perspective (IPCC/TEAP, 2005). Nitrous oxide emissions occur during the denitrification process in wastewater treatment, at the disposal of nitrogenous wastewater into aquatic systems and also during mineral nitrogen fertiliser production. For climate protection, nitrogen in excreta or wastewater can be recovered and reused as a fertiliser to save energy.

[3] WSSCC working group on WASH and climate change www.wsscc.org/topics/hot-topics/climate-change-and-wash

3 Climate change mitigation and adaption potential of sanitation

3.1 Mitigation measures

3.1.1 Energy recovery

Sanitation systems can be designed and operated to produce renewable energy in the forms of either biogas or biomass and thus reduce primary energy consumption (see Section 4 for details). Small scale biogas systems can generate enough biogas to cook main family meals and thus replace part of the traditional used cooking fuels. It should, however, be kept in mind that particularly in small systems the organic load from human excreta alone is in most cases not high enough for the economical usage of biogas for cooking, lighting or heating but still beneficial. Much more biogas is produced if animal excreta, organic solid waste (e.g. from kitchens and/or markets), or agricultural waste is co-digested as well.

Figure 2: Biogas stove at Cachoire Girls High school, Kiambu, Kagwe District, Kenya (source: S. Blume, 2009). More photos about this project: www.flickr.com/photos/gtzecosan/collections/72157616752316076

Biogas can also be used for combined heat and electricity generation by means of a combined heat and power (CHP) plant. This can substitute the use of fossil or non-renewable energy sources.

Another possible energy recovery method is the recovery of heat from wastewater especially in cold countries where the wastewater temperature is higher than the ambient temperature. Warm greywater from showers, wash basins and sinks (with temperatures of up to 35°C) usually flows directly into the sewage system. The energy contained in the greywater can however be effectively recovered by means of heat exchangers installed inside or close to the house. Conversely, most of the thermal energy in the wastewater is lost in the sewer. Depending on climate,

region and season wastewater temperature can go down below 12°C making it much more difficult and insufficient for energy recovering. Similarly, a large amount of warm wastewater is also produced in industries, hospitals, swimming pools etc., which could also be harvested and used efficiently for preheating cold water.

3.1.2 Nutrient recovery

The macronutrients nitrogen (N), phosphorus (P) and potassium (K) contained in human and animal excreta can be locally recovered and safely used as fertiliser in agriculture. Hence, a substitution to the manufactured mineral fertilisers with their associated energy intensive production and transport over long distances. Further information on the safe use of excreta in agriculture can be found in WHO (2006) and Gensch et al. (2012).

Figure 3: Urine application in agriculture, in Ouagadougou, Burkina Faso (source: S. Tapsoba, 2009). For more information on this project see the SuSanA case study: www.susana.org/lang-en/case-studies?view=ccbktypei tem&type=2&id=84

Nitrogen fertilisers require more energy (Remy and Ruhland, 2006) and are consumed in larger amounts than P- and K-fertilisers (Gellings and Parmenter, 2004). Since 87% of the excreted nitrogen is contained in urine, concentrating on the recovery and reuse of the nitrogen contained in urine represents a possible means of emission reduction through nutrient recovery.

A life cycle analysis study comparing the energy demands for nutrient removal and mineral fertiliser production versus nutrient recovery identified a considerable energy saving potential with urine diversion nutrient recovery (Maurer et al., 2003). Compared to a conventional wastewater treatment system, the use of reuse-oriented sanitation systems can lead to energy savings (e.g. due to smaller sewer networks and treatment plants). However, when reuse-oriented sanitation systems are dependent on road-based transportation of excreta or sludge, they are also associated with energy consumption. Thus, while comparing reuse-oriented with conventional sanitation systems, a careful analysis of the different systems from an energy perspective is necessary.

The emission reduction potential through energy recovery (biogas) and nutrient recovery (urine) was analysed for a case study in India (Olt, 2008). For nutrient recovery it was calculated as 23 kg CO_2/person/year resulting mainly from savings in energy consumption for the production and transportation of mineral fertiliser, savings in field emissions during fertilisation and avoided disposal of nitrogenous wastewater into aquatic systems. From an emission reduction point of view, this case study however faced unfavourable conditions in view of nutrient recovery as pumps were used to pump flush water to overhead storage tanks from the wells. Therefore, the above indicated value of emission reduction through nutrient recovery can be regarded as a lower value.

Source separation of urine and subsequent use of urine as fertiliser reduced the climate impact by 33 kg CO_2/person/year in a scenario study evaluated with life cycle assessment methodology, where wheat production in Sweden with urine as fertiliser was compared to conventional mineral fertiliser use and wastewater treatment (Tidåker et al., 2007). The benefits originated mainly from an avoided need for the production of mineral fertilisers and from avoided field emissions.

Therefore, artificial mineral fertilisers should be replaced by safe application of excreta-based fertilisers (urine, faecal or wastewater sludge, dried faeces) as far as possible.

3.2 Adaptation measures in the area of sanitation

Adaptation to climate change ensures that sanitation systems can in the future - with a potentially different climate - still deliver services and maintain safe hygiene practices to prevent the spread of diseases.

Adaptation measures include the planning for preparedness, prevention, protection, and response (relief and rehabilitation). Risk management and adaptation planning aims to develop different strategies based on the different scenarios, by choosing technologies that are resilient to the expected scenarios, by adapting operation and management of existing services, and by taking into consideration socio-economic factors. Furthermore, it is also advisable to separate the preparedness for extreme events and adaptation measurements from expected perpetual challenges.

Figure 4: Tanker supplying water to low-income areas in Lima, Peru (source: H. Hoffmann, 2010). Climate change will aggravate the existing water scarcity problems in Lima due to melting and

disappearing of glaciers in the Andes – which is currently the source of water supply for Lima. More photos showing water scarcity in Lima: www.flickr.com/photos/gtzecosan/sets/72157629511631340/

Climate change proofing measures involve households, communities, service providers and governments alike, and some examples are given below.

3.2.1 Adaptation to increased occurrence of droughts and increasing water scarcity

In order to adapt sanitation systems to water scarcity, the measures that can be taken include for example:

- Wastewater especially greywater, treated to the appropriate degree for the intended use can be reused for the irrigation of food crops, energy crops, parks, lawns and other public spaces, for groundwater recharge or as service water. In cases where potable water is used for irrigation, the use of treated wastewater would substitute the extraction, processing and distribution of potable water and thus may lead to energy savings. The nutrient content of the wastewater also reduces the need for mineral fertiliser input. Further information on wastewater reuse in agriculture can be found in WHO (2006).
- Dry toilet systems can be an alternative, especially in water scarce areas, to water-flushed toilets. Toilets which do not require water for flushing, but can nevertheless be indoors (such as urine diversion dehydration toilets (UDDTs) or composting toilets), save about 40L/person/day in comparison to conventional flush toilets.
- Water or wastewater irrigation methods should minimise water losses through evaporation. Therefore, subsurface drip irrigation is generally preferable although possible nozzle clogging should be considered (Palada et al, 2011).

3.2.2 Adaptation to increasing amounts and periods of rainfall and flooding

In order to adapt sanitation systems to flooding, one effective measure is building sanitation structures in a way that they are above ground and either not affected by flooding such as UDDTs built high enough above ground, or to use mobile toilet systems (Johannessen et al., 2012)[4]. Another measure is building sanitation systems where flood water can drain quickly, such as elevated sludge drying beds, or constructed wetlands.

3.3 Emission trading as an additional financial benefit

The first phase of the Kyoto Protocol – the internationally binding contract on climate protection measures valid until the end of 2012 – assigns each participating country which has emission reduction commitments, an allowed amount of greenhouse gas emissions. In order to reach this emission target at the least macroeconomic costs, the Kyoto Protocol offers three market-based flexible mechanisms. One of them, the Clean Development Mechanism (CDM), is designed for trading emission reductions which have been achieved in developing countries.

The CDM can be used for emission reductions achieved through sustainable sanitation systems. It can contribute to an additional financial benefit but also generates CDM-related costs which are mostly fixed and which negate achieved credits to some extent.

Hence, for sustainable sanitation systems a minimum project scale is required to make CDM economically attractive. This is dependent on the baseline and the project scenario, the energy demand of the fertiliser production plants, the different available sources of energy of the country being considered, the transaction costs and the price of carbon credits which fluctuates.

The minimum project scale for an economic use of CDM for energy recovery (biogas use) and nutrient recovery (urine use) was analysed for a case study in India (Olt, 2008). Assuming average transaction costs and a long-term price of 20 EUR/CER[5], the minimum viable project scale was found to be around 25,000 PE[6] for energy recovery, and 37,000 PE for nutrient recovery.

From an emission reduction point of view, this project had favourable conditions regarding energy recovery but unfavourable conditions regarding nutrient recovery. Therefore the above indicated project scale for energy recovery represents an absolute minimum value, while the value for nutrient recovery can also be lower.

In order to reach this project size, similar CDM projects may be bundled together to a "Programme of Activities" (PoA). A manual for biogas plants at household level is given in GFA (2009). Further information on PoA is available at the website of UNFCCC[7].

4 Renewable energy production from sanitation

4.1 Biogas production

4.1.1 Overview

Biogas is a renewable energy that can be used for cooking, lighting, heating and for generating electrical power. It is produced by bacteria that decompose organic matter under anaerobic conditions (i.e. in the absence of oxygen). The technology of anaerobic digestion has been applied to human and animal excreta for over 150 years. The anaerobic bacteria grow slowly, and higher temperatures result in faster decomposition rates[8].

For biogas generation various substrates can be used (also in combination with each other):

[4] See publications of SuSanA library dealing with the issue of flooding: www.susana.org/lang-en/library?search=flood

[5] 1 CER (Certified Emissions Reduction) is considered equivalent to one metric ton of CO_2 emissions

[6] PE = population equivalent, equalling approximately the organic biodegradable load of one person.

[7] http://cdm.unfccc.int/ProgrammeOfActivities/index.html

[8] For further information on anaerobic digestion and biogas production, please see the SuSanA library and filter for biogas systems. Also photos of biogas systems are available in the Sustainable Sanitation photo collection: www.flickr.com/photos/gtzecosan/collections/72157 626218224122/

- organic waste from households or agricultural farms
- animal manure
- sewage sludge originating from domestic wastewater treatment
- blackwater, i.e. mixture of excreta and flushing water (best from low-flush or vacuum toilets)
- fresh faecal sludge from public toilets and septic tanks and pit latrines

Figure 5: Construction of a fixed dome biogas plant, Lesotho (source: M. Lebofa, 2006).

In many Asian countries, e.g. in China, India and Nepal, human excreta are treated in this way together with animal manure and other organic waste. As a result of a Chinese national programme in the 1970s ("Biogas for every household"), addressing increasing energy demand and wood cutting, there is an on-going interest in China in biogas which is supported by the Ministry of Agriculture. For example, there are now approx. 5 million family-sized biogas plants of 6, 8 and 10 m^3 in operation, mainly built as fixed dome plants (Balasubramaniyam et al., 2008).

Due to the two benefits of energy production and fertiliser production, anaerobic digestion (AD) is receiving interest as an option in sustainable sanitation concepts.

For a sanitation system, maximising the stabilisation and hygienisation of the wastewater is more important than maximising the biogas production. The pathogens contained in the raw wastewater are reduced somewhat during anaerobic treatment but not to a high degree. In general the pathogen reduction during anaerobic digestion is higher the longer the retention time.

Biogas from anaerobic wastewater treatment contains 60-70% methane. The biogas production depends on the amount of organic matter removed by anaerobic treatment. 1 m^3/d of biogas is enough to cook three meals for a family of 5-6 members. According to Balasubramaniyam et al. (2008), as an indicative value, this can be produced from excreta of either, 50 - 90 humans, 2 - 3 cows or 7 - 8 pigs over a 24 hour-period. This means that the excreta from approximately 10 people is needed to produce biogas for the cooking needs of one person. Hence, the available energy potential in human excreta should not be overestimated. An advantage is that, there is no human health risk at all caused by pathogenic contamination in biogas itself (Vinnerås et al., 2006).

If the biogas cannot be used, then it should at least be flared (this converts methane to carbon dioxide which has a 25 times lower GHG potential than methane, see Section 3.2). However, as described in Hoffmann et al. (2011), when biogas needs to be burnt, there are additional costs for equipment. The flare for a household plant has nearly the same costs as a flare for a large plant of 20,000 inhabitants – thus the specific costs per person are relatively high for flares implemented in small systems.

If neither biogas use nor flare can be realised, uncontrolled biogas production should be avoided. There are various possibilities to reduce unintended biogas leakage:

- Replace existing anaerobic ponds and septic tanks by a controlled anaerobic treatment system such as biogas plant, UASB reactor or anaerobic baffled reactor.
- Design and build any new anaerobic treatment systems as a closed gastight construction with biogas capture.
- Make existing open UASB reactors as well as leaky biogas plants gastight and avoid biogas emissions by installing or restoring the flares.

Where septic tanks are too small for a controlled anaerobic treatment (i.e. generally or household level), consider replacing septic tanks by appropriate, low-energy, composting toilets or aerobic treatment methods such as dry toilets, or constructed wetland systems.

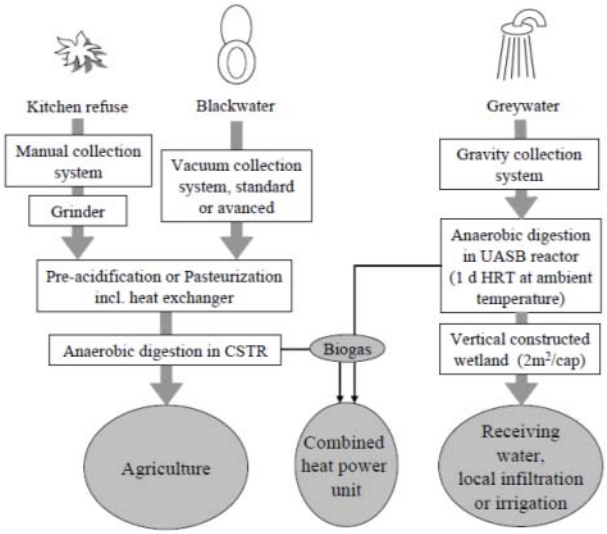

Figure 6: Schematic of the proposed AD system for household wastewater which includes a Decentralised Wastewater Treatment System (DEWATS) for greywater (source: C. Wendland, 2009).

4.1.2 Use of the biogas

Biogas can either be burnt in a gas stove or used within a combined heat and power unit (CHP) for electricity generation. For use in a CHP, the biogas must be filtered to remove aggressive sulphur compounds. The CHP is equipped with a gas engine for producing electricity and heat. The efficiency is 30% for electricity generation and 60% for heat production which may sum up to a total energy efficiency of 90% in case the excess heat is used on-site.

This high efficiency represents the main advantage of a CHP compared to a biogas plant.

4.1.3 Use of the digestate

After the generation of biogas, the residue of anaerobic digestion (called "slurry or digestate") still contains all the nutrients and some organic matter. This residue is therefore suitable for application in agriculture as a fertiliser and soil conditioner. The macronutrients (N, P and K) which are contained in the substrates remain in the digestate and are easily available to plants.

Organic matter is reduced by the digestion process but is still available in the digestate, and can contribute to raising the soil organic matter content. The digestate is “stabilised” with reduced odour emissions, pathogens and weed seeds compared to undigested manure (pathogens are not removed to a significant extent). The use of the digestate as a fertiliser reduces the need for mineral fertilisers, which reduces costs as well as greenhouse gas emissions. However, safety measures in the application of digestate should be applied, especially when the substrate sources contain human and animal excreta.

4.2 Biomass production

4.2.1 Overview

Biomass is a non-fossil energy source which can substitute fossil fuels. However, it is neither always harmless nor always neutral to the climate. According to the UNFCCC definition (UNFCCC, 2006), renewable biomass is understood as:

- wood (provided that wood harvest does not exceed wood growth)
- other wooden biomass (provided that the cultivated area remains constant)
- animal or human manure
- solid organic waste (domestic or industrial)

Both food and biomass or energy production are essential for people's livelihoods, and often compete with each other for available land, water and nutrient resources. Food and biomass production might be seen as equally important in economically rich countries with a safe food supply. But in many developing countries food production takes priority, whilst at the same time people are dependent on biomass (particularly on wood) for their energy supply, primarily to cook their food.

Conducting a national food balance, which takes into account food production versus consumption is one way to establish whether priorities should tend towards either food or biomass production[9]. This can then be used as a basis for making decisions regarding the cultivation of more food or more energy crops. The use of sanitation-derived fertilisers in agriculture may increase the productivity of the land and thus decrease the conflict between food and biomass production at the local level.

If the decision has been made in favour of the cultivation of energy crops, the reuse of domestic wastewater to irrigate and fertilise energy crops in so-called Short-Rotation-Plantations (SRP) is a new approach which aims at using the nutrients contained in wastewater for an enhanced biomass growth.

The term SRP refers to plant species which are harvested after short periods, usually between 2-8 years, but also annually in the case of herbaceous plants or grasses. Their cultivation intensity, their high nutrient uptake and the frequent harvests require irrigation and fertilisation. By irrigating with wastewater rich in plant-available nutrients, fertiliser costs are zero, plant growth is enhanced, and wastewater is subjected to a more sustainable treatment[10].

While constructed wetlands focus on wastewater treatment only and are sealed at their base for groundwater protection, the advantage of SRPs over constructed wetlands lies in the combined wastewater treatment and the production of wooden biomass. An SRP is not lined at the base and has a filter height of between 1.0 and 1.5 m resulting in an effective reduction of pathogens. Wastewater is usually applied on SRPs by means of sub-surface irrigation in order to avoid aerosol formation and spread of pathogens by air.

Figure 7: A two year old short-rotation-plantation (SRP) in Braunschweig, Germany, (source: TTZ, 2006).

In order to avoid nutrient overload, wastewater application has to follow a dosing recommendation depending on the site and plant species and – if built within the European Union – comply with the EU Nitrates directive. In addition, the nitrate content has to be monitored by soil samples or by sampling from drainage channels.

The following substrates can be applied on SRPs:

- domestic wastewater which contains nutrients in ratios that are close to the nutrient needs of SRP plants,
- sewage sludge originating from domestic wastewater,
- industrial wastewater from food processing or beverage industries.

[9] A useful online resource by OECD for agricultural food production by country and commodity is: http://stats.oecd.org/Index.aspx.

[10] Further information is available on the website of TTZ, Germany. www.ttz-bremerhaven.de/

Besides the above-mentioned benefits there are also some drawbacks to consider:

- Groundwater pollution could occur and needs to be prevented (from nitrate, pathogens and toxic substances especially if industrial wastewater is applied).
- The increase in soil salinity resulting from the irrigation with wastewater containing salts such as sodium chloride and hydrocarbonates might be a problem.

Figure 8: Short-rotation-plantation (SRP), Spain (source: TTZ)

4.2.2 Treatment performance of SRP

With a 10 hectare SRP, the wastewater of approximately 6,500 people with a daily discharge of 100 L/person may be treated, corresponding to an area of 15 m^2/person. The actual wastewater treatment takes place in the root system of the trees where bacteria are active. When the soil freezes, biological activity slows down considerably and there is a need for storage ponds to retain the wastewater during cold periods. Note that the area requirement per person is much higher for SRPs than for constructed wetlands. SRPs cannot be used when there is a space limitation.

4.2.3 Use of the biomass

The biomass produced in SRPs is most commonly used in European countries as wood chips for direct combustion in district heating plants or processed further into wood pellets or briquettes to be used in private households, smaller enterprises or hotels. However, the biomass can also be used for a variety of biomass conversion products and processes (i.e. combustion, gasification, hydrolysis, and fermentation) which can produce heat, electrical power, combined heat and power, ethanol or syngas (mixture of carbon monoxide and hydrogen).

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Acknowledgements are given to the following persons for their valuable contributions:

Elisabeth von Muench (GIZ, Germany), Patrick Bracken (AHT, Germany), Mirko Haenel (TTZ, Germany), Dexter Lo (Xavier University, Philippines), Christoph Platzer (Rotaria del Perú, Peru), Rob Lichtman (e-systems, The Netherlands), Kim Andersson (SEI-International, Sweden)

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sustainable sanitation alliance

SuSanA factsheet

Sanitation systems and technology options

April 2012

1 Summary

To address the great sanitation challenge in developing countries, numerous technological innovations have been developed. But with so many innovations and a wide range of existing technologies for different settings, difficulties with knowledge dissemination hinder informed decision making and the integration of all sanitation elements.

This factsheet makes a plea for a sanitation system approach where technologies are categorised based on their "product-process" characteristics and then linked into logical systems using a "Flowstream" concept. Technologies are grouped and used to construct seven logical systems. This method for organising and defining sanitation systems helps facilitate informed decision making and consideration of an integrated approach.

By using the sanitation system and its technology configurations from user interface to reuse and disposal, other aspects can now be further highlighted such as the inherent implications for operation and management (O&M), business and management models, service and supply chains, possible involved stakeholders, and finally the associated health risks by exposure of different groups of people to waste products. Such a health risk assessment for different sanitation systems has recently been published by Stenström et al. (2011).

2 Introduction: the need for a systems approach

Technology choice should be based on determining the best possible and most sustainable solution within an urban or rural context. There is often a prevailing assumption that centralised water-based sewer system can be the solution in all urban and peri-urban contexts. Site specific considerations such as the scarcity of fresh water, farmers' demand for treated wastewater or excreta-based fertiliser, or lack of technical skill and institutional or socio-economic barriers to such centralised sewer systems are often neglected (Luethi et al., 2011).

Sanitation programmes and projects often ignore the impacts of different waste inputs on the treatment processes, and on the quality of the final products (sludge and final effluents). A typical example is the implementation of waterborne sanitation with sewer systems without consideration of water availability and reliability or an appropriate wastewater treatment technology of adequate size to accept the additional raw sewage inputs. Consequently, subsequent poor operation of the system has potentially severe impacts on the environment, resulting in health risks to those served as well as of downstream populations.

On the other hand, on-site sanitation, like in the South Asian rural context, consists of the widespread promotion of pour flush latrines with on-site disposal pits which in many cases are not able to cope with the hydraulic or organic loads due to certain geological, groundwater and climatic conditions.

Figure 1: Schematic of school toilets connected to biogas settler and anaerobic baffled reactor at Adarsh College, in Badlapur, India (source: N. Zimmermann, 2009)[1].

The options: to change the basic design or to consider alternative sanitation technologies to take into account the specific on site conditions are often overlooked or not investigated. As a result, in spite of significant investments, a number of latrines are found to be either dysfunctional or malfunctioning and the unsatisfied users have reverted to open defecation or the use of unsanitary pits latrines. In addition, the focus is often on the construction of *toilets* alone with little consideration given to the management of the generated *faecal sludge*, including its collection, transport, treatment and possible reuse or disposal.

There is a great need for sanitation practitioners to plan sanitation from a more holistic perspective, for example by considering the entire municipal area and the sanitation chain in order to come up with an overall sanitation concept. A holistic perspective includes components such as technical, (socio-) economic, institutional and financial feasibility studies, consultation with the users in which the whole life cycle of different sanitation options are presented and discussed, quality assurance during implementation,

[1] See SuSanA case study for details: www.susana.org/lang-en/library?view=ccbktypeitem&type=2&id=38

and ongoing institutional support during the O&M phases. Training is another very crucial aspect as even the most inexpensive or sophisticated technologies eventually fail if they are not accompanied by a trained service provider.

One of the challenges for improving sanitation in low and middle income countries involves acquiring a sound knowledge of the wide range of sanitation options to ensure informed decision making. The most feasible sanitation systems and technologies - for the different habitats in urban and rural areas, which can achieve the objectives of improved health, changed hygiene practices, minimal impact on the environment, improved quality of life, and are best suited to the site specific context - can be chosen when decision making is informed.

Commonly asked questions when faced with deciding on a sanitation option are: What are the available sanitation systems? Which sanitation systems are appropriate for which kind of faecal waste inputs? What kinds of waste products are produced from the technologies that transform waste inputs? This factsheet summarises and highlights previous work conducted by various authors who worked on the categorisation of sanitation systems (Cruz et al., 2005; IWA, 2005; Tilley and Zurbruegg, 2007; DWA, 2010; Tilley et al., 2008).

3 Systemising sanitation systems

The main objective of a sanitation system is to protect and promote human health by providing a clean environment and breaking the cycle of disease transmission, as well as to preserve the dignity of users - particularly women and girls. In order to be sustainable, a sanitation system has to be not only economically viable, socially acceptable, and technically and institutionally appropriate, it should also protect the environment and the natural resources (SuSanA, 2008).

A sanitation system - contrary to a sanitation technology - considers all components required for the adequate management of human excreta. Each system represents a configuration of different technologies that carry out different functions on specific waste inputs or waste products. The sequence of function-specific technologies through which a product passes is called a “Flowstream”. Each system is therefore a combination of inputs, function-specific technologies, and products designed to address each flowstream from origin to reuse or adequate disposal.

Technology components exist at different spatial levels, each with specific management, operation and maintenance conditions as well as potential implications for a range of stakeholders. A system can include waste generation, storage, treatment and reuse of all products such as urine, excreta, greywater, organic solid waste from the household and agricultural activities such as manure from cattle at or near the source of waste generation. However, the requirement to effectively contain the wastes and prevent the spread of diseases and the pollution of the environment can often not be solved at the household level alone.

Households “export” waste or environmental contaminants generated by the wastes to the neighbourhood, town, or downstream population. In such cases, it is crucial that the sanitation system is extended to include these larger spatial areas and take into account technology components for storage, collection, transport, treatment, and discharge or reuse at all levels.

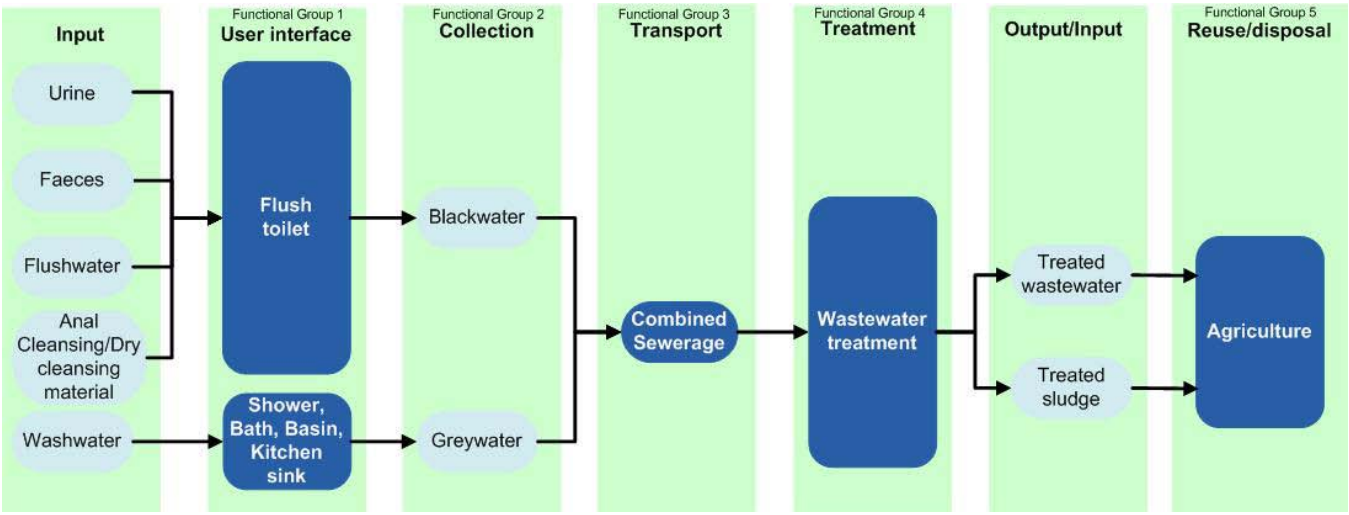

Figure 2: System template providing a schematic overview of the specific inputs of a sanitation system (left column), their transformation in the four functional groups “user interface”, “collection”, “transport” and “treatment“, the specification of two outputs for the fifth functional group “reuse/disposal” (in this example “nutrient reuse in agriculture”) (source: Luethi et al, 2011).

Sanitation systems can be distinguished by being water-reliant or non-water reliant for the transport of excreta and wastewater (Cruz et al., 2005; Tilley and Zurbruegg, 2007). Some manuals on technology options have used the type of anal cleansing (anal cleansing with water or dry anal cleansing material), water availability and affordability as distinguishing factors for on-site sanitation technologies.

Another common categorisation divides sanitation systems into on-site and off-site (i.e. whether treatment of the wastes occurs on-site or the wastes are transported off-site for treatment).

In addition to water-reliant or non-water reliant, or on-site or off-site, another distinction can be made in the various degrees of separation of incoming wastes. Urine diverting sanitation systems keep urine separate from faeces from the very beginning. On the other hand sewered sanitation systems mix faeces, urine, flushing water, greywater as well as wet or dry anal cleansing materials resulting in a waste product called wastewater. Depending on the degree of waste separation, various flowstreams can be distinguished, which must be accounted for in the subsequent functional components of the sanitation system.

It is also important to note the similarity in the naming convention between products and flowstreams. For example, blackwater is a product, but the entire process of collecting, treating and disposing of blackwater is referred to as the blackwater flowstream. Similarly, greywater can be managed separately as an independent product, but when it is combined and treated along with blackwater, the flowstream is referred to as the "blackwater mixed with greywater" flowstream (Tilley et al., 2008).

"Wet" and "dry" indicate the presence of flushing water for the transport of excreta or the use of water for facilitating the treatment of the wastes. This however only gives a certain indication of how wet or dry the collected waste materials will be. Although flushing water might not be used it would not necessarily qualify as a "dry system" as it may nevertheless contain anal cleansing water or even greywater. Also, it should be remembered that wet systems also contain solids, like faecal material and anal cleansing materials. In wet systems the solids flowstream must be taken into account and treated accordingly with its own set of specific technologies for reuse or disposal.

In this factsheet seven distinctly different sanitation systems are described based on the categorisation from the EU-funded NETSSAF project (Network for the development of Sustainable approaches of large-scale implementation of Sanitation in Africa[2]). They all have their place and application, and not one of them is per *se* better than the other.

a) Wet mixed blackwater and greywater system with offsite treatment

In this system, all wastewater which is created by households and institutions, also partly industries and commercial establishments is collected, transported through gravity sewers or pumping mains, and treated without stream separation. There are different user interface technologies available for the collection of blackwater. These can be cistern-flush toilets or pour-flush toilets.

After collection, the blackwater is mixed with household greywater as it leaves the house; the mixture (referred to as "wastewater") is transported to a centralised treatment plant. Then a wide array of technology options for wastewater treatment can be applied. These treatment processes are generally biological reactors that convert the organic matter into bacterial cells, CO_2, and other non-noxious carbonaceous products. Some of the nutrients such as nitrates and phosphates can also be removed in the treatment process. The treated effluent is then discharged into the environment while the sludge produced is dried and disposed of on land or used as a soil conditioner.

The most common transport technology for "system" is sewer pipes with gravity flow. This system is generally called conventional sewer system. Occasionally, non conventional vacuum systems are used as a transport technology.

For this system new approaches and technologies have also been developed to take into account the limited financial capacities of low and middle income countries. Simplified sewers, also called condominial sewers, have less stringent design criteria, are located in backyards or sidewalks rather than under the roads, and can be constructed together with the community, although operational challenges have to be considered. This is a type of technology for wastewater transport which is used for example in Brazil.

b) Wet mixed blackwater and greywater system with semi-centralised treatment

This system, like the previous one, is characterised by flush toilets (cistern flush, pour flush or vacuum toilets) at the user interface. Here however, the treatment technology is located closer to the source of wastewater generation. Depending on the plot size, the treatment technology will be appropriate for one house, one compound or a small cluster of homes or an entire settlement.

Transport to the treatment plant is limited to short distances mostly by gravity sewers. There are various technology options for on-site wastewater treatment, which differ from those typically used for centralised, off-site technologies. These may or may not treat the wastewater to the same effluent standard as a centralised treatment facility, but due to the smaller volumes this can still be acceptable in environmental terms. Examples include anaerobic baffled reactors, constructed wetlands, DEWATS[3] and biogas plants (Gutter et al., 2009). Although it is commonly practiced, pits

[2]Information about NETSSAF and its outputs: www.susana.org/library?search=netssaf

[3]DEWATS stands for Decentralised Wastewater Treatment Systems, see www.borda-net.org

should not be used as disposal sites for mixed wastewater systems.

Figure 3: Vertical flow constructed wetland in the "Olympic forest park" located north of the city centre of Beijing, Peoples Republic of China, 2008 (source: J. Germer, 2008)[4].

c) Wet blackwater system

In this system, urine, faeces and flushing water (together called blackwater) are collected, transported and treated together. However, greywater is kept separate. Since greywater accounts for approximately 60% of the wastewater produced in homes owning flush toilets, this separation simplifies blackwater management. A common example of this system is the double-pit pour flush toilet; this technology allows users to have the comfort of a pour-flush toilet and water seal. Another technology option is anaerobic treatment for blackwater with biogas production.

In this system, a separate process for greywater management must be implemented. Since separated greywater contains few pathogens, and usually low concentrations of nitrogen and phosphorus, it does not require the same level of treatment as blackwater or mixed wastewater. Greywater can be treated with soil filters and recycled for irrigation, toilet flushing, cleaning around the house etc.

d) Wet urine diversion system

In this system, faeces, flushing water and greywater are collected, transported and treated together but urine is kept separate. The diversion of urine from the other flowstreams requires a specific user interface, known as a urine diversion toilet. Urine can be either collected with or without flushing water (see von Muench and Winker, 2011, for a detailed description of this concept).

The objective of the urine separation is to keep the urine free of pathogens and to ultimately facilitate its reuse in agriculture. In wet urine diverting systems, the faeces are flushed with water to an off-site treatment facility. Sometimes the urine is mixed with a small amount of flushing water. Due to the novelty of the user interface and the complicated infrastructure required for this type of system, it is not widely used yet and exists only in some demonstration projects[5].

e) Dry excreta and greywater separate system

Here excreta, a mix of urine and faeces, are discharged at the user interface without using any flushing water. Greywater is collected separately. Consequently, although the mixture of urine and faeces is wet, the system is referred to as "dry" because there is no flushing water. Depending on the cultural habits, anal cleansing water may or may not be included although odour and flies are minimised if the mixture is kept as dry as possible. This is particularly true for the simple composting toilets (such as Arborloo, Fossa alterna) that can become smelly if too much water is added.

Generally, the system is characterised by "drop and store" latrines that are emptied or abandoned when full. The separate greywater should be treated close to where it is generated (on-site-treatment). The faecal sludge may be further treated off-site. Generally, off-site treatment of faecal sludge for pathogen removal is difficult to organise properly and unfortunately often neglected. Households who do not have sufficient space to move their latrine over a new pit once it is full will often revert to emptying the pits by hand and burying the sludge in shallow pits nearby. It is possible to either reuse the recovered resources (greywater or treated faecal sludge) or to dispose of them when interest in reuse is lacking.

Figure 4: Faecal sludge being discharged from trucks into treatment beds in Cotonou, Benin (source: S. Blume, 2010).

[4] See SuSanA case study for details: www.susana.org/lang-en/case-studies?view=ccbktypeitem&type=2&id=36

[5] See SuSanA case studies with urine diversion flush toilets in Linz (Austria) www.susana.org/lang-en/case-studies?view=ccbktypeitem&type=2&id=66 and in Eschborn (Germany) - www.susana.org/lang-en/case-studies?view=ccbktypeitem&type =2&id=63

Certain innovations of this type of system have incorporated an enhanced drying process for the pit contents, producing dry compost that is simple to handle and dispose of. These latrines, also called desiccating latrines, generally use passive air flow enhancers and/or solar heat to speed up the drying process.

f) Dry urine, faeces and greywater diversion system

This system is characterised by the separation of urine, faeces and greywater into three different flowstreams, and, where anal cleansing water is used, a fourth flowstream. In this way, each flowstream can be separately managed in terms of its volumetric flow, nutrient and pathogen content and handling characteristics. This diversion can facilitate more targeted treatment and end use for the different fractions. This system requires a urine diversion dehydration toilet (UDDT) and a separate greywater treatment system.

In UDDTs, urine is collected through the front outlet and conveyed to a collection vessel (a tank in larger, more expensive systems or a jerrycan in smaller, simpler systems), or a soak pit if the urine is not reused. Through the second outlet the faeces are collected in a container located underneath the toilet pan or seat. The urine diversion squatting pan or seat can also be equipped with an additional outlet for anal cleansing water which is then treated in a separate flowstream. More information on UDDTs is available in Rieck et al. (2012).

g) Dry excreta and greywater mixed system

Urine, faeces and greywater are mixed in the same on-site collection, storage and treatment technology. Although this type of system with a simple soak pit for excreta and greywater together can be found in rural and peri-urban areas of many developing countries, it is not considered to be good practice in densely populated areas, or areas with high groundwater tables or unfavourable soil conditions. The difference between this system and the dry excreta and greywater separate system is the lack of separation of greywater. The performance of these systems has been enhanced through the incorporation of a sealed chamber into which all the wastes are disposed (a digester or type of septic tank system) with a filter at the outlet before the effluent enters a soak-away. The digester provides an environment for the partial treatment of the wastes.

Box 1: Note on reuse of sanitation sludge

Care should be taken in promoting the direct reuse of sanitation sludge for agricultural purposes. The digestion of wastes, even over long periods, may not render the compost-looking sludge completely free of pathogens. In particular the ova (eggs) of many protozoan parasites are not easily rendered non-viable even under good composting conditions. Users should always be informed on the safe use of the sludge including use of protective clothing (boots and gloves), and which crops it can be applied to.

4 Description and evaluation of technology components

In all the recent publications that have described sets of typical sanitation systems (Cruz et al., 2005; IWA, 2005; Tilley and Zurbruegg, 2007; Tilley et al., 2008; DWA, 2010) a certain procedure was applied to characterise technologies: along with the description of the sanitation system, each technology (or technological component) is discussed and described. The technology is grouped according to its role in the process (i.e. the function that it serves) while on the other hand it is also sub-divided according to the flowstreams that it deals with.

Table 1: List of sustainability criteria that can be used to evaluate and compare technological components and complete sanitation systems

Health issues	
reduces exposure (and thus health risks)	of users
	of waste workers
	of resource recoverers /reusers
	of "downstream" population
hygienisation rate	
increases health benefits	
Impact on environment / nature	
use of natural resources	needs low land requirements
	needs low energy requirements
	uses mostly local construction material
	low water amounts required
low emissions and impact on the environment	surface water and groundwater
	ground water
	soil / land
	air
	noise, smell, aesthetics
good possibilities for recovering resources	nutrients
	water
	organic matter
	energy
Technical Characteristics	
allows simple construction and low level of technical skills required for construction	
has high robustness and long lifetime/high durability	
enables simple operational procedures and maintenance; low level of skills required	
Economical and financial issues	
has low construction costs (unit cost per household) and low operation and maintenance costs	
provides benefits to the local economy (business opportunities, local employment, etc.)	
provides benefits or income generation from reuse	
Social, cultural and gender	
delivers high convenience and high level of privacy	
requires low level of awareness and information to assure success of technology	
requires low participation and little involvement by the users	
takes special consideration of issues for women, children, elderly and people with disabilities	

The technological components and the complete sanitation systems need to be discussed and evaluated with respect to specific sustainability criteria. Examples for such criteria are given in Table 1. This can lead to a comparison of the sustainability of different systems. Examples of such evaluations are given in Section 12 of each SuSanA case study (www.susana.org/case-studies).

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Acknowledgements are given to the following persons for their valuable contributions:
Elisabeth von Münch and Rahul Ingle (GIZ, Germany), David Del Porto (Ecological Engineering Group Inc., USA), Alexander Grieb (KfW, Germany), Ian Pearson (consultant, South Africa)

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More photos of sanitation systems and technology options are available here: http://www.flickr.com/photos/gtzecosan/collections/72157626218059440

sustainable sanitation alliance

SuSanA factsheet

Productive sanitation and the link to food security

April 2012

1 Summary

This factsheet provides information on the link between sanitation and agriculture as well as related implications on health, economy and the environment. It presents examples of treating and using treated excreta and wastewater in a productive way and describes the potential for urban agriculture and resource recovery in rural areas. Institutional and legal aspects, business opportunities and management of associated health risks are also discussed.

Productive sanitation is the term used for the variety of sanitation systems that make productive use of the nutrient, organic matter, water and energy content of human excreta and wastewater in agricultural production and aquaculture. These systems should enable the recovery of resources in household wastewater, minimise consumption and pollution of water resources, support the conservation of soil fertility as well as agricultural productivity and thereby contribute to food security and help to reduce malnutrition.

The implementation and scaling-up of productive sanitation systems is inhibited by weak, non-existing and sometimes prohibiting legislation. It is therefore necessary to develop relevant legislation along the sanitation chain taking into consideration the type of crops, occupational health, food hygiene and other preventive and risk management measures. This requires awareness raising, advocacy and behavioural change by all stakeholders. Further applied research is also needed to assess risk management options at the interface between agriculture and sanitation to support policy dialogue at the local and national level.

2 Background

Food security and the access to safe water and sanitation are fundamental human rights that for many people remain a promise unfulfilled. Globally still some estimated 2.6 billion people do not use improved sanitation facilities (WHO/UNICEF, 2010) and around 925 million worldwide are chronically undernourished (FAO, 2010).

To meet the dietary demands from a growing world population, projected to reach 9 billion by 2050, the world food production in 2050 would need to increase by 70% (FAO, 2009). A great deal of the population growth will take place in urban areas leading to a substantial increase in urban food demand and a corresponding increase in the amount of organic waste, human excreta and wastewater from cities to be managed in a safe and productive way. The safe recycling of sanitation products can contribute to improved resource management, reduce environmental impact and improved health and nutrition.

The resource perspective

Considering the number of people to be fed and the existing resource limitations, the food security issue should be approached with having resource preservation and recovery in mind. Here, productive sanitation systems play a key role.

At present farmers worldwide use around 164 million tons of synthetic fertiliser[1] in terms of N, P_2O_5 and K_2O annually (IFA, 2011). The production of the most important and commonly used fertiliser ingredients i.e. nitrogen (N), phosphorus (P), and potassium (K) is energy-intensive. Furthermore, the mineable phosphorus and potassium reserves are finite. The crop yields today depend to a large extent on mined phosphate rock and potassium, a significant departure from historical food production methods (UNEP, 2011).

Figure 1: Left: Greywater towers in Arba Minch, Ethiopia (source: W. Shewa, 2009). Right: Urine applied on petchay crops in Cagayan de Oro, Philippines (source: W. Repulo, 2007).

How long exactly the phosphorus and potassium reserves will last is hotly disputed as estimates depend on many factors, like the potential discovery of new reserves, increasing population growth and demand, increasing difficulty to extract reserves, and related market price developments (Cordell et al., 2009; UNEP, 2011). One additional concern is that lower grade phosphorus which might increasingly be mined in the future is often contaminated with radioactive uranium.

Recent phosphorus fertiliser price increases and the uncertain phosphorus future, stress the need for resource

[1] The term “synthetic fertiliser” in this factsheet equates more or less to other terms used colloquially for this type of fertiliser, namely industrial, chemical, commercial or inorganic fertiliser.

recovery on a global level (Rosemarin et al., 2009). It is estimated that the globally available phosphorus from urine and faeces could account for 22% of the total global phosphorus demand (Mihelcic et al., 2011).

Nitrogen can be extracted from the surrounding air but the industrial Haber-Bosch process is energy-intensive and today strongly based on limited fossil fuels. Furthermore, human activities now convert more nitrogen from the atmosphere into reactive forms than all of the earth´s terrestrial processes combined (reactive nitrogen is ammonia, ammonium, nitrate, nitrite and nitrous oxides, i.e. NO and NO_2) (Gruber and Galloway, 2008). This is four times the rate proposed as the planetary boundary for human modification of the nitrogen cycle, in order to avoid large-scale ecological impacts, such as oceans becoming eutrophic due to nitrate (Rockström et al., 2009).

This results in a triple driver for treated excreta use in agriculture in terms of nitrogen – to reduce fossil fuel use, reduce emissions of gases responsible for climate change and to reduce the input of reactive nitrogen in ecosystems.

Another essential resource in food production is water. Agriculture is a water intensive process and consumes 70% of the total water withdrawn globally (FAO, 2011). The supply and availability of water is increasingly diminishing and is unevenly distributed globally. Already today, large parts of Asia, Africa and the Middle East face either physical or economic water scarcity.

Environmental consequences

As urbanisation has outpaced sanitation infrastructure in many countries, today only a small fraction of human excreta receives appropriate treatment, and generally resource recovery is not included. Cordell (2009) estimated that only 10% of nutrients in excreta return to arable soil.

The disposal oriented sanitation systems together with continuous and excessive use of synthetic fertilisers on farmlands can lead to serious environmental consequences such as eutrophication of surface waters, dead zones along coastal estuaries and high nitrate concentrations in groundwater with a negative impact on human health.

Although in conventional agriculture the loss of the most important macronutrients is being compensated through application of synthetic fertilisers, these fertilisers cannot replace the loss of organic matter, microorganisms and many micronutrients equally important for fertile top soils. In many parts of the developing world the “mining” of soil nutrients is severe and crop yields are falling, as nutrients removed by the crops are often not replaced.

Health impacts of undernutrition

Undernutrition causes weakness and fatigue, inhibits mental and physical development particularly in children (where it also causes stunting), and makes people susceptible to other fatal diseases such as pneumonia and diarrhoea. In fact, it is estimated that the underlying cause for around one third of all deaths of children under five years old is undernutrition[2]. Children and adults who are suffering from diarrhoea and intestinal worm infections like ascaris, trichuris and hookworm obtain fewer calories from the food they eat. See for example DFID (2009) and Humphrey (2009) for more information on these health issues.

Productive sanitation could lead to higher crop yields, leading to less undernutrition and hence less susceptibility for disease, growth stunting in children and death. In addition, preventing diseases caused by lack of sanitation, such as diarrhoea and helminth infections, would lead to a more efficient use of available nutrients in food.

3 The historical link between sanitation and agriculture

Food production is historically linked with using liquid and solid waste from human settlements in agriculture. In former centuries the removal of organic matter and nutrients from the soil through harvested crops was compensated through application of animal manure, human excreta, compost or long fallow periods (see Lüthi et al., 2011). Only after the introduction of phosphorus mining in the mid 19th century, and industrial ammonia production at the beginning of the 20th century, it became the prevailing practice to replace nutrients removed with the harvest from the soil and the addition of human excreta with synthetic fertilisers.

In the same era water based sanitation systems with flush toilets and sewers were installed as a response to the acute health crisis in large cities at that time. Although these new sanitation systems did improve public health at that time significantly, they also contributed to polluting water resources and broke nutrient cycles.

The idea that human excreta is a waste product without a useful purpose is a modern misconception: pits, water bodies and landfills are used nowadays as sinks for nutrients, organic matter and pathogens.

4 Economic implications

A high percentage of the population in areas affected by the sanitation crisis carry out subsistence farming (IAASTD, 2009), and struggle to maintain an income for feeding their families. Workdays and income won through improved water and sanitation services are thereby also a contribution to food security.

Many farmers are nowadays facing higher prices of fertilisers, due to increasing demands, higher energy and transport costs as well as rising production costs (IWMI, 2011). Food and fertiliser prices have been particularly unstable since the beginning of 2008 (see Figure 2). When fertiliser prices rise, developing countries which are dependent on fertiliser imports for agricultural production are particularly vulnerable. Poor infrastructure and high costs of transport, particularly to remote areas, adds to the problem and further increases the local market prices for synthetic fertilisers.

Synthetic fertilisers are often not affordable for small-scale farmers in developing countries unless they are subsidised.

[2] See also www.childinfo.org/undernutrition.html

Recycling of nutrients and organic matter from human and animal excreta, wastewater and organic waste can therefore make a big difference to local crop yields.

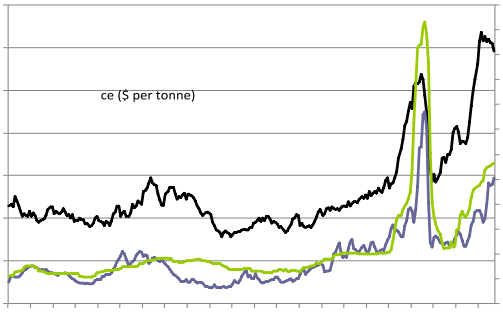

Figure 2: Food price index and fertiliser prices during 1990 to 2010 (source: FAO, 2011). Urea is a nitrogen fertiliser and TSP is a phosphorus fertiliser (Tri Super Phosphate).

There is almost a completely closed mass balance between nutrient consumption and excretion since – "what we eat is what we excrete". Therefore, the protein consumption of a person can be used to estimate the nitrogen and phosphorus content in their excreta (Jönsson et al., 2004).

An estimate of the value of plant nutrients in human excreta can be made based on the local cost of synthetic fertilisers with an equivalent quantity of nutrients. Such an estimate for urine in Burkina Faso was 7.5 EUR per person per year (Dagerskog and Bonzi, 2010) and in the case of the Philippines around 3.1 EUR per person per year (Gensch, et al, 2011).[3] To give another example: the average rural family of 9 in Niger excretes annually the nutrient equivalent of 100 kg (2 bags) of synthetic fertilisers (Dagerskog and Klutse, 2009).

Figure 3: Fertiliser bags brought along to illustrate annual nutrient amount present in excreta from one rural family in Niger (source: L. Dagerskog, 2010).

The resource reuse in agriculture can boost yields considerably. For example vegetables fertilised with urine produced 2-10 times more crops compared to those grown unfertilised (Jönsson et al., 2004). Fertilising with urine can achieve comparable results to synthetic fertilisers (Gensch et al., 2011).

[3] Based on the average annual exchange rate of the USD in 2009 (1 USD equals 0.75 Euros)

The increase in crop yield improves the availability and affordability of food and can result in higher food security. The increased agricultural yields can have a significant impact on the household income for the poor population, even if only subsistence farming is practised. Within the poor population in developing countries an estimated 40-80% of all generated household income is used for food (Viljoen, 2006). Where there is space for gardens, productive use of sanitation products can reduce household expenditures for the purchase of food.

5 The productive sanitation approach

Productive sanitation is a general term used for the variety of sanitation systems that make productive use of the nutrient, organic matter, water and energy content of human excreta and wastewater in agricultural production and aquaculture. These systems enable the recovery of nutrients and/or energy in household wastewater, minimise consumption and pollution of water resources and support the conservation of soil fertility as well as agricultural productivity and thereby contribute to food security. Productive sanitation systems can be considered sustainable if technical, institutional, environmental, social and economical aspects are appropriately addressed, according to the Vision Document of SuSanA.

Treated human excreta and wastewater, animal manure and organic solid waste can serve as important sources for soil amelioration, as they deliver relevant micro and macronutrients, organic matter and water needed for plant growth.

Some technologies out of a great number of options for treating and using excreta and wastewater in a productive way include[4]:

- **Use of source-separated urine:** Separately collected and treated urine is a complete fertiliser rich in nitrogen that can replace or complement synthetic fertiliser. Urine can be applied on fields, beds, vertical or container gardens, school gardens, or rooftops. This can be done on household or community level without sophisticated transport and application, but it is more difficult at city level due to high transport costs.
- **Struvite production:** Struvite is a mineral powder with high fertiliser value that can be produced from urine. Volume and weight are reduced compared to urine, it can be stored in a compact form and is easy to handle, transport and apply. Industrial struvite precipitation reactors exist (see www.saniresch.de/en).
- **Arborloo:** The Arborloo is a shallow pit latrine filled over time with human excreta and ash or soil added after each defecation and is only suitable for rural areas. As soon as the pit is full, the superstructure can be moved to a new area while a tree (such as fruit trees like banana or mango) can be planted on top of the nutrient-rich substrate of the old pit.
- **(Co-)Composting:** Organic solid waste can be collected from households and composted at community-based or

[4] For more information see respective SSWM technology sheets under: www.sswm.info/category/implementation-tools/reuse-and-recharge.

centralised composting plants. Pre-treated faecal sludge can be co-composted together with organic solid waste.

- **Short rotation plantations:** Short rotation plantations are an integrated agro forestry land-use system combining biomass production with wastewater use. Fast growing tree species are managed in short cropping cycles. These non-food crops have a high demand for nutrients and water, which may alternatively be met by using pre-treated wastewater and sewage sludge. The biomass produced can be used as renewable fuel for heat/power generation.
- **Biogas plants:** This process produces biogas and fertiliser under anaerobic conditions (absence of oxygen) from organic inputs. Biogas production from organic waste is interesting, as the revenue generated in that market might offset some of the costs for transport and treatment of organic waste (IWMI, 2011).

Flow streams

Wastewater and human excreta consist of different streams. Due to their different characteristics, it can be advantageous to consider separate collection with adapted treatment processes and application methods according to the flow stream's properties:

- **Human urine** contains essential plant nutrients like N, P, K and smaller fractions of micronutrients, in plant available form. On average, an adult person produces around 500 litres of urine per year. Human urine, when leaving the body, is essentially pathogen-free and can be considered a well-balanced nitrogen-rich liquid fertiliser.
- **Human faeces** contain lesser amounts of nutrients than urine and are rich in organic matter but also contain a high number of pathogens especially when a person is sick. On average an adult person produces around 50 kg of faecal matter annually although this figure varies widely depending on diet. Faeces are a valuable soil conditioner and can improve pH, nutrient content and water retention capacity of the soil and the ability of plants to withstand insects, parasite attacks and pests.
- **Greywater** is the wastewater from kitchen, baths and showers. It contains a low nutrient load compared with excreta or wastewater and hardly any pathogens. After appropriate treatment or other risk reduction measures greywater can be safely reused for irrigation.
- **Wastewater** is a term used for all kinds of wastewater and storm water mixed together. Due to its high nutrient and water content it can also be used as a fertiliser and irrigation source. However, due to the high pathogen load in domestic wastewater, treatment and appropriate risk reduction measures should be applied before use in agricultural production.
- **Organic solid waste** consists of organic kitchen waste, leaves, grass etc. that accumulate in households. Organic waste can also be used for gardening after a treatment process such as composting.

Benefits of productive sanitation include:

- The efficient resource reuse minimises uncontrolled excreta discharge in surface and groundwater with less environmental degradation.
- The use of treated wastewater as irrigation water can lead to a more economical use of potable water.
- In terms of soil fertility the nutrient loss through the harvest is almost completely compensable with excreta-based fertilisers.
- The organic matter from human and animal excreta improves the water retention capacity of the soil reducing irrigation water requirements and the vulnerability to droughts. Moreover the organic matter balances the soil temperature and enhances the buffering capacity of the soil.
- It can reduce health costs due to a better nutritional status of the population and less exposure to pathogens.

6 Cities as hot spots for resource recovery

The current global urban population is expected to double by 2050 compared to 1990[5], with 90% of urban growth taking place in developing countries (Drechsel et al., 1999). We need a transition to sustainable and resilient cities, which requires enhancing quality of life while minimising resource extraction, energy consumption, waste generation and safeguarding ecosystem services. This is directly related to city planning: to the development of city-based energy, waste, transportation, food, water and sanitation systems (Lüthi et al., 2011).

Urban and peri-urban agriculture (UPA) is the production of food and related services within and around cities. UPA includes urban horticulture, livestock, (agro-) forestry, aquaculture and related processing and marketing activities. Production of food by poor urban households can supply up to 20-60% of their total food consumption (De Zeeuw and Dubbling, 2009). Urban households that are involved in farming or gardening have in many cases a better and more diverse diet and are more food secure than households not involved in urban agriculture. UPA also increases the availability of fresh, healthy and affordable food for a large number of other urban consumers.

Urban centres are hubs of consumption of all kinds of goods including food, which makes them major waste generation centres. If this waste remains in the urban areas, the result will be vast, uncontrolled sinks for resources such as water, nutrients and organic matter. This poses environmental, health and economic challenges. Moreover, water demand for food production is increasing due to rising populations as well as due to changes in urban food consumption patterns.

Urban producers and farmers have a variety of motives for using untreated or partly treated wastewater. In semi-arid and arid areas it is often the only source of water available all year round. It is also an inexpensive source, not just of water but also of nutrients. Irrigated urban agriculture provides livelihoods and has an important niche function (Drechsel et al., 2010).

Management of urban wastes is a high-cost concern for many cities. Instead of flushing waste out of the city or bringing the waste to heaps in landfills, illegal dumps or transfer stations, there is growing understanding that composting and local reuse is an environmentally attractive way to manage parts of these otherwise wasted resources.

[5] http://esa.un.org/unpd/wpp/Analytical-Figures/htm/fig_1.htm

Decentralised safe reuse of wastewater and composted organic waste in UPA will help to:

- Adapt to drought by facilitating year-round production, making safe use of wastewater and nutrients in water and organic waste;
- Reduce the competition for fresh water between agriculture, domestic and industrial uses;
- Reduce the discharge of wastewater into rivers, canals and other surface water and thus diminish their pollution;
- Make productive use of the nutrients in wastewater and organic wastes.

UPA contributes to local economic development, poverty alleviation, social inclusion of the urban poor – women in particular – and to reduced vulnerability of cities and their inhabitants. Nutrient loops can be closed and the environmental benefits of urban agriculture can be enhanced.

7 Resource recovery in rural areas

Almost 50% of the world population still live in rural areas, where local reuse can be relatively simple and make a big difference, especially for smallholder farmers. The resource potential of human excreta needs to be emphasised, and a close collaboration with the agriculture sector established.

Two recent productive sanitation projects in Burkina Faso and Niger were financed from the agricultural sector (EU food facility and IFAD), where treated urine and faeces have been termed “liquid and solid fertiliser”, and toilets and urinals are promoted as “fertiliser factories” (see Dagerskog and Bonzi, 2010). Agricultural extension workers were at the forefront of these projects, using farmer field schools to show the effect of treated urine and faeces as fertilisers.

Figure 4: Increased vegetable crop yields when using urine as fertiliser in “Productive Sanitation in Aguié Project” (source: L. Dagerskog, 2010). More photos: www.flickr.com/photos/gtzecosan/sets/72157627175906041.

This created demand for toilets and urinals that transformed dangerous raw excreta into safe fertilisers. There are examples of villagers selling and buying treated urine and faeces, as well as households in surrounding villages that construct toilets or urinals on their own initiative to obtain the safe fertiliser.

8 Institutional and legal aspects

Weak, non-existing or sometimes prohibiting legislation on reuse of excreta and wastewater makes it difficult to implement and scale up productive sanitation systems. Ideally, a regulatory framework should facilitate the safe reuse of resources from sanitation systems. Resource reuse may require changes to existing sanitation, environmental and agricultural policies, or the development of new policies. Effective laws and regulations establish both incentives for complying as well as sanctions for not complying with the requirements.

The “Guidelines for safe use of wastewater, excreta and greywater in agriculture and aquaculture” (WHO, 2006) can be used as a reference when national policies and legislation are developed. These guidelines aim to protect the health of individuals and communities by recommending safe practice requirements and supporting the development of risk management.

It is necessary to develop relevant legislation along the sanitation chain, from excreta treatment and transport to application of fertiliser, restrictions on the type of crops grown, occupational health, food hygiene and other preventive measures.

A legal framework that focuses on desired functions of the sanitation system rather than specific technologies stimulates innovation and is not out-dated as fast as technology prescriptive regulatory frameworks. This is described by Kvarnström et al. (2011) using Sweden as an example where in 2006 national guidelines for on-site sanitation were developed.

The Swedish guidelines are not focussing on technology per se but on the function of the sanitation technology instead. They guide local authorities on what kind of expected results from the sanitation system they should impose on the house owner. The national guidelines especially emphasise the need to reduce the phosphorus loads to the recipient water bodies and the importance of nutrient recycling.

In a setting with large-scale recycling of excreta (or “sanitation products”), it is important to guarantee the quality from both a hygienic and an agricultural point of view to maintain trust between stakeholders. This could be achieved with a system of certification, including permits for professionals who work in the sanitation chain, as well as quality control of the sanitation products. It is important not to over-burden the control system as the regulations should be feasible to implement under local circumstances.

Allowing treated excreta as fertilisers and organic matter sources in organic and conventional agriculture would certainly boost recycling. The International Federation of Organic Agriculture Movements (IFOAM) restricts the use of human excreta on food crops, but exceptions may be made where detailed sanitation requirements are established by the standard setting organisation to prevent the transmission of pathogens (IFOAM, 2005). However, if the use of sanitised excreta in agriculture is prohibited in the food importing country, the exporting country will not use it except for own consumption. An example is the EU legislation on

organic farming, which does not allow the use of sanitation products as fertilisers for organic crops to be sold in the EU (Richert et al., 2010).

9 Management of health risk

Sanitation related health risks occur mainly through persistent pathogenic organisms in excreta such as bacteria, viruses, protozoa and helminths. If not collected, treated, transported and applied properly this can lead to transmission of infectious diseases such as diarrhoea and the proliferation of intestinal worms. The purpose of every sanitation system is therefore to protect human health and install effective barriers against possible exposure to pathogens.

In this context the WHO has set up guidelines to protect the health of individuals and communities regarding the productive use of excreta, greywater and wastewater and recommend a flexible multi-barrier approach for managing the health risks. The guidelines give recommendations for adequate use in agriculture and offer management solutions if effective wastewater treatment is not possible. It is stated in these guidelines that wherever the use of wastewater, excreta and greywater "contributes significantly to food security and nutritional status, the point is to identify associated health hazards, define the risks they represent to vulnerable groups and design measures aimed at reducing this risks" (WHO, 2006).

The WHO recommends that the additional disease burden arising from wastewater and excreta use in agriculture should not exceed 10^{-6} DALYs (disability-adjusted life years). This means that only one year out of a million human life years should be lost because of disability or death from a disease caused by the use of wastewater or human excreta. This high level of protection was adapted from the recommendations used for WHO drinking water guidelines and is currently under discussion as possibly being too strict (Mara, 2011).

Partially treated or untreated wastewater can be used provided that barriers are applied at various stages of the process, like crop restrictions, application techniques, and food handling by vendors and consumers. This requires awareness raising, advocacy and changes in attitudes of a wide variety of stakeholders, both rural and urban. In addition to the WHO guidelines, the Stockholm Environment Institute recently published a support tool for practitioners, planners and engineers to allow for a rapid assessment of health risks associated with the components or functional groups of sanitation systems (see Stenström et al., 2011).

Hormones and pharmaceutical residues do occur in wastewater and sludge as human beings excrete them with their urine and faeces. There is a theoretical possibility that if wastewater is reused in agriculture, but even more so in aquaculture, these micro-pollutants could enter the human food chain. However, these risks are small in comparison to the dangers of pathogens and diarrhoea which are the main challenges when sanitation is lacking, but also in comparison to pharmaceutical residues contained in animal manure, or risks resulting from pesticide use. Soil is considered a more suitable medium for natural degradation of pharmaceuticals than water. Pharmaceuticals can be degraded better in aerobic, biologically active soil layers with a high concentration of microorganisms and longer retention times than in the more sensitive ecosystems of water bodies (Richert et al., 2010).

Contamination of wastewater with heavy metals from industrial wastewater should be avoided through introduction of cleaner production approaches which keep industrial wastewater apart from domestic wastewater and imposing proper treatment processes within industries.

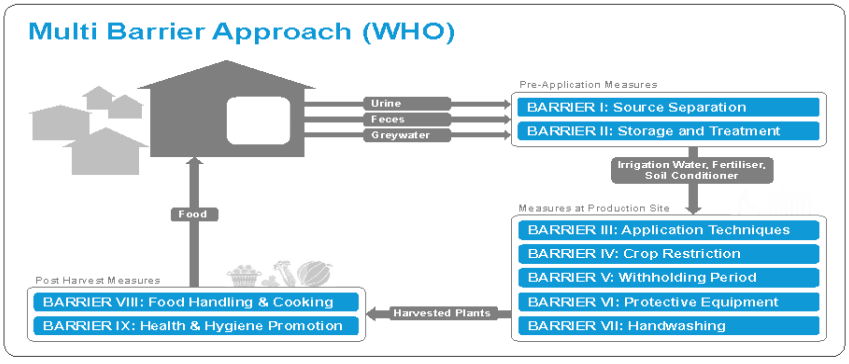

Figure 5: WHO multi-barrier approach to safe use of excreta and greywater in agriculture.

10 Business opportunities

The water, nutrients and energy recovered could enable cost reduction or recovery in the sanitation service chain and could offer market opportunities[6].

Increasingly there is agreement on the need to move from "treatment for disposal" to "treatment for reuse" (Drechsel et al., 2011). Successful involvement of the private sector in providing sanitation services and recovering resources in waste materials will directly enhance the livelihoods of millions of households in rural and peri-urban areas of developing countries (ibid.).

In low-income countries, sanitation and waste management traditionally have been either neglected or subsidised by public-sector agencies, with service quality varying across locations and income levels resulting in notable health and environmental problems. This reliance on public-sector provision has prevented development of markets in sanitation services that might be best provided by private companies. The market analysis and business planning needed to promote private sector or public private activities has not been conducted, although interest in developing viable business models is increasing among donors and international organisations (ibid).

11 Challenges and way forward

Despite all known and convincing benefits of productive sanitation, a number of challenges and problems still need to be overcome which differ largely between countries and regions. These concern cultural barriers and perceptions, political will, missing knowledge on economics of waste management and reuse, development of appropriate regulations and legal frameworks, and technical aspects of making reuse profitable.

In most parts of the world, the productive sanitation concept has not been fully embedded in legislation. The cultural barriers, fear of health impacts, and the neglect of sanitation and wastewater management in general might explain the lack of clear policies in support of safe reuse options.

Reversing current trends and patterns requires the adoption of holistic and integrated approaches. Multi-stakeholder consultation, joint planning and decision-making will be needed to adapt existing policies or develop new ones. More applied research is also needed to assess risk management options in the agriculture and sanitation interface in support of policy dialogue at the local and national level.

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Acknowledgements are given to the following persons for their valuable contributions:
Moussa Bonzi (CREPA, Burkina Faso), Dierk Demand (consultant), Axel Drescher (University Freiburg, Germany), Philipp Feiereisen (GIZ, Germany), Jörn Germer (University Hohenheim, Germany), Richard Higgins (Nutrition Through Food, United Kingdom), Robert Holmer (AVRDC, Thailand), Ester de Jong (GWA), Håkan Jönsson (SLU, Sweden), Cecile Laborderie (ECODOMEO, France), Analiza Miso (XU SUSAN Center, the Philippines), Elisabeth von Münch (GIZ, Germany), Thilo Panzerbieter (GTO, Germany), Gerhard Pelzer (consultant, Germany), Gopal Poyyamoli (Pondicherry University, India), K. V. S. Prasad (AME Foundation, India), Anna Richert (consultant, Sweden), Arno Rosemarin (SEI, Sweden), Emery Sindani (SuSan Design, Kenya), Laurent Stravato (iDE, Burkina Faso), Christine Werner (GIZ, Morocco), Bismark Yeboah (GIZ, Germany).

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sustainable sanitation alliance

SuSanA factsheet

Planning of sustainable sanitation for cities

April 2012

1 Summary

This factsheet deals with the planning of sustainable sanitation for urban and peri-urban areas of developing countries and its importance for achieving comprehensive and inclusive sanitation coverage in cities.

The key messages of this factsheet are:

- Top-down, supply-driven planning continues to dominate much of sectoral planning in the developing world. The resulting capital-intensive solutions tend to be costly, energy-intensive and inflexible, and often fail to reach large proportions of the urban poor.
- Experience has shown that importing sanitation planning models from industrialised countries and implementing centralised "one-size-fits-all" solutions is in many cases inappropriate and not sustainable in developing countries. Thus, planning approaches must be adapted to better allow for the planning and implementation of context-specific sanitation systems.
- Recent innovations in sanitation planning include a more integrated planning approach; a greater emphasis on the actual needs and financial capacity of the users, encompassing close consultation with all stakeholders[1] and a systems approach to sanitation, integrating all domains of the city.
- There is a lack of integration between the various components of environmental sanitation[2] – excreta, domestic and industrial wastewater, solid waste and storm water are managed in separate systems, which are often run by different agencies or institutions. Better use of generated synergies through integrated approaches could lead to more sustainable and cost-effective solutions.
- Political economy issues: improving sanitation coverage especially for the urban poor means tackling vested interests and corrupt practices of regulatory authorities, the private sector and politicians. Planning must openly deal with these issues and seek to increase incentives for anti-corrupt behaviours and to achieve greater transparency at community and city levels.
- Local authorities, utilities and donors have to be convinced that commitment and effective participation from all stakeholders are needed to achieve adequate and inclusive sanitation services.

This factsheet elaborates on the shortcomings of supply-driven planning and presents three demand-led approaches which recognise that stakeholder involvement is a prerequisite to effective planning. Based on past experiences we propose guiding principles for better sanitation planning in cities of developing countries.

2 Introduction

The United Nation's International Year of Sanitation 2008 highlighted the need for an enormous increase in the number and use of sanitation facilities in order to meet the MDG target on basic sanitation (to halve, by 2015, the proportion of the population without sustainable access to basic sanitation). Although 1.3 billion people gained access to improved sanitation between 1990 and 2008, the world is still likely to miss the MDG target by one billion people. And even if the target was achieved, 1.7 billion would still remain unserved (WHO/UNICEF, 2010).

Figure 1: An unplanned urban area with iron sheet and mud houses in Mathare (Nairobi, Kenya) (source: L. Kraft, 2010).

One of the reasons why the world is not on track to meet the MDG sanitation target is that service provision cannot keep up with the unprecedented growth in urban populations and the increasing socio-economic disparities. While the number of people practicing open defecation declined in rural areas between 1990 and 2008, it increased in urban areas, with the poorest segment of the population being much more likely to practice open defecation than the wealthiest (WHO/UNICEF, 2010).

[1] Stakeholders in the sanitation sector are households, local and national authorities, community-based organisations, community leaders, utilities, private service providers, NGOs and farmers.

[2] Environmental sanitation includes sanitation, stormwater drainage and solid waste management. Water supply is also addressed in so far as it impacts on the above environmental sanitation services.

The daunting task of improving global access to sanitation is complicated by the fact that conventional technologies such as pit latrines or sewer systems that discharge into local water bodies are often not environmentally and economically sustainable (SuSanA, 2008).

To address these tremendous challenges, improved approaches for planning and implementation of sanitation infrastructure and services are urgently needed.

Planning in its most general sense is about decision making and can be defined as *"a process of making choices among the options that appear open for the future and then securing their implementation"* (Roberts, 1974).

Ever since the beginning of urban civilisation 5000 years ago, humans have to some extent been planning urban environments and their corresponding services and infrastructure. Since the 19th century, urbanism and urban planning have developed into a field of knowledge and practice whereby the city is viewed as an object for study, intervention and control.

The full range of urban sanitation problems is not discussed here, as this is the focus of the thematic paper "Sustainable Sanitation for Cities" (Panesar et al., 2008).

3 Shortcomings of conventional planning approaches

The principles of planning that continue to dominate the thinking of urban and infrastructure planners and political decision-makers in the South are based on the concept of "manageable towns". Today, however, large parts of cities in developing countries are completely neglected by mainstream planning. The majority of urban populations live in informal, unplanned settlements which are often considered illegal or unauthorised and only tolerated at best. The combination of the pace and scale of urban population growth in developing countries is undermining the efforts of city and municipal administrations to plan and guide urban development.

Current practices of town planning tend to be dominated by top-down, technocratic approaches which are excessively restrictive, divorced from reality and oblivious to the present and future needs of poor citizens. This type of planning is adopted in the so-called Master Plan[3] or Comprehensive Development Plan approach. Experiences from the last few decades have shown that the implementation of master plans rarely keeps pace with the development of new areas. The practice of planning lags behind what happens on the ground: first, there is occupancy or squatting; second, construction; third, "informal" planning of basic infrastructure; and fourth, normative regularisation.

There are other problems with a top-down, technocratic planning practice:

- It is often dominated by vested interests, powerful elites and influential figures at national and local level that tend to promote expensive "supply-driven" approaches (see following section). Little attempt is made to include the views of all stakeholders, particularly the users, when large schemes and new neighbourhoods are planned and implemented.
- A major disadvantage of master plans is their inflexibility in form and content. This inflexibility stems from the burdensome procedure to produce and later amend the official plans. If a plan requires modification after formal adoption, councils must repeat all of the procedures required prior to adoption.
- The restrictive nature of city master plans is also problematic. Current urban planning departments are heavily biased towards development control, covering only a fraction of the built city.
- The majority of national legislation and regulations tend to favour planning of centralised sewer-based solutions – neglecting household interests and their ability to pay for these systems. Centralised sewer-based solutions carry with them a technology lock-in, have high capital, operation and maintenance costs, and need a reliable supply of energy to run. Often, the process lacks consideration of other decentralised solutions that could prove to be more economical and environmentally viable options.
- The lack of a holistic approach in establishing a service delivery chain from collection to reuse and disposal often leads to dysfunctional decentralised solutions.

Supply-driven planning

The traditional planning approach to urban sanitation infrastructure has been one in which planners and engineers assess the needs of a given area, and then decide what type of service will be provided (supply-driven approach). A common failure of planning and implementation in the past, was the failure to take into account the needs and conditions of the users of the sanitation facilities as well as of other important stakeholders (land owners, financial institutions, users of wastewater or other products generated from sanitation systems).

Government and donor agencies generally continue to rely on supply-driven approaches that have distinct drawbacks (Wright, 1997):

- The main beneficiaries are the richer neighbourhoods that can afford higher levels of services (sewers, septic tanks, household water connections, etc.) which are often also subsidised. Poorer neighbourhoods tend to be excluded for both cost and technical reasons.
- Investment and operation and maintenance (O&M) costs are often not recovered, with the result being that neither proper O&M nor service extensions are possible.
- Due to the costs of these capital-intensive solutions being so high, public investment to improve sanitation coverage also in poor urban areas is typically not available.
- If solutions are sought for low-income neighbourhoods, they tend to be "one-size-fits-all" solutions, with little consideration of the negative effects such as possible environmental pollution.

[3] A master plan is a comprehensive long-term strategy with detailed guidance and instructions in achieving its set goals.

- The high initial cost of such large-scale projects restricts competition as only large companies have the resources to tender for such construction contracts, hence smaller and medium-size local contractors are excluded.

An example of supply-driven sanitation is the Centrally Sponsored Rural Sanitation Programme (CRSP) which was launched in 1985 in India to improve sanitation coverage in rural areas. The approach adopted by the Government of India was to provide free or heavily subsidised services in the form of twin-pit pour-flush toilets. The only potential customers were upper-income land owners living in large permanent dwellings and a few influential local figures who had these toilets built for themselves at the state's expense (Black and Fawcett, 2008). Fortunately, the Indian Government has drawn lessons from failed programmes like these and is now supporting more demand-led initiatives such as the Total Sanitation Campaign (WSP, 2010).

Unfortunately, most infrastructure planning and service delivery to date continues to be supply-driven with a high degree of centralised control, little local accountability and little involvement of the end users. Gradually utilities and service providers are "waking up" to the fact that "more of the same" will not suffice. In the past decade, several new multi-stakeholder and partnership approaches have been developed and tested. These will be focussed on in the following section.

4 Innovations in sanitation planning

There are three important approaches to sanitation planning for urban and peri-urban areas of developing countries which recognise that stakeholder involvement is a prerequisite to effective planning, and seek to overcome the shortcomings of top-down and supply-driven approaches:

- The Strategic Sanitation Approach (Wright, 1997)
- Community-Led Urban Environmental Sanitation Planning: CLUES (Lüthi et al*.*, 2011a)
- Sanitation 21 (Parkinson and Saywell, 2011)

Example 1: The Strategic Sanitation Approach (SSA)

Strategic planning is an integrated, comprehensive approach that emphasises not only the technical and economic aspects, but also the challenges of institutional capacity and public participation. Central to the approach is the comprehensive systems analysis of the strategic options selected. The strategic planning process differs from sectoral planning in its global approach and from the classical master planning approach, in its methodology and its orientation – it is more flexible and responsive, less static and not overly complex.

The Strategic Sanitation Approach (SSA) was developed in the 1990s by the UNDP-World Bank "Water and Sanitation Programme" (WSP) and tested in two pilot towns in Kumasi, Ghana and Ouagadougou, Burkina Faso (Saidi-Sharouze and Botte, 1994). The most comprehensive review of the SSA was published by Wright (1997).

Central to SSA are the twin principles of demand and the attention paid to incentives. The former is seen first and foremost in economic terms and strongly linked to the concept of willingness to pay. This has raised a debate on the appropriateness of limiting demand to economic aspects only. While urban poor residents may indicate a high willingness to pay for services such as water and electricity, they may indicate a low willingness to pay for other services such as sanitation or drainage which have important impacts on environment and health (Cotton and Tayler, 2000). Demand is a multi-faceted issue which must also include cultural norms, individual behavioural aspects as well as economic aspects (ability to pay and financing mechanisms).

Preconditions for adopting a strategic sanitation planning approach include the formulation of demand-based policy (as opposed to supply-driven approaches described above) and the development of an institutional framework to provide the right incentive structure. Programme management is done by a "core group" of experts from the City Engineers Department, the Planning Department and selected short-term consultants.

Box 1: Kumasi Sanitation Project (1989-1994)

The Kumasi Sanitation Project in Ghana applied SSA to develop a flexible strategy for urban sanitation in Kumasi, a city of 770,000 inhabitants in which 75% lacked adequate sanitation services. A demand-oriented approach was adopted that differed from previous agency-led initiatives by:

- tailoring recommendations on technical options to each type of housing in the city;
- considering user preferences and willingness to pay;
- using a short term planning horizon (10-15 years);
- emphasising actions that can be taken now;
- breaking the strategic plan into projects that can be implemented separately.

The project partners were the Kumasi Metropolitan Assembly (KMA), the UNDP-World Bank Regional Water & Sanitation Group for West Africa for technical assistance and the Kwame Nkrumah University of Science and Technology (KNUST). By the end of the 5 year pilot project, 160 KVIPs (with 240 individual units) serving a population of 4,000 in the low-income pilot areas were built and a simplified sewerage system cum septic tanks was built in the Asafo area serving around 20,000 persons.

Source: Saywell and Hunt (1999)

The UNDP and World Bank funded Strategic Sanitation Approach was a great step forward in adopting more realistic and appropriate sanitation planning strategies for cities of developing countries. There are however, three drawbacks worth mentioning:

- Despite the rather high amounts invested by the project (1 million US$ for Phase 1 during 1990-2000), coverage rates in Kumasi remained very low, due to the high construction cost and the amount of subsidy of the strongly promoted KVIP[4] (~200 US$); households did not have a choice of lower-cost options.

[4] KVIP stands for Kumasi Ventilated Improved Pit Latrine.

- The technical, planning and promotion approach followed was biased towards the technology choice rather than health or hygiene promotion.
- The SSA does not deal with all processes of the sanitation system and failed to plan for the wider aspects of faecal sludge management (transport, treatment, and disposal or reuse).

The SSA was also implemented in India, Pakistan, Thailand, Indonesia, Brazil and Burkina Faso[5]. Its effectiveness has been proven in Indonesia where the government intends to scale up the formulation of city strategies from 2010 onwards (Collin et al., 2009).

Example 2: Community-Led Urban Environmental Sanitation (CLUES)

CLUES is a demand-led approach for the planning and implementation of environmental sanitation infrastructure and services in deprived urban and peri-urban communities. It is a multi-sector and multi-actor approach which emphasises the participation of all stakeholders from an early stage. It places the community at the core of planning and implementation.

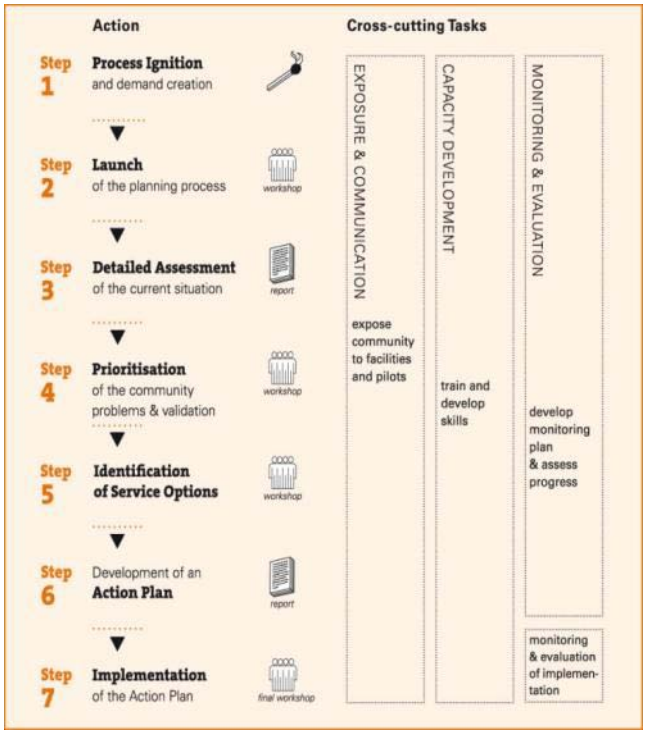

Figure 2: The seven steps of CLUES planning (source: EAWAG, 2011)

By involving all relevant stakeholders, particularly the targeted community, this approach attempts to consider the whole range of perspectives and expectations. This should help to find and implement, through common agreement, the best possible environmental sanitation solution.

CLUES is a further development of the Household-Centred Environmental Sanitation (HCES) planning approach (Eawag, 2005) with a revised and simplified set of planning guidelines, which is based on the Bellagio principles for sustainable sanitation (WSSCC, 2000). Intensive piloting and evaluation of the HCES approach took place between 2006 and 2010 in Africa, Asia and Latin America, in seven different urban and peri-urban sites (see Box 2).

Box 2: CLUES in Nala, Nepal (2009-2011)

CLUES was field-tested in Nala, a peri-urban setting in Nepal. The aim was to validate the planning approach, identify challenges and improve the process. The participatory multi-stakeholder process involved household mapping and surveys, user needs identification and prioritization as well as stakeholder analysis.

Following an experts' assessment of potential sanitation options, community sensitization campaigns took place through exposure visits, a sanitation bazaar (figure 3), and focused community interactions. Among the pre-selected sanitation alternatives the community members showed strong preference for a small-bore sewerage system with a decentralised wastewater treatment plant. An action plan which details the wastewater, stormwater and solid waste management concepts was developed. Health and hygiene upgrading as well as local capacity building were additional components of the plan. Implementation started in 2010, focusing on upgrading household sanitation facilities, constructing the sewer network and decentralised wastewater treatment system, and building local capacity.

Several experiences and lessons have been gained from this participatory, integrated environmental sanitation planning exercise in Nala. Setting the right balance between empowering people to take informed decisions and keeping the participation process intact until the final stage was a major challenge. Although participatory planning consumes time, it is worth investing as it builds local ownership and assists in informed decision-making processes for selecting affordable sanitation options that best meet the users' needs.

Source: Sherpa et al. (2012)

Figure 3: Sanitation bazaar as part of the CLUES process in Nala, Nepal (source: Sandec, 2009)

[5] IWA Water Wiki: http://iwawaterwiki.org/xwiki/bin/view/Articles/Strategic+Sanitation+Approach#HEvidenceofeffectiveness

There are three cross-cutting tasks which are relevant throughout the entire planning process.

1. *Awareness raising and communication* are key to creating demand and raising people's ability to make informed choices about the most appropriate solutions.
2. *Capacity development* aims to strengthen skills for process management and collaborative planning and skills like engineering, construction, operation and maintenance.
3. *Process monitoring and evaluation* allows one to identify and correct mistakes, imbalances or even to change the shape and direction of the project before it is too late.

In order for a CLUES process to be effective and successful, it has to be embedded in a so-called enabling environment. An enabling environment can be seen as the set of interrelated conditions that impact on the potential to bring about sustained and effective change (adapted from World Bank, 2003). The six elements that define an enabling environment (see Figure 4) need to be nurtured and pro-actively fostered to provide favourable conditions for planning in challenging urban environments.

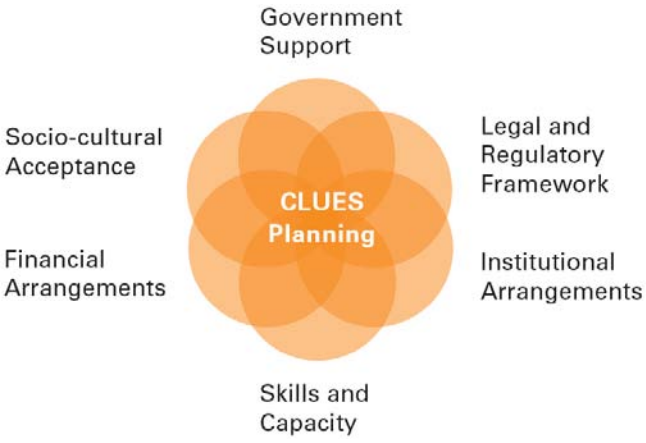

Figure 4: The six elements of an enabling environment (source: EAWAG, 2011)

CLUES adopts a flexible and neutral approach with regard to technology choice, taking into account economic factors (ability and willingness to pay) and social benefits such as privacy, dignity and convenience. The approach combines expert knowledge at national and municipal level with local knowledge at community level. CLUES is primarily focused on solving sanitation problems in unserved (often informal) settlements and aims at deriving solutions requiring minimum external support and, at the same time, complementing citywide and strategic approaches such as Sanitation 21.

Example 3: Sanitation 21 – Simple approaches to complex sanitation

Sanitation 21 is a comprehensive approach for the assessment of planned or unplanned sanitation situations. However, unlike the previous example which provides detailed guidelines, this is a planning framework, and it does not provide in-depth guidance for planners and operators. The Sanitation 21 approach suggests that technical planners and designers have to develop more sophisticated planning systems that respond to the needs of rapidly growing cities. With regards to the human and political context, this will require a change in the manner of making technical decisions. Sanitation 21 draws on well-established principles of good planning and design practice from within the technical world and also from a lot of inputs by the developing world contexts (Parkinson and Saywell, 2011).

Box 3: The 9 planning steps of Sanitation 21

Part 1: Defining the context

1. Identify key actors at each level. Carefully assess the range of interest groups.
2. Identify interests of key groups - what do they want from a sanitation system?
3. Understand what external factors drive decisions at each level. Are they fixed or can/should they be changed?
4. Identify capacities at each level for implementation and long-term management of any system. Include interests, skills, resources, and time.

Part 2: Sanitation systems or options

5. Analysis of existing systems. Where there is an existing system, map this against the identified levels. Segregate the system to make it clear what elements exist and function at each level.
6. Identify in detail the management requirements for the systems segregated across each level. These requirements include skills, human resources, time, tools etc.

Part 3: Fit for Purpose

7. Does the proposed or existing system meet the objectives at each level? Does it provide the service households expect? Will it address environmental concerns at the city level?
8. Can the system be managed the way it needs to be managed at each level? If not, what are the alternative system arrangements (institutionally or technically) making it more likely for management to be carried out in the long term?
9. By taking all the previous steps and technical considerations into account, will (or does) the system work? If a number of workable options are thus identified, these (and only these) may be suitable for an economic and financial assessment to identify the long-term costs of the solution.

Source: Parkinson and Saywell (2011)

The Sanitation 21 planning framework includes three parts (see Box 3):

- Part 1: The Context – understanding the context and environment;
- Part 2: Technical Options – the sanitation system and its components;
- Part 3: Fit for Purpose – how well does the system fit with the context?

Sanitation 21 was conceived with the same vision as the community-led approach presented above. Similarities include the concept of dividing the city into different domains of intervention (household to city level), the system options analysis and the importance of analysing stakeholders'

interests or "drivers" at each level. Unlike the two previous approaches, Sanitation 21 has not yet been tested on the ground.

Sanitation 21 identifies eight generalised system typologies depending on the different flow streams. The systems range from on-site dry toilets with (semi-)centralised treatment to conventional waterborne sewerage with centralised treatment.

Sanitation 21 includes further planning innovations such as in Part 3 of the framework, where the likelihood of success at each level should be assessed. The "level approach" allows an assessment of the proposed or existing system across all urban levels. This can reveal why a system which appears to meet the city's objectives may not result in better services for households, or why a system selected by households may result in worsening the situation at "downstream" levels.

Whilst the Sanitation 21 planning framework is not a new planning approach, its principles are based on the intense prior planning work and it motivates a new mindset amongst technical planners and those responsible for urban sanitation. In particular, it seeks to open up debates and encourages the technical professional community to think beyond "business as usual" approaches, appealing to strong business arguments of efficiency and effectiveness in design as the way to bring about positive change.

Table 1 provides an overview of the features and strengths of each approach presented. The three examples illustrate that there is no "silver bullet" for planning for sustainable sanitation – each approach has advantages and disadvantages depending on context, available skills and capacity. Future research efforts must focus on how these approaches can be further improved, linked with each other, institutionalised and taken to scale.

Table 1: An overview of the main characteristics of the three sanitation planning approaches

	Strategic Sanitation Approach (SSA)	**Community-Led Urban Environmental Sanitation (CLUES)**	**Sanitation 21 – Simple approaches to complex sanitation**
Focal aspects	- socio-economic - technical - institutional set-up	- user involvement - enabling environment - action planning - environmental aspects	- socio-economic - technical - environmental aspects
Stakeholder involvement & methods used	- community consultation - core group of experts	- all stakeholders encouraged - to participate - include community in all planning steps	- focus on planners & experts - institutional mapping, understand the drivers at each level
Technology choice	- unbundle solutions by zone or neighbourhood - mostly disposal oriented	- open to all system options - solutions according to expressed needs & available resources - involvement of stakeholders, final choice by community	- open to all system options - integrated solutions across boundaries
Special features	- cost-recovery important - contingent valuation survey - willingness to pay	- waste diluted as little as possible integrated solutions: environmental sanitation - complementary to city-wide approaches	- holistic: from households to downstream domains - city-wide approach

5 Guiding principles for better sanitation planning

When planning for the complex realities of the one billion people currently living in informal urban settlements worldwide, some radical rethinking is required. This factsheet maps out the key issues that need to be addressed in order to achieve progress in replicating good practice and moving to scale. Some key issues and pointers for adopting successful planning approaches are summarised below.

a) Understand power relationships

Stakeholder assessment, institutional mapping and regulatory review tools of analysis are effective for analysing existing power relationships and vested interests in an urban context. Such an analysis must include formal and informal institutional arrangements, as well as public, private and civil society institutions. It should focus on groups and individuals whose interests are likely to diverge. Understanding the dynamics and the regulatory environment of an urban setting is a prerequisite for producing informed planning solutions. This means being aware of and trying to work against corrupt practices by promoting the greatest possible transparency of planning decisions.

b) Ensure effective participation

All of the above planning approaches underline the importance of stakeholder participation. It is of great importance to empower local people through raising their skills and capacities. The key issue here is information sharing from the outset of any project or programme.

There are three capacity components which should be developed for improving participation and action. These are (adapted from Goethert and Hamdi, 1997)[6]:

- **Individual capacity** (particular skills individual people in the community have)
- **Collective capacity** (a community's capacity to organise, mobilise and support collective actions)
- **Institutional capacity** (the institutional framework having an influence on communities and their longer-term sustainable development)

c) Build partnerships and reach consensus

Good partnerships and participatory programmes begin when actors come together to achieve a common goal based on agreed priorities. Of great importance is developing local champions at community and municipal level which can drive the process forward. Wherever possible, one should utilise participatory action planning methods to converge the interests of stakeholders and to pool resources, and effectively incorporate them in the project objectives. It should be noted however, that partnerships are not always easy and that it takes considerable effort and time to maintain them and to keep them going over time.

d) Aim for closed-loop solutions if appropriate

Waste should be considered as a resource and its reuse should be encouraged from the very start of any planning process. Examples for reuse or "productive sanitation" are greywater reuse, production of biogas, liquid fertiliser or soil conditioner, composting etc. (see also Gensch et al., 2012). These technologies may also be less energy intensive and have lower capital and operation costs than other end-of-pipe solutions which are purely disposal oriented. Testing of pilot technologies can be the first step in convincing users about safety, advantages and convenience.

e) Be realistic about the complexity of sanitation interventions

Lacking political will, unclear land ownership and tenure, as well as technical, financial and institutional challenges of providing affordable and manageable sanitation solutions for dense, informal settlements have been the main reasons for low coverage to date. To move forwards, initiatives should aim for the "unbundling of interventions": breaking the plan into projects that can be implemented separately and incrementally. There is a trade-off to be made between short-term "quick fix" solutions versus long-term sustainable infrastructure improvements.

f) Understand the drivers of sanitation

We should recognise that sanitation improvements have many drivers and sources of motivation – not only the existing sector institutions and their agendas, but also individual aspects such as customs and habits, context specific practices, social status, or the demand for reusable products such as fertiliser from sanitation systems. To bring urban sanitation coverage to scale, new innovative tools like social marketing, Urban Community-Led Total Sanitation[7] campaigns and public-private partnerships must be adopted and applied in a context-specific manner. This is discussed further in the SuSanA factsheet on public awareness and sanitation marketing.[8]

The concepts presented in this factsheet have formed the basis for a more extensive book entitled "Sustainable sanitation in cities: a framework for action" by the same authors which was published in 2011 (Lüthi *et al.*, 2011b).

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[6] For more on Capacity Development for Sustainable Sanitation, see Spuhler et al., (2012): www.susana.org/lang-en/library?view=ccbktypeitem&type=2&id=1229

[7] See Sijbesma, C. (2011) Sanitation financing models for the urban poor, see Chapter 5.2: www.irc.nl/home/information_services/publications/publications_by_date/sanitation_financing_models_for_the_urban_poor

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Acknowledgements are given to the following person for her valuable contributions:
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sustainable sanitation alliance

SuSanA factsheet

Sustainable sanitation for schools

April 2012

1 Summary

The aims of this factsheet are to:

1. Advocate for sustainable sanitation in schools in developing countries and countries in transition
2. Highlight existing challenges
3. Explore various innovations both in hardware and software using examples from developing countries
4. Identify the common principles that are needed to achieve the desired outcomes.

The guiding principles for successful and sustainable school sanitation are:

- Stakeholder involvement in decision making and planning, particularly to ensure children's participation and good leadership.
- Creating demand through stakeholder involvement (demand-driven approaches) and identification of suitable sanitation technologies for local conditions including reuse options in school gardens if possible.
- Monitoring outcomes, impacts and processes, including health and hygiene assessments, school attendance and usage of facilities.
- Using many channels and different media for sanitation and hygiene advocacy beyond health benefits only (multi-faceted approach) including advocacy through working with local institutions.
- Establishment of an enabling environment at policy level with relevant government ministries through the development of guidelines and standards, legislation and enforcement and sufficient budget provision.

This document's target audience includes practitioners, policy-makers, researchers and the general public who would like to learn more about sustainable sanitation in schools.

2 Background

Sustainable sanitation systems in schools include both hardware (toilet and handwashing facilities) and software (sensitisation, hygiene practices, monitoring, training and advocacy) components. Toilet options may be selected from a wide range of simple to more complex technologies.

Sustainable sanitation is defined as promoting and improving health and hygiene, protecting environmental and natural resources, and being technologically and operationally appropriate, financially and economically viable and socio-culturally and institutionally acceptable (SuSanA, 2008).

Sustainable sanitation solutions must be implemented against the backdrop that "acceptable levels of safe water, sanitation and hygiene are not met in many schools worldwide" (WHO, 2008).

In developing countries two-thirds of schools do not have sanitation facilities (CARE et al., 2010). Also many countries in transition, for example in Central and Eastern Europe, have low coverage of access to safe water and sanitation in schools (Deegener et al., 2009). Even many schools in industrialised countries have challenges of hygienic use and maintenance of their toilet facilities.

Figure 1: Pupils at a school in Epworth, Harare in Zimbabwe learn to build their own toilets: digging the shallow pit of an Arborloo inside a concrete ring beam (source: Aquamor, Zimbabwe, 2009). More photos of this school available here: www.flickr.com/photos/gtzecosan/sets/72157626300000229/

Schools, the very places to *educate children* and *provide a healthy environment*, are unable to fulfil these obligations mostly due to the lack of political motivation and attention for sanitation and hygiene. This leads to:

- Schools with inappropriate, poorly managed and insufficient facilities for children, especially for children with disabilities, adolescent girls and young children under the age of eight years old.
- Lack of financial resources for cleaning and maintaining toilet facilities in schools.
- Lack of proper hand washing facilities and anal cleansing material such as water, toilet paper, or leaves.
- Lack or poor enforcement of regulations and guidelines related to school sanitation and keeping the premises clean.

- Insufficient or non-existing budgets and financing for new sanitation facilities and also operation and maintenance of existing facilities.
- Lack of awareness of the importance of safe school sanitation.

Access to safe sanitation is a human right that has to be recognised and fulfilled (Stock, 2011). The major challenge to reach the Millennium Development Goal for improved sanitation (MDG 7)[1] is not merely technical nor economic, but lies in raising awareness on preventable sanitation-related diseases, changing traditional views and encouraging habits for good hygiene (UNICEF/WHO, 2008).

Figure 2: School children in Epworth, Harare, learning how to make simple low-cost hand washing devices (source: Aquamor, Zimbabwe, 2008).

Behaviour is formed during childhood and therefore education on health and hygiene in schools is vital to improving conditions of people's lives from childhood to adulthood. School sanitation and hygiene programs can have important outreach functions for targeting households. Children have demonstrated that they can be effective agents of change as demonstrated in School-led Total Sanitation programs in Asia, Latin America and Sub-Saharan Africa.

Children are change agents. Schools are important links to reaching individual families and communities. Children pass on their knowledge from school to their families and thus influence the communitv.

Sanitation issues for *urban* schools tend to differ somewhat from those at *rural* schools. For example, urban schools often have less space, but sometimes have the possibility to connect to a centralised sewer system. Some technologies like pit latrines and Arborloos might be feasible for rural schools but not for most urban schools. The involvement of parents and the wider community might also have a different intensity at urban schools. Nevertheless, the same guiding principles apply to school sanitation in all settings.

[1] Toilets at schools are not counted in the MDG monitoring system of WHO and UNICEF, called Joint Monitoring Program (JMP), and thus do not directly support reaching the MDG Number 7 for sanitation. However, sustainable school sanitation leads to lasting behaviour change which will result in a higher degree of demand for sanitation amongst the children once they are adults.

3 Defining the problems

A number of challenges for sustainable school sanitation are described below. Many of these are not specific to schools but relate to sanitation in general. Where this is the case, the specific school factors are highlighted.

a) Poor access and use of sanitation facilities

It is estimated that approximately two-thirds of primary schools in the developing world do not have adequate sanitation (CARE et al., 2010). Lack of sanitation leading to diarrhoea in children is attributed to 272 million schools days lost each year and to intestinal worm infestation of an estimated 400 million children. Where facilities do exist, as many as 150 children have to share one toilet in some schools. At that ratio, pupils have to queue up to use the facilities; also the toilet pits fill up quickly (in the case of pit latrines) and toilets become smelly making them both unattractive and unhygienic for the pupils to use (Zomerplaag and Mooijman, 2005).

A study in Colombia found that 40% of diarrhoea cases were transmitted at schools and not at the children's home, further underlining the importance of the availability and proper use of school sanitation facilities (CARE et al., 2010).

Moreover, the provision of hand washing facilities in schools and day-care facilities resulted in a 30% reduction in cases of diarrhoea (CARE et al., 2010). In spite of these findings, most schools in developing countries do not provide appropriate hand washing facilities with soap. Where these facilities do exist, they are often poorly located, have insufficient hand washing materials or have other shortcomings (World Bank, 2005). Hand washing facilities are possible to implement with innovations to bring water to the schools by rainwater harvesting, carrying water from home in jerry cans or tanks filled by water trucks. Soap can also be made locally.

b) Lack of policy framework and institutionalisation of school sanitation

Generally, there is a lack of political frameworks for sanitation and WASH in general at all levels to guide implementation, operation and maintenance. Where sanitation policies do exist, they are often unclear, or even contradictory, in their aims and objectives (Elledge, 2003*).* There is also a lack of responsibility taken for school sanitation by the school principal or even school inspectorates who do not prioritise the responsibility for proper operation and maintenance of facilities.

School principals are more likely to implement sustainable sanitation approaches if guided by a policy or strategy. Policy influences incentives and can encourage positive institutional behaviours and actions through regulation, enforcement, economic measures, as well as related information and education programs. Policies are pivotal in assigning rights and responsibilities for providing services (Elledge, 2003).

Therefore, school sanitation and hygiene policies are likely to create the enabling environment for access, use and maintenance of facilities. Policies also provide the foundation for scaling-up initiatives.

However, many countries still do not have adequate policies for school sanitation, as it falls under the responsibility of three or even four ministries. Education ministries are responsible for schools, but technical support for sanitation, hygiene and water supply comes from Ministries of Water, Health and or even Public Works (or Infrastructure). Where decentralisation or devolution of government services is taking place, local government also has a role in coordination and management of budgets for water and sanitation facilities at schools. This leads to the need for complex new working arrangements.

Institutional reform is necessary to delineate roles and responsibilities such that facilities can be properly managed by schools and communities, get the necessary technical back-up from NGOs, community-based organisations and the private sector through a facilitated and regulated process (World Bank, 2005).

Where national standards do exist for school sanitation, they may also be stifling innovation, as they tend to prescribe technologies which are based on "Western" influences and norms, such as flush toilets connected to sewer systems. If schools cannot afford to operate such types of toilets, they often do not get enough institutional support to look for alternative, low-cost solutions.

> Schools play an important role as refuge and relief centres during an emergency. Having good sanitation facilities and hygiene practices at schools - before, during and after an emergency - will serve a wider community beyond the school.

c) Lack of budget allocation for operation and maintenance

Public schools, like most public institutions, are generally not oriented towards being particularly economical and cost-effective. This is because of the lack of incentives to do so since they are not fully in charge of their own annual budgets.

There is also a lack of supporting policy environment, therefore finding economically viable solutions or maintaining existing sanitation facilities in a cost-effective manner is unfortunately not a priority for many schools. Muellegger et al. (2012) provides more details on operation and maintenance (O&M) problems and solutions for sustainable sanitation systems in general.

Facilities may not be regularly cleaned because there is no consideration or availability of funds for cleaning. Cleaning is often not seen as a necessity, as documented in an Ethiopian study, where cleaning averaged only once a week (DeGabriele and Porto, 2007). Project funds are allocated to the construction of toilets but no arrangements are made to support schools for maintenance or cleaning materials. Government operational budgets for schools rarely consider routine maintenance, cleaning supplies, soap or toilet paper as they have a perceived lower priority in relation to other needs of the school. Schools then often rely on parents to make contributions for these supplies.

When given choices for sanitation facilities, the real or "hidden" operation and maintenance costs for toilet facilities are not presented to schools to make informed choices. This is an issue for example for flush toilets connected to a septic tank which needs regular desludging.

Lockable toilet doors are another issue where the costs and benefits carefully need to be weighed up. The doors are important for privacy, particularly for girls. But they are also prone to vandalism and deterioration due to wind and rain. Once the door is broken, the facility is rendered useless if the school does not replace or repair the door. Blind corners or spiral designs with lockable gates at the end of the spiral could be alternative options, requiring less maintenance. These different door options need to be discussed during the planning phase.[2]

> Providing mirrors at the toilet facility can make toilet use more attractive. Being able to see the visible difference with a clean face has an attraction for girls and boys. Adolescent girls in particular value mirrors.

Figure 3: Two of the winning posters during the "My School Loo" city-wide contest in Cagayan de Oro, Philippines (source: M. Masgon, 2011). More photos on this campaign available here: www.flickr.com/photos/gtzecosan/sets/72157626926206066/.

d) Inappropriate designs for children, especially girls, small children and children with disabilities

Sadly, the few toilet facilities present at schools often do not meet children's needs. Small children are affected in terms of the size of the drop hole in the case of pit latrines, size of squatting pan or pedestal as well as issues of darkness in the toilets which creates fear. Children with disabilities are often excluded altogether by the lack of accessible facilities.

[2] Another disadvantage of lockable doors can be that they are locked to keep children from using the toilets because children make the toilets "dirty". Here again, doors for privacy end up being a barrier for girls to use the facility (example from UNICEF Cambodia).

Adolescent girls are affected and distressed in terms of privacy, security and menstruation management.

Facilities intended for children are often not designed with the children in mind. This is primarily because approaches for sanitation and hygiene often do not involve or consult user groups in the decisions of design, location or numbers. This has led to facilities being too large for children to use, such as pit latrines with wide-spaced foot rests, or hand washing facilities too high for children to use unassisted.

Toilets which are not designed to be "child friendly" may be scary or difficult to use for small children, as in Malawi where children feared falling into the large drop holes of pit latrines or entering the dark facilities with little light or ventilation. The results were that children defecated in the entrance to the latrine and in the corners of the latrine – rendering them filthy and unhygienic to the next user (B. Abraham, personal communication, 2010).

Issues of access are particularly challenging for children with disabilities, as schools and toilets are not adequately designed to cater for their needs. Children with disabilities are unable to use facilities without assistance because of poor design choices. Children with mobility or vision challenges may be forced to crawl or feel their way to a toilet often coming into contact with faeces on the ground (Bwengye, 2004). To further exacerbate the situation, there is frequently not an accessible or functioning hand washing facility either.

In the case of urine diversion dehydration toilets (UDDTs), it is important to use the bench design or to build ramps in order to cater for the needs of people with disabilities such as wheelchair users. This is required because UDDTs have the faeces vaults fully or partly above ground and have stairs towards the entry of the toilet cubicle (Rieck et al., 2012; von Muench and Duering, 2011).

For adolescent girls, considerations for menstrual hygiene, privacy and security are often overlooked. Fearing the possibility of not being able to change menstrual hygiene products or the embarrassment of soiling oneself, teenage girls often choose to stay home during their menstrual period (Nahar and Ahmed, 2006).

Given the fact that girls on average begin menstruating at around 12 years old, and menstruate for about 3-5 days per month, the total number of school days lost during schooling years of a teenage girl can be significant (approx. 40 school days per year). If the girl is not attending classes during her menstruation, these missed school days likely lead to low performance and eventual drop-out from school.

> Listen to the girls! We are learning from examples in Malawi that girls want lockable doors with no bottom and peek-proof ventilation as well as find the use of girls urinal attractive (DeGabriele et al., 2004).

Figure 4: School girls inspecting the faeces chamber of a urine diversion dehydration toilet in Nakuru, Kenya[3] (source: R.M. Gacheiya, 2009). More photos of this school available here: www.flickr.com/photos/gtzecosan/sets/72157624069945409/

e) Social and cultural norms against dealing with human excreta

Sustainable sanitation solutions with a component of reuse of treated excreta or wastewater are generally perceived to be more complex to operate and maintain than conventional technologies without reuse. On the other hand, they can be utilised to teach children about growing vegetables in school gardens, using compost and fertiliser from "productive" sanitation systems; see Section 5 in this factsheet.

In terms of ecological sanitation (ecosan), which is part of sustainable sanitation, human excreta are regarded as a resource which can be used as a fertiliser in agriculture or to produce biogas. However, for many people, the idea of handling excreta brings a strong feeling of disgust, related to unpleasant past experiences of strong odours, flies and the unsightliness to the immediate environment.

Hence methods to bury excreta, flush it away or just walk away from it have become the practice of millions of people worldwide – in order to avoid having to "deal with" human excreta. The resulting solution usually has a low degree of sustainability and can lead to abandoned pit latrines after the pits are full or environmental pollution in the case of flushing without wastewater treatment.

f) Lack of stakeholder involvement

The importance of stakeholder involvement is addressed in detail in Section 6.

4 Examples of what is working well and lessons learned

There are many examples of school sanitation projects and programmes throughout the world from which we can learn important lessons towards improving school sanitation approaches. See for example the case studies on the SuSanA

[3] This project at Crater View Secondary School is also described further in a SuSanA case study: www.susana.org/lang-en/library?view=ccbktypeitem&type=2&id=125.

website here: www.susana.org/lang-en/case-studies?showby=defa ult&vbls=5&vbl_5=22&vbl_0=0

5 Linking sanitation and nutrition

Malnutrition, iron and zinc deficiencies are major nutritional shortfalls from which pre-school and primary school children suffer. This makes a good case for sustainable sanitation linked to school gardens with three main objectives: 1) an educational objective to teach children about growing healthy foods; 2) a nutritional objective to provide children with healthy food and; 3) an economic objective to generate a supplementary income for schools (Drescher, 2002; Morgan and Shangwa, 2010).

One of the advantages with choosing those types of sustainable sanitation technologies which emphasise reuse of treated excreta (such as urine diversion dehydration toilets (UDDTs), Arborloos and Fossa Alternas) is that human waste can be used as fertiliser and soil conditioner after sanitisation (see Richert et al., 2010). Also, the children can be involved during the construction of these toilets.

Sanitised human excreta can be used for nutrient recycling in school gardens, where children can be taught how to grow their own vegetables (see Morgan and Shangwa (2010) for examples in Zimbabwe). Biogas produced from human waste and other organic matter in biogas digesters can be used for cooking in the school kitchen. Treated wastewater can be applied in the school garden for irrigation.

If the local socio-cultural norms do not support the reuse of excreta, additional awareness raising is necessary by demonstrating the nutritional and economic benefits for the schools. Planning needs to be done in collaboration with school staff and adjacent farmers to investigate possibilities for transport and use of urine and treated faecal matter on nearby farms.

Selling vegetables from a school garden which is more productive due to the additional “toilet fertiliser” could give the school a small income, covering for example provision of soap and toilet paper. This incentive may also lead to greater care for the school toilet by users and cleaning staff as the fertiliser production would have a real value for the school.

Without proper consideration of the reuse part of toilets which were designed for reuse, facilities can become obsolete and not used, as observed by SNV in Rwanda (Verweij and Nyirishema, 2010). By providing back-up support and an incentive for the reuse of faeces and urine, an inherent incentive for schools can be created to adopt and maintain productive sanitation for better nutrition and supplementary income.

6 Guiding principles for sustainable sanitation in schools

General factors for achieving long term success in implementing sustainable school sanitation are:

- Awareness raising among the decision-makers on the importance of school sanitation.
- Stakeholder involvement in decision making and planning, particularly children’s participation and good leadership
- Creating demand through stakeholder involvement by employing demand-driven approaches.
- Monitoring outcomes, impacts and processes, including health and hygiene assessments, school attendance and usage of facilities.[4]
- Using many channels and media for promotion of sanitation and hygiene emphasising also benefits beyond health benefits alone (multi-faceted approach).
- Having an enabling legal, technical, economical and social framework in place for the implementation of new and sustainable sanitation concepts for schools.

Figure 5: School children in the Philippines practising to wash hands with soap (source: R. Gensch, 2008). More photos on this project: www.flickr.com/photos/gtzecosan/sets/72157611890084172/

Sustainable sanitation in schools does not need to be expensive. A simple, low-cost toilet can meet all the principles of sustainable sanitation (health, hygiene, environment, economical, technologically appropriate and socio-culturally acceptable). However, superstructures made of cheap materials might need to be renovated faster (and re-investment financing is difficult to find again). Investments for school sanitation should focus on the long-term maintenance and operation to ensure sustained use and health benefits for children.

[4] An impressive example for a well set-up monitoring and evaluation system in the school health context is the large scale “Fit for School” program in the Philippines (www.fitforschool.ph).

Conditions for successfully planning and building sustainable school toilets with the involvement of *key stakeholders* include (Deegener et al., 2009):

- The school ensures the training of all *pupils* before and after the toilets are constructed. Training for pupils must be carried out every year again when new pupils come to school.
- The same type of toilet should be installed for the teachers.
- The pupils can even be involved in building their own toilets (see Figure 1 and Morgan and Shangwa (2010)).
- All *teachers and staff members* participate in the trainings. Information on operation and maintenance of the toilet facility is available for *school staff and caretakers*.

The school employs *paid cleaning staff* who clean the toilets several times a day, ideally after each break.

- In the case of UDDTs: the toilet products are ideally reused as fertiliser by the school or a nearby *farmer*.
- The *school or community* takes the responsibility for maintenance and repair of the facility.
- The *school administration* is ready and able to provide the hand washing facilities, water, soap, and toilet paper.
- All legal aspects must be considered and discussed with the *local authorities* in advance if a technology with reuse is implemented.

Further specific factors for achieving sustainable school sanitation are:

a) Children at the centre: Child-friendly facilities[5]

The involvement of children in planning and design of both hardware and software is essential. Without a child-centred approach, the sanitation system may remain unused and unhygienic behaviours may prevail (such as open defecation and no hand washing).

Child-friendly facilities should (more details provided in IRC, 2007):

- Have appropriate dimensions for children to be able to use them correctly and at any time.
- Offer enough capacity and minimise waiting times, otherwise children may resort to open defecation.
- Use appropriate locations for young children considering cultural, environmental and practical aspects which encourage regular use.
- Address gender roles and needs, particularly those of adolescent girls during menstruation.[6]
- Address the needs of children with special needs, particularly those with disabilities.

b) Demand-driven approach

School-led Total Sanitation uses schools as the entry point for total sanitation in communities. This was demonstrated with some positive examples in Nepal, Indonesia, India and Kenya (UNICEF, 2008; Kurniawan, 2008; Otieno, 2008). School children have provided the impetus through self-respect, pride, guilt, shame and disgust to end open defecation in schools and the communities, and have created a demand for sanitation.

c) Multi-facet approach to advocating and promoting sustainable sanitation through skills-based education

Construction of sanitation facilities alone is not enough to make significant impacts on health and livelihoods (World Bank, 2005). Based on the experiences of Community-led Total Sanitation (CLTS), advocating for sanitation purely on health benefits alone is also not enough to elicit change in behaviour and encourage households and pupils to adopt new behaviours (Kar, 2010). A multi-faceted approach which uses different concepts and methodologies to encourage people to assess their situation and find appropriate solutions is essential.

In schools, skills-based hygiene education which includes songs, drawings and daily routines are more likely to reach a wider audience and raise the interest of more children including their parents. One successful example for a skills-based approach in terms of handwashing is the Fit for School program in the Philippines (Benzian et al., 2012). Moreover, building arguments with demonstrated successes based on improved livelihood, increased attendance rates, convenience, economic advantages, environmental improvements, or pride and status, go a lot further to mobilise key decision-makers in schools and communities to support sustainable sanitation.

7 Conclusions

Sustainable sanitation in schools can contribute to reaching Millennium Development Goals 2, 3, 4 and 7 for primary education, gender equality, reduction of child mortality and access to sanitation. With greater attention to guiding principles (stakeholder involvement, demand-responsive approaches and skills-based education) and adequate financial instruments, schools have the potential to reach hundreds of millions of school children and their families with sustainable sanitation including good hygiene behaviours.

The examples mentioned in this document show how various considerations in different conditions are having positive benefits for children in terms of improved attendance rates, better health as well as economic and nutritional benefits.

Fortunately, a growing database of initiatives throughout the world is providing evidence that a lot can be done to improve sanitation in schools. Firstly, promotion of sustainable sanitation must consider the development of high quality advocacy campaigns which convince decision-makers of the "value-added" and benefits for society through effective targeting and awareness programs. Secondly, monitoring of sustainable sanitation systems must go beyond the focus on counting facilities to include health and hygiene baselines as well as monitoring regular use, quality of technology, operation, maintenance, and socio-cultural acceptability.

The over-riding element for success is stakeholder involvement and ownership. Beyond a superficial or passive

[5] A number of resources exist when planning child friendly facilities. See for example: www.washinschools.info/.

[6] This goes far beyond physical infrastructure but requires significant education and awareness for the girls and boys, too (see Wendland et al, 2012)

engagement, stakeholders – in particular the pupils, teachers, parents, caretakers and school administration – should ideally be involved in the selection, design and if possible construction of facilities, as well as organisation of management, long-term monitoring and problem solving. Stakeholder involvement and subsequent ownership ensures that local and appropriate solutions are applied, making the sanitation system sustainable.

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Acknowledgements are given to the following persons for their valuable contributions:

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More photos of sustainable school sanitation are available here: www.flickr.com/photos/gtzecosan/collections/72157626092 939057/

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sustainable sanitation alliance

SuSanA factsheet

Integrating a gender perspective in sustainable sanitation

April 2012

1 Summary

The overall objective of this factsheet is to provide background information on the needs and methods required to integrate gender perspectives into sustainable sanitation. Access to safe sanitation is a basic human right for all women, men and children. Our objective is to offer guidance to those seeking to incorporate gender into the sanitation sector.

Integrating gender in sanitation requires comprehensive information about the gender specific local context provided by assessments such as socio-economic analyses and impact assessments of policies and programmes on females. Project managers should consider a gender balance in project teams and make budget allocations for gender strategies. The involvement of women in leadership and management training programmes and adequate support to enable women to be involved in the operation and maintenance of sanitation facilities needs to be integrated into sanitation projects.

Key messages from this factsheet are:

- Gender equality is an integral part of sustainable sanitation meaning that the sanitation system should consider the differing needs and should be suitable for women, men and children.
- Women are often involved in water, hygiene and sanitation but lack support to deal with these issues
- Planning, design and implementation of a sanitation programmes should not be regarded only as a male domain but can and should be equally undertaken by women.
- There is a widespread lack of suitable sanitation facilities compounded by a lack of privacy. This increases female vulnerability to violence and impacts their health, wellbeing and dignity.
- Data regarding gender needs should be disaggregated to give recognition and acknowledgment to women's needs and priorities.
- There is an unspoken but grave situation in the everyday lives of millions of school girls and women that make it difficult for them to walk freely and in a comfortable manner, to go to the toilet or to manage their menstruation sustainably.
- The special needs of menstruating girls and women need to be considered in appropriate sanitation programme designs by providing adequate female hygiene materials, discreet disposal and washing facilities.

2 Background on gender and sanitation

Access to safe and sustainable sanitation is essential to ensuring health and wellbeing. It reduces the burden of treating preventable illnesses and is a prerequisite for ensuring education for all and the promotion of economic growth in the poorest parts of the world. Access to adequate sanitation is a matter of security, privacy and human dignity.

Integrating a gender perspective into the sanitation sector does not only require addressing differences in gender relations, it also means uncovering and challenging uneven hierarchical structures based on gender. Consequently, a gender-sensitive approach seeks to equalise the uneven distribution of sanitation roles and responsibilities and the access to safe and appropriate facilities by considering the basic needs of all men, women and children.

One of the most significant divides between women and men, especially in developing countries, is found in the sanitation and hygiene sector. The provision of water, hygiene and sanitation is often considered a woman's task. Women are promoters, educators and leaders of home and community-based sanitation practices yet their own concerns are rarely addressed. Societal barriers often restrict their involvement in decisions regarding sanitation facilities and programmes (GWA, 2006).

Figure 1: Sanitation approaches can be more empowering if both women and men are involved in planning and training: Sanitation workshop in Central Asia (source: F. Jorritsma, WECF, 2010).

In many societies, women's views, in contrast to those of men, continue to be systematically under-represented in decision-making bodies (ADB, 1998). This lack of a

participatory approach is closely related to the uneven power structures in decision-making processes that characterise these societies and the sanitation sector in particular. Where sincere efforts have been made to integrate gender perspectives into the water and sanitation sector, these have unfortunately often failed to address strategic gender needs (Coles and Wallace, 2005).

Women suffer more than men when there is a lack of appropriate sanitation facilities. Women suffer more indignity from defecating and urinating in the open than men and in some countries are regularly at risk of assault and rape while going to the toilet (COHRE et al., 2008). In many countries, hygiene conditions in public toilets are poor and spread infectious diseases. In the absence of sanitary facilities or due to cultural reasons, women in many countries often have to wait until dark to go to the toilet or the bush. As a result, these women try to drink as little as possible during the day and often suffer from associated health problems such as urinary tract infections, chronic constipation and other gastric disorders (GWA, 2006; Milhailova and Diaz, 2007).

In rural areas, men avoid the stench of unimproved pit latrines and relieve themselves outside whilst women remain dependent on the pit latrines. Often in urban areas, women and girls face innumerable security risks and other dangers when they use public facilities which are open to both men and women. Research in East Africa indicates that safety and privacy are women's main concerns when it comes to sanitation facilities (Hannan and Andersson, 2002). Without safe sanitation, women's dignity, safety and health are at stake.

3 What does gender mean?

Gender identifies the **social relationships between women and men.** Gender is socially constructed; gender relations are contextually specific and often change in response to altering circumstances (Moser, 1993). Men and women fulfil a number of concurrent social roles and social relations that are influenced by other people. Race, ethnicity, age, culture, tradition, religion and an "individual's position" (wealth, status) also contribute to differentiating the experience of being a man or a woman within a particular society. Gender identity and gender roles are the result of learned behaviour and given the right impetus and motivation can change. The challenge in this context is that men's and women's gender roles determine their access to - as well as their power and control over - adequate water supply, sanitation facilities and hygiene. Unchallenged, these roles can continue to have a direct negative effect on communities, households and individuals, in particular women and children.

Gender equality (or equity) means equal visibility, opportunities and participation of women and men in all spheres of public and private life. Gender equity is often guided by a vision of human rights that incorporates acceptance of the equal and inalienable rights of women and men. Gender equality is not only crucial for the wellbeing and development of individuals but also for the evolution of societies and the development of countries. However, gender equality has not yet been achieved. Male violence against women continues to be a cause of death and suffering worldwide. There are 600 million illiterate women compared to 320 million men worldwide. In South Asia and Sub-Saharan Africa in particular, girls have a lower chance of completing primary education compared to boys. Although important progress has been made, for example in respect of universal school enrolment, and women's access to the labour market and the political sector, gender inequality is still one of the most pervasive forms of inequality worldwide (UNFPA, 2005; UN, 2007; UN, 2011).

4 International commitments and goals for gender equality in relation to sanitation

Millennium Development Goal (MDG 3) calls for the promotion of gender equality and women's empowerment. Four indicators are used to monitor progress: education, literacy, wage employment and political representation.

In addition to the millennium development goals, resolutions, comments and expert reports recognising the right to water and safe sanitation there are some specific international instruments relevant to promoting a gender perspective within the sanitation sector (WEDO, 2003):

The Convention on the Elimination of all Forms of Discrimination against Women (CEDAW) (1979) is the most important legally-binding international instrument for the protection of women's rights. Addressing the living conditions of women in rural areas, the CEDAW states in article 14(2) (h), that parties shall ensure that women have "the right to enjoy adequate living conditions, particularly in relation to housing, sanitation, electricity and water supply, transport and communication." The CEDAW already asserts the right of rural women to water (article 14). However, because women often lack land rights, they are unable to assert their water rights.

The **UN Resolution** of the 23rd Special Session of the **General Assembly**, New York in June 2000 emphasised "Further actions and initiatives to implement the *Beijing Declaration and Platform for Action*". Actions should be taken by governments at the national level to: "Ensure universal and equal access for women and men throughout the life-cycle to social services related to health care, including education, clean water and safe sanitation, nutrition, food security and health education".

Human rights[1]**:** In July 2010, the UN General Assembly recognised for the first time that access to water and sanitation is a basic human right. This right was confirmed in a resolution by the Human Rights Council in October 2010 and was declared legally binding. The content of the human right to water and sanitation is still under discussion. Five normative criteria (availability, accessibility, quality/safety, affordability, acceptability), and five cross-cutting ones (non-discrimination, participation, accountability, impact and sustainability) are used to define this right.

[1] See also a compilation of relevant documents here: www.susana.org/lang-en/library?view=ccbktypeitem&type=2&id=1331

5 The role of women and men in sanitation

In most countries, cleaning toilets is primarily the responsibility of women, for any type of sanitation system. Men are generally responsible for the construction and technical maintenance of the sanitation facility (e.g. digging and repairing). In many households, women are responsible for making sure there is sufficient water for sanitation purposes which may involve carrying water for long distances. They are also involved in pit emptying activities; although this is a burden for men as well (anecdotal evidence suggests that e.g. in India and Pakistan, more women than men have to empty pits whereas in countries in Sub-Saharan Africa it is the other way around). Either way, the conditions under which such manual pit emptying is carried out are usually appalling, regardless of whether it is men or women doing the work.

In the design, location, selection and construction of sanitation facilities, too little attention is paid to the specific needs of women and men, girls and boys as well as their respective roles in terms of maintaining the facilities. Sanitation programmes, like many other development programmes, often assume a high degree of gender neutrality. This results in gender-specific failures such as toilets with doors facing the street in which women feel insecure, school urinals that are too high for boys, a lack of disposal facilities for female sanitary materials and pour-flush toilets that increase the workload of those women who have to carry the water needed for the toilets.

Sanitation blocks are sometimes used for other purposes as well such as washing and drying clothes and provision of shelter from rain. Despite the role of women in hygiene and sanitation at the household level, many programmes presume that it will be the men who will be more suited for such entrepreneurship. However, both women and men can benefit from income generation through sanitation related businesses if a sustainable sanitation chain system approach is implemented. Businesses may include production of sanitation hardware, installation of sanitation systems, operation and maintenance (O&M), promotion and advertisements, emptying of toilets, collection and safe disposal of faecal matter, training and education and reuse of nutrients, water, organic matter and biogas.

A combination of unequal and uneven power and legal structures based on discrimination and a lack of political commitment often leads to the neglect of women's needs and hinders their involvement in sanitation development and planning. The majority of the world's 1 billion people living in poverty are women and the feminisation of poverty, particularly among women-headed households continues to increase in a number of regions. Land tenure is a particularly significant stumbling block. It is generally estimated that men's landholdings average three time those of women. Women represent fewer than 5 percent of agricultural landholders in North Africa and Western Asia and an average of 15 percent in sub-Saharan Africa (IFAD, 2011). As a result women often lack access to related assets and resources for toilet construction (COHRE et al., 2008).

Experiences with gender aspects in water and sanitation projects in Armenia, Bulgaria, Romania, Ukraine and Mexico showed that stronger involvement of civil society, women and minority groups in decision making on sanitation and wastewater systems is necessary to make a breakthrough and to enhance participation and capacity building (Milhailova and Diaz, 2007).

Figure 2: School toilet in Tanzania: The special needs of girls and women during the time of menstruation – such as privacy, facilities for disposal of sanitary materials – must be brought to the forefront (source: M. Sommer, 2009).

6 Methods to assess the role and impact on females in sanitation

Although at the level of policy formulation there is no shortage of support for gender inclusion by official agencies and governments, the improvements in gender equality in the water and sanitation sector in a number of countries is still slow.

This lack of progress is partly due to the general absence of specifically collected data from and about females in water and sanitation. This lack of data causes issues such as:

- Difficulties to adequately *measure change over time*, and the impact interventions have had on gender equality and whether such changes contribute towards the Millennium Development Goals (MDGs) or other goals.
- Difficulties to make effective *analytical assessments* of the comparative situation of women and men.
- Sound policy formulation is hampered by the lack of information about the gender-related realities of water and sanitation access as well as the need and use of sanitation in private and public sectors. Gender-disaggregated data is crucial when assessing the effects of policy measures on women and men.

Monitoring data is essential in evaluating and tracking the pivotal role of women in development and understanding the specific contribution of women in society (UN-DESA, 2009). A closer definition of the gender-disaggregated indicators needed for data collection can be found in UN-DESA/UNW-DPC (2009).

7 Special needs of girls and women during menstruation

The disposal of female hygiene products needs special attention as tampons, pads, cloths or rags can lead to blockages in pipes (in the case of water-flushed toilets and septic tanks) or make reuse of excreta more difficult (if disposed in the faeces vaults of urine diversion dehydration toilets). Other hygiene-related needs also need to be taken into consideration. Therefore, wrapping materials and adequate bins to enable discreet disposal should be provided. This is particularly important in public places and in schools (WECF, 2006; Wendland and Dankelman, 2008; Sommer and Kirk, 2008).

Box 1: Menstrual hygiene management (MHM) in Magadi Secondary School, Kenya, a town in the Great Rift Valley, located southwest of Nairobi

Menstrual Hygiene Management is an enormous challenge for the 45 girls in Magadi Secondary School. The number of girls receiving education is very low in Magadi as the Maasai tribe restricts girls from attending formal education.

Most of the girls at Magadi Secondary school don't have money for sanitary towels therefore most do not go to school when they are having their period. Even if the girls get sanitary towels, they have no underwear. They therefore use old pieces of rags and jeans to hold the sanitary towels up. The boys regularly tease the girls when their clothes are stained.

Most of the girls drop out by the time they are 15 because they already have 1-2 children. Another difficulty is that most undergo Female Genital Mutilation (FGM) when they are about 13 years old. Therefore if alternative solutions such as menstrual cups are to be incorporated in MHM, this should be combined together with awareness raising, education and addressing the cultural factors that form barriers when including the girls in finding sustainable solutions to address MHM.

The girls face further challenges in disposing the sanitary towels. Before, they used to litter the sanitary towels all over the school compound behind bushes. The teacher then told the girls to collect all the sanitary towels weekly and they would collectively burn them behind the school.

The solution here should include sustainable approaches to addressing MHM such as menstrual cloths and cups. Educational materials on MHM that can be understood by the girls should be incorporated in the school curricula. In addition, all stakeholders need to be involved in the decision making processes so that cultural barriers that negate approaches towards sustainable MHM can be addressed.

Source: Doreen Mbalo, personal communication, 2011

School sanitation is a neglected issue in many parts of the world[2]. After the onset of menarche in puberty, many girls miss school or even drop out partly, because of lack of sanitation facilities or the absence of separate toilets for girls and boys. A study of 20 schools in rural Tajikistan revealed that girls chose not to attend school when they have their period because there were no toilets available (Mooijman, 2002).

In rural Pakistan, more than 50% of girls drop out of school in grade 2-3 due to a combination of religious rules and a lack of separate toilets for girls and boys. When a Muslim girl reaches 7 years of age, she needs to use a toilet specifically for females as the mixing of sexes is not allowed from that age onwards (UNICEF, 2003).

The lack of adequate toilets and hygiene in schools is a key and critical barrier to school attendance and education for girls (COHRE et al., 2008). In addition, if there are inadequate sanitation facilities, women might decide not to attend (vocational) training and meetings. Simple measures such as providing schools with safe toilets, promoting hygiene education in the classrooms and ensuring private hand washing facilities are located very near the toilets increases school attendance amongst girls and reduces health-related risks (UN Water, 2006).

There is a long overdue need for the water and sanitation community to address the need for menstrual hygiene management (MHM) in schools in low-income settings as it has been overlooked in the past[3]. Key components of a girl friendly school environment include:

- Well-designed, clean, safe, private toilets in sufficient numbers for female students with locks on the inside of the doors;
- Clean water inside or very near to the toilets so girls can wash menstrual blood off their hands and stains from their clothing without boys watching;
- Adequate and culturally appropriate disposal systems for used menstrual materials, including dustbins inside latrines and an incinerator or pit where materials can be burnt;
- A private location for girls who use menstrual cloths so these can be washed and dried;
- Availability of credible and empowering puberty and menstrual management guidance, such as the girl's puberty book *"Growth and changes"* developed through participatory activities with girls in Tanzania (Sommer, 2009) or the guide to menstrual management for school girls "Growing up at school" developed in Zimbabwe (Kanyemba, 2011);
- Sensitising school administrators and teachers to challenges associated with menstrual hygiene management;
- The provision of menstrual adaptable underwear for girls (with removable sanitary pads).

It is critical to engage adolescent girls in the decision making process right from the initial stages of designing appropriate facilities and in identifying and ensuring that they have adequate MHM support and guidance (Sommer, 2010).

However this is not sufficient on its own. The water and sanitation community is encouraged to collaborate with education and health communities within each country and context in an effort to provide a holistic and interdisciplinary response to ensure menstruating girls continue to attend and

[2] See also the SuSanA factsheet "Sustainable Sanitation in Schools": www.susana.org/library?view=ccbktypeitem&type=2&id=1188

[3] For further information and discussions about MHM, please visit the MHM section of the SuSanA discussion forum: http://forum.susana.org/forum/categories/24-menstrual-hygiene-management-mhm

complete their education. Relevant stakeholders such as education departments and ministries, school authorities, WASH sector departments, politicians, leaders, teachers and most importantly parents need to be involved to make a significant and long term change to the situation.

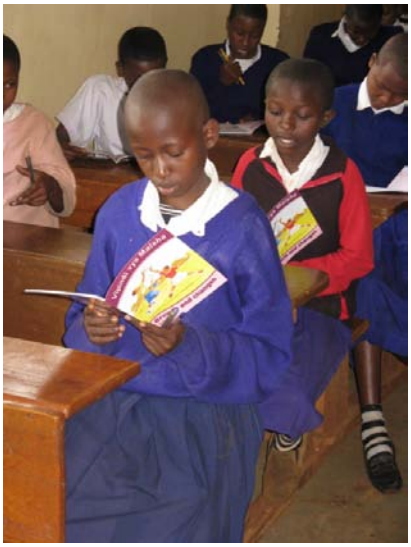

Figure 3: Hygiene education at school for both girls and boys in Tanzania (photo by M. Sommer, 2009).

Urine diversion dehydration toilets (UDDTs) have one distinct difference compared to flush toilets and pit latrines when it comes to use by women during menstruation: Traces of blood can be visible in the urine section of the bowl or pan. Therefore, the users must be given an option to clean off the blood. A simple solution to the problem is to provide a cup with water to wash the toilet in the eventuality that blood is left. There is no harm in adding a little water to the urine jerry can or soak pit (WECF 2006).

8 Integrating gender in sanitation

There is an urgent need to prioritise gender in the sanitation sector whilst addressing strategic gender needs. The process of thoroughly integrating gender concerns into institutional operations is called gender mainstreaming.

According to the Ecosoc (UN Economic and Social Council) definition, **gender mainstreaming** can be understood as "the process of assessing the implications for women and men of any planned action, including legislation, policies or programmes, in any area and at all levels. It is a strategy for making the concerns and experiences of women as well as of men an integral part of the design, implementation, monitoring and evaluation of policies and programmes in all political, economic and societal spheres. That way, women and men benefit equally and inequality is not perpetuated. The ultimate goal of mainstreaming is to achieve gender equality." (Ecosoc, 1997).

The concept of integrating gender should be free from discrimination against either sex to ensure balance and equality. Gender mainstreaming therefore works best through an adaptive, process-oriented approach that is participatory and responsive to the needs of women. Specific institutional arrangements are needed to ensure that gender is considered an integral part of efficient and effective planning and implementation. This includes, for example, the development of gender policies and procedures, commitment at all organisational levels and the availability of – internal or external – gender expertise (GWA, 2006). Gender must be addressed in policy formulation and by-laws. The following elements of the gender mainstreaming process can safeguard a gender perspective in sustainable sanitation (ADB, 1998).

a) Gender analysis

A socioeconomic gender analysis is required to explore the cultural concerns and the sociological and economical roles of men and women in a project area. There is a list of guideline questions in the following section that can provide a framework for such an analysis. A gender analysis facilitates an understanding of the demands and needs of women and men, their respective knowledge, expertise, attitudes and practices and it clarifies the constraints that hinder the participation of women and men in specific activities (Asia Water Watch, 2006).

b) Impact assessment

It is also important to assess the impacts of policies and programmes on women and men from different social and age groups. Here it should be questioned who benefits and who bears the burden or faces the drawbacks of these policies and programmes (Asia Water Watch, 2006).

c) Composition of project teams

Project teams in the field should strive for a gender balance and be sensitive to gender and related cultural concerns. This can be enhanced by selecting field team members with gender awareness, local knowledge, cultural understanding and a willingness to listen (ADB, 1998).

d) Empowerment

To ensure women's participation and involvement, leadership and management training for women are important project components. Additionally, training women to help run and maintain sanitation facilities forms an important part of the empowerment process (ADB, 1998).

e) Financing and budget allocations

Adequate resources should be allocated to implement gender strategies in the sector (Asia Water Watch, 2006). This however is not enough. Institutional arrangements and policies coupled with budgeting that ensures that both men and women benefit from hygiene and sanitation efforts is indispensable in ensuring integration and participation.

f) Income generation

Opportunities should also be given to women to earn income through sanitation projects as builders, suppliers of materials, health and hygiene educators, and as contractors.

g) Involvement of boys and men

In order to successfully incorporate gender perspectives into sustainable sanitation policies and programmes, it is imperative that boys and men are also involved. This will enable them to share their views on gender issues and promote their gender sensitivity and awareness.

Box 2: The Global WASH campaign: lessons learned

The Global WASH Campaign (Water, Sanitation and Hygiene for all), which was initiated in 2001 by WSSCC, has delivered significant results. Putting gender issues at the centre of water, sanitation and hygiene, the activities led to

- better health and wellbeing for women, men and children;
- greater privacy and dignity for women;
- increased number of girls attending schools;
- improved economic and social status of women;
- improved service provision.

For further information see WSSCC (2006)

When mainstreaming gender in sanitation, one has to be aware of a few pitfalls:

- Women are often encouraged to take on sanitation management roles and additional work, but they may not have received the necessary resources (i.e. time, capacity, resources) to perform these tasks.
- The introduction of a "user pays" system for sanitation facilities may create a considerable burden for women, particularly for those living in poverty. On the other hand, there are also studies that show women are willing to pay for hygienic and safe sanitation (GWA, 2006).
- If hygiene education is identified solely as a "women's area", men may be reluctant to be involved and as a result, sanitation components in a project may be seen as less important. Therefore men must also be included in the decision making process regarding hygiene education so that they understand the challenges that women face.
- Women may receive more training but may be prevented from putting their own skills and knowledge into practice by cultural or social norms.

9 Guiding questions for integrating gender perspectives into sustainable sanitation

The following guiding questions can be helpful in the process of integrating gender perspectives into sustainable sanitation planning, designing and implementing (ADB, 1998; Van Wijk-Sybesma, 1998; UNICEF, 2003; Asia Water Watch, 2006; UN Water, 2006; UN, 2007; COHRE et al., 2008; UNICEF, 2008). The authors consider a critical engagement with the following guiding questions crucial to identifying strategic gender needs.

a) Gender aspects

- Has a socio-economic and cultural profile of the target population been developed including the different roles and tasks assigned to men and women?
- Have the particular issues of concern to females related to sanitation provision and use in the project area been investigated?
- Have the separate sanitation needs, interests and priorities of men, women, boys and girls been considered?
- Define the gender-specific elements in the sanitation policies and strategies of the government, company or institution.
- Use a gender perspective to gather information and generate information so that it is possible to understand the specific needs and policy implications for females.

b) Institutional aspects

- Ensure expertise in social development, sanitation and hygiene education is available in the organisation, project or programme team.
- Are women and men fully integrated at all levels in the organisation and have external and internal discriminatory factors been tackled successfully? Are there any constraints for women and/or men in accessing and controlling resources?

c) Gender impact assessment

- Will the programme's objectives and activities have an impact on existing inequalities between women and men, as well as between boys and girls?
- How will females and males be affected by the programme? For example, will their work burden increase or decrease? Will their health be affected? What are the economic benefits? Is there a gender balance in the burdens and benefits?
- Does the budget reflect the needs and wants of both genders?

d) Gender specific monitoring and evaluation

- How do you measure and monitor the specific effects on females and males?

e) Location and design

- Does the design and location of sanitation facilities reflect the differing needs of children, women and men?
- Are toilets and hand washing facilities situated in such a way that the physical security and wellbeing of women and girls is ensured?
- Is the toilet location in the home (ideal case) or close to home and is the path to the toilet easily accessible, secure and well-lit?
- Have separate toilets for females and males been constructed and are these being operated and maintained (for example in schools, factories and public places)?

f) Technology and resources

- Does the technology used reflect women's and men's priorities and needs?
- Is the technical and financial planning for the on-going operation and maintenance of facilities in place? How are men and women involved?
- Have funds been earmarked for separate sanitation facilities for girls and boys and for hygiene education in school curricula?

g) Empowerment and decision making

- Has the capacity of women been developed and their participation in training encouraged?
- Have women and girls been enabled to acquire access to relevant information, training and resources?
- Are both men and women actively participating right from the initial stages in the decision-making process in the sanitation sector?
- Are men and women involved in planning, the location

choice, quality selection and management of sanitation services on an equal basis?
- Have hygiene education messages been promoted through women's groups, schools and health clinics?

10 Productive sanitation and UDDTs

Productive sanitation is a new term for sanitation systems which focus on increased crop yields by using treated excreta and greywater in agriculture[5]. It is important to closely monitor sustainable sanitation projects and the way they operate in a gender specific way. However, gendered perspectives of productive sanitation projects have not been fully explored yet. In many parts of the world, women are primarily responsible for food production and food security. In terms of its impact, it will therefore be women who will benefit directly from the increased availability of soil nutrients that can be used for rural and urban agriculture (Hannan and Andersson, 2002).

The urine diversion dehydration toilet (UDDT) is one type of technology that is often used within productive sanitation concepts. UDDTs require no water for flushing and this will reduce the workload of women if they have to fetch the water for sanitation. In Zimbabwe, women in some rural areas preferred the ecological sanitation alternative – the "Arborloo"– to the conventional pit latrines because they can be built closer to their home. When the pits are full, the women plant fruit trees on the full pits. Men also preferred the Arborloo because the pits are shallower and require less labour to dig.

Anecdotal evidence seems to suggest that women's attitudes towards UDDTs are more positive than those of men. In one project in rural Romania for example, women preferred the UDDTs while men had a distinct preference for water flush toilets. Women would like to have the toilet in their home, as this would reduce walking distances while also increasing security. Studies show that women are also willing to use the fertiliser derived from these toilets in their fields and gardens.

Demonstration projects that centre on local women's groups can have the effect of stimulating rapid and sustainable change (Milhailova and Diaz, 2007). Some experts however point out that UDDTs may require more work for women as far as cleaning, maintenance and the subsequent application of urine and faeces as fertiliser are concerned (Samwel et al., 2006b).

[5] See also the SuSanA factsheet on "Productive sanitation and the link to food security" available here: http://www.susana.org/lang-en/library?view=ccbktypeitem&type=2&id=101

Box 3: Are UDDTs resulting in a heavier work load for women?

The *Centro Mujeres Tonantzin* in Mexico carries out women's empowerment and leadership training amongst the very poor in the slums of Ciudad Juarez, close to the border between Mexico and the USA. Here 700,000 people live in poverty in desert-like conditions without any water or sewage facilities. The women work in factories, clean houses or sell second hand clothes in order to support their families. Between 2001 and 2007, 250 in-house bathrooms with UDDTs were built in this area. However some women stopped using their UDDTs because the compost and urine containers have to be emptied out which meant heavy work for the women especially as they got no help from the men. In such a case, a urine infiltration system would have been the better option so as to decrease the work load for the women.

It is important to provide follow-up for at least one year on the use and maintenance of the toilets but people complained about community workers checking on their toilets (Raminez and Penan in Mihailova and Diaz, 2006).

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Acknowledgements are given to the following persons for their valuable contributions:
Elisabeth von Münch and Martina Winker (GIZ, Germany), Penelope Phillips-Howard (Liverpool School of Tropical Medicine, United Kingdom), Ian Pearson (consultant, South Africa), F. H. Mughal (consultant, Pakistan).

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sustainable sanitation alliance

SuSanA factsheet

Sustainable sanitation for emergencies and reconstruction situations

April 2012

1 Summary

This factsheet addresses current developments, challenges, gaps and solutions in the planning and implementation of sustainable sanitation for emergencies and reconstruction situations focusing on low and middle income countries. It is mainly intended for students, researchers, policy makers and practitioners.

Shortcomings of current approaches for emergency prevention and relief include: Insufficient resources invested in sanitation, lack of prioritisation of sustainable solutions, inadequate human resource capacity for urban sanitation in humanitarian agencies and lack of good governance for reducing disaster risks. The last issue particularly impacts the risk reduction potential of countries. To reduce the risk and potential effects of disasters, sanitation solutions need to be robust to buffer against certain challenging environments. In emergency situations, groups with specific needs need to be considered (i.e. children, women, elderly, injured and people with disabilities) and appropriate emergency relief measures for each stage of an emergency situation need to be selected.

We recommend the following to the actors in the emergency and reconstruction sectors:

- Increase funding for sanitation in emergency and reconstruction situations with regards to software as well as hardware components.
- When implementing immediate sanitation solutions, apply those which can be adapted in later phases to become more permanent and sustainable.
- Use adequate sanitation options which are robust and can cope with challenging environments.
- Build capacity in local entrepreneurship for long-term self-help in the reconstruction phase.
- In between emergencies incorporate risk reducing measures in local and urban planning which will prevent and reduce the need for response efforts.
- Engage in learning activities and experiment together with other professionals to increase innovation of options.

2 Introduction

The United Nation's International Year of Sanitation 2008 highlighted the need for improved access to sanitation systems in general. In addition, many disaster situations demonstrate the need to address sustainable sanitation solutions in particular. Sustainable sanitation systems take into consideration aspects of health, environmental resources, economic viability and socio-cultural acceptance as well as technical and institutional appropriateness (SuSanA, 2008).

Sustainable sanitation systems in emergencies also require examining the resilience and robustness of existing systems to function during the entire emergency. For example, disaster situations often present additional challenges of difficult environments, such as flooding, lack of transport and access of materials. There are also challenges of a traumatised and injured population and disruption of societal functions exposing vulnerable people to even more health risks.

Figure 1: Raised toilets in Haiti provided by IFRC for 275,000 people per day with materials produced in Dominican Republic and constructed in Haiti (source: IFRC, 2010).

Sustainable solutions also have to manage the transition into a post-disaster phase and future development, and assure that immediate measures do not create unwanted health hazards or other undesirable consequences in the longer term. Many humanitarian actors (mostly NGOs, UN, unilateral aid, etc.) acknowledge that current sanitation practices are often not sufficient.

There is a need for innovation through interaction with experts who are not normally involved in emergency responses, such as private manufacturers, urban sanitation engineers, and industrial designers. This exchange and learning is not that easy as the various actors involved in disaster response usually have little time for networking, research and updating their expertise on other systems. The SuSanA Working Group 8 is aiming to act as an open platform to bring people together with the purpose of pushing

towards more sustainable solutions and information exchange.

3 Shortcomings of current approaches

a) Insufficient resources invested in sanitation

Emergencies pose huge challenges for containing large volumes of excreta of the affected or displaced population. Interventions need to be carried out as quickly as possible in places submerged by flood water or in ruins after an earthquake or due to other disasters. The great focus on water supply in emergencies has made sanitation a forgotten area, often resulting in a sanitary disaster threatening the very health objectives which clean water supply aims to address. Agencies and donors are generally more willing to fund expensive water treatment units (which are often high-tech and can easily be shipped in one container) than to make the expenditure for sanitation systems – which are also less attractive in terms of media coverage (Andy Bastable, Oxfam GB, personal communication, 2011).

Figure 2: Unusable pit latrine during a flood in Bangladesh (source: S. Uddin, 2007)[1].

The result is that toilet pits or containers fill up quickly and become sanitary hazards. For existing sanitary facilities, there is often a lack of consultation with users at the design stage, leading to facilities that are not used as intended. Insufficient resources provided for maintaining and cleaning public facilities lead to unused toilets. Finally, inadequate supervision of self-build sanitation programmes can cause incorrect positioning and construction (Groupe URD, 2010).

b) Lack of prioritisation of sustainable solutions

Due to the focus on speed and quantity, sustainable solutions are often not prioritised. This is related to the phased approach of sanitation interventions in an emergency. In the height of an emergency, options are applied as short term measures (e.g. trench latrines[2]). These options are later replaced in a phased manner by more permanent options such as pit latrines, septic tanks, urine diversion toilets etc.

Challenges commonly faced are high water tables, unstable sandy soils and crowded urban areas, which require creative ideas in the height of the emergency and in the long term for a sustainable solution. If these challenges are not addressed the result can be overflowing, leaking, malfunctioning, or unused toilets, even for solutions designed for that particular emergency phase. When humanitarian agencies leave, there is a lack of sustainable alternatives for the long term, which is a challenge in the prolonged emergency.

c) Inadequate human resource capacity in humanitarian agencies for urban sanitation

There is an increasing number of urban disasters. At the same time humanitarian agencies have inadequate human resource capacity to implement urban sanitation solutions. Such sanitation systems would have to be integrated in the existing urban systems which were often not working well even before the emergency and which are complicated to fix (Heeger, 2011). The most common solution currently used, the pit latrine, is not a viable solution for crowded urban conditions, where it may contaminate the groundwater and thus the water supply. Pit latrines remain however a better solution than a total lack of sanitation solutions i.e. open defecation. The recent response after the earthquake in Haiti in 2010 has led to innovative thinking by many WASH practitioners working in the urban environment of Port au Prince for the first time (see Box 1 and 4).

d) Lack of good governance for reducing disaster risk

In 2010, the earthquakes of nearly the same magnitude in Haiti and Chile disclosed the importance of better building codes, resulting in only 200 lives lost in Chile compared to 200,000 in Haiti. In addition, Haiti had inadequate water and sanitation systems before the earthquake, making the system vulnerable to disasters. For example, it was difficult to agree on a designated area for waste disposal and this led to dumping solid and faecal sludge in the same uncontrolled ways as before the earthquake (see figure 3).

Bad governance, poverty and corruption make a population very vulnerable to disaster. Also, urban development in coastal areas is increasing and consequently there is also a growing exposure of the inhabitants to coastal hazards on a regular basis. Due to lack of planning and infrastructure (e.g. drainage), peri-urban low income areas are turned into sanitary health hazards especially in the rainy season. Vulnerable people with low coping capacity living in these areas might easily get locked in poverty cycles. Peri-urban areas present furthermore a risk as authorities often do not assume formal responsibility and they are effectively left ungoverned (Andrew Parker, UNICEF, personal communication).

[1] For further information see: www.susana.org/lang-en/library?view=ccbktypeitem&type=2&id=1206

[2] The term “toilet” is used for the general function of a user interface and for toilets which are above ground. “Latrine” is used for types of toilets which require a hole in the ground, e.g. a pit latrine.

Figure 3: Dumping of sewage or faecal sludge from a UN camp into a lake in the surroundings of Port au Prince in Haiti in 2010 (source: L. Pierre, "Organizing for Haiti", 2010).

4 Resilient and robust sanitation systems

Natural hazards such as extreme rainfall (leading to floods) and earthquakes do not necessarily result in disasters. They only turn into disasters when human society is unprepared for them, where infrastructure and planning has not been designed to withstand or buffer against them and if society cannot respond or learn adequately. Human history, human action or inaction and exposure (e.g. geography) determines the level of robustness or resilience of a population to the impact of natural hazards.

Solutions need to be robust to buffer against certain challenging environments which include for example:

- Unstable soils (e.g. sandy soils) make the lining of pits necessary to prevent them from collapsing.
- High groundwater tables and flooding cause problems with the containment of the excreta. Potential solutions include sealed pits or above ground structures.
- Rocky soils make digging difficult and uneven geology (e.g. sand mixed with rocks) increases risks of groundwater pollution with pathogens and nitrate.
- Spatial constraints mainly in urban areas where the construction, replacement and maintenance of toilets, as well as pit emptying, is restricted due to a high population density.

Apart from buffer capacity or robustness of technologies, resilient systems also involve the adaptive (social) capacity to learn, adapt and self-organise (Folke, 2006). When disasters occur, informal social structures are important, and in most cases government bodies and local volunteers from organisations such as Red Cross/Red Crescent are early on site and mobilised quickly.

Box 1: Sanitation technology development in Haiti
After the earthquake in Haiti (2010), a very crowded environment combined with extremely difficult digging conditions made many agencies install a considerable number of raised and portable toilets. Haiti thus triggered more innovative thinking about sanitation solutions from all agencies e.g. biodegradable plastic bags, biogas systems, urine diversion and compost toilets. An indicator of the effort in sanitation by the agencies was the fact that the cholera outbreak in Port au Prince did not become an epidemic in the camps, while this was the case outside the camps (Johannessen, 2011).

Apart from robust technology or "hardware solutions", appropriate "software methods" that engage target groups, create demand for services and encourage the change of behaviours also need to be applied. This is often coordinated by the WASH cluster[3]. Good practice includes the introduction and support of health committees, training WASH (water, sanitation and hygiene) workers, appointing a focal point for cleaning, and paying people to do this with a certain rotation frequency. Further examples include:

- PHAST (Participatory Hygiene and Sanitation Transformation) triggers behaviour change in communities, and empowers them to plan and operate WASH systems, and is used during emergencies.
- Community Health Clubs have been used for cholera mitigation in Zimbabwe (2008-09) where health education and changes of hygiene practices prevented a cholera epidemic. It has also been applied in refugee camps in Uganda (Waterkeyn et al., 2009).
- During the flood in Pakistan in 2010, a great number of camps used CLTS (Community Led Total Sanitation) to encourage people to use toilets (Johannessen, 2011).
- An "EcoSan toilet beauty contest" by SCOPE after the Indian Ocean tsunami in 2004 was a popular form to involve communities during the reconstruction phase[4]. In fact, the lack of a severe disease outbreak after this tsunami is to a considerable part credited to extensive hand washing and hygiene campaigns.

Interventions in emergencies tend to be managed well when they are implemented by dedicated groups of staff working with small communities with whom they develop clear reciprocal relationships and understanding. Local NGOs already active in the area are often invaluable in mobilising and reaching local communities and building their trust.

Box 2: Adapting toilets to fit special needs
In 2011 ACF cooperated with the manufacturer Nag Magic to develop an improved plastic slab design. The new design makes it possible to transport more slabs at a time, to support people who have difficulties with squatting, to make it easier for wheelchair users to enter and turn, has bright colours which help visibly impaired people and has adaptations for children (Johannessen, 2011).

[3] More information on the WASH cluster (WASH stands for water, sanitation, hygiene): www.humanitarianreform.org
[4] SCOPE in Trichy, India: www.scopetrichy.com

5 Consideration to groups with specific needs

a) Specific needs of children

- Young children defecate either in the open or in a potty, which needs to be managed by their parents or carers. Cleaning and disposal of children's faeces needs to be done rapidly and hygienically, as the faeces can be highly infectious.
- Young children prefer bright toilets, without a roof and door (Harvey, 2007) or only a slab. They need to be near the women's toilet and require accessories such as: extra step, potty and low hand washing if integrated with adult toilets.
- Children's latrines can be painted with hygiene related messages specifically targeted at children thus creating awareness and ownership.
- When surrounded by chaos, schools can provide children with a sense of normality and personal safety, helping them to recover psychologically. Appropriate WASH measures in schools should be taken[5].

Figure 4: Child friendly toilet which is open and bright for use by young children in a post Tsunami camp in Sri Lanka in 2004 (source: J. Lapegue, ACF, 2004).

b) Specific needs of women

- Women should be consulted on the design and location of the toilet, to consider their preferences and reduce security risks, especially at night (Adams, 1999).
- In many cultures, toilets and relevant training needs to be separate for women, men and children.
- There is a need to provide menstrual pads and underwear in an emergency, bearing in mind the cultural context and appropriateness e.g. colour, shape, disposable versus recyclable. In the long term, refugees can produce their own pads out of local and recycled materials (Ann-Kathrin Scheuermann and Annelie Albers, GIZ, personal communication, 2011).
- Some agencies (e.g. Red Cross) provide "hygiene comfort kits" which include underwear that is important to accompany the menstruation items and extra cloth.

c) Specific needs of people with disabilities, elderly or injured people

As many as 1 out of 5 people can be disabled by birth or due to temporary illness and injuries in an emergency (Jones and Reed, 2005). People with disabilities need to be able to access the toilet and need support for sitting. There is also a need for space for a wheelchair user to enter the toilet cubicle and turn around.

Box 3: Key socio-cultural considerations

- User consultation is crucial also in the immediate phase.
- Accountability of the operation and maintenance can be supported by limiting access (e.g. using a padlock).
- Information, training and sensitising can achieve significant reductions of diarrhoeal diseases.
- Cultural considerations, e.g. people who practice anal cleansing with water need access to water. Toilet seats and urinals oriented towards Mecca might be rejected in Muslim cultures.

6 Solutions for the immediate to short-term stages of an emergency

Top priority in immediate emergencies is containing excreta as fast as possible. Defecation fields are frequently mentioned in the literature but are not often implemented. Often the implemented minimum standard is a simple pit latrine structure. In addition, it is necessary to equip each toilet or block of toilets with a hand washing facility with soap. Desludging and safe disposal of the collected excreta is crucial for the mitigation of health risks but is often very challenging.

Humanitarian agencies usually install so called rapid latrines. These latrines are ready-made solutions and normally part of the agency's contingency stocks in the region or are ready at the headquarters' warehouses to be shipped at the height of a crisis. At the initial stage, there is also a need to plan intermediate steps, such as communal toilets, setting up a slab manufacturing facility and collecting local materials for superstructures.

Humanitarian agencies have realised that the more permanent these initial structures are, the better. They also recognise that the first 1-2 weeks are the most critical as this is the time when there is a big gap in suitable technologies even without considering aspects of sustainability.

In 2011, WASTE and Oxfam GB organised a workshop in Stoutenburg, the Netherlands, involving sanitation specialists from different humanitarian agencies and the development sector to discuss how to improve gaps in technologies for the immediate phase and to understand more of the product design process. Three technology gaps were identified: 1) raised toilets; 2) improved desludging options; and 3) sludge disposal and treatment kits. These

[5] www.unicef.org/wash/schools/files/WASH_in__Schools_in_Emergencies_Guidebook_for_teachers_.pdf

three gaps were selected acknowledging that much work had already been done on slabs and on biodegradable bags. Each of these would need design specifications to fulfil the requirements of an emergency (lightweight, pallet size, flat packed etc.) (Johannessen, 2011). In the following some of these more sustainable immediate solutions are described.

Box 4: Oxfam's new sanitation approaches in Haiti

Oxfam's response in Haiti included pit latrines, septic tanks, portable toilets ("port-a-loos"), urine diversion, and biodegradable toilet bags. The latter two approaches are described below:

1) **Urine diversion dehydration toilets (UDDTs)** were funded and installed in cooperation with the local partner SOIL. This involved the installation of 200 urine diversion toilets in 31 camps in PAP in the months immediately following the earthquake. Urine was diverted either to a soak-away or was stored for agricultural use. After each excreta deposit, users added a small amount of chopped sugarcane. The mix was contained in a plastic drum, which was removed weekly by the local partner SOIL, who composted it. The aim of the urine diversion was to reduce the volume of faecal sludge and to produce a demand for the urine and compost. Users indicated that they preferred this to pit latrines or raised toilets as the UDDTs were considerably less smelly (http://oursoil.org/what-we-do/ecosan/).

2) **Peepoo toilets or simple biodegradable bags** were used directly inside of cubicles or by placing them inside of small containers for home use. Male and female urinals were also part of this approach. People used the urinals and defecated into a bag, tied a knot in the bag and deposited it in a covered plastic drum, emptied daily. The contents were taken to a local composting site. This approach has also received very good feedback. It is a good solution when desludging trucks are unable to access the congested camps, or for use at night.

Source: Cocking and Bastable (2010) and Patel (2011)

a) Biodegradable plastic bags

Biodegradable bags can be inserted into a locally available small container to create individual toilets or to be used as part of a communal facility. During emergencies, biodegradable bags could help address the time needed to construct adequate latrines or where traditional options cannot be utilised, or if there are gaps in coverage (for household-level use especially by people with disabilities, children and women at night). Proper burial or collection for a composting system must be ensured to make it a hygienically safe system. Further research is needed regarding the cost effectiveness over time and phase-out points or upgrading strategies.

Figure 5: How to use the Peepoo (source: www.peepoople.com)

The "Peepoo toilet" is one such model on the market. Pathogens in the faeces which are collected in the bags are killed due to ammonia gas which develops when the urea granules supplied inside of the bags get wet. This technology can include a reuse aspect, and the fertiliser value of the bag's content could create an income for collectors.

b) Emergency urine diversion toilet slab

The prefabricated plastic toilet slab for immediate dispatch is central in an emergency, as other toilet parts are often locally available. Some humanitarian agencies have taken measures to diversify the standard squatting slab by adding a urine diversion part to separate urine and faeces.

The urine diversion slab allows for immediate separation of urine. By reducing the liquid content the time that the toilet can be used for – before the container or pit fills up – is prolonged. Separating urine also accelerates the drying process of faecal matter and reduces odour and flies. The urine, which contains the most nutrients of human excreta, can either be drained into a soak pit or collected and reused. However, the reuse of urine and faeces is an "add on" and can only be applied at a later stage (in the recovery phase). Urine does not necessarily have to be reused if the only aim of the separation is to reduce volume of faecal waste, and reduce odour and flies.

Challenges may however be:

- User acceptance and willingness or behaviour change to use the toilets correctly, such as ensuring that anal wash water is discharged separately from the faeces.
- Urine pipe blockages.
- The urine diversion pan may be more difficult to clean compared to a normal pit latrine slab.
- Finding suitable local or regional suppliers in the longer term.

c) Raised toilets with or without urine diversion

The raised toilet is appropriate when it is physically not possible to dig into the soil (hard surfaces) or land ownership prohibits digging. In Haiti, for example, IFRC could not use their rapid toilets in many places. Disadvantages of raised toilets include relatively slow and costly installation and the need for more frequent desludging than toilet options dug into the ground where all liquids are allowed to infiltrate (Johannessen, 2011). The speed and cost issues are currently being optimised.

Figure 6: Left: Plastic urine diversion slab prototype by Indian manufacturer Nag Magic, is not yet available on the market (source: Oxfam GB, 2011). Right: Raised toilets in Bangladesh are still functional during flood events (source: S. Uddin, 2007).

Table 1: Simplified overview of different priorities and technology choices depending on the phase of emergency.

	Immediate (<one month)	Short term (one to six months)	Medium term and recovery (six months to one year)	Long-term (>one year)
Priorities	Fast containment of excreta (and hand washing)	Promoting use, organising people for O&M of toilets, hand washing	Longer term use and sharing	Improvement of sanitation where people demand it
Solutions	Collective solutions	Collective and household solutions	Household solutions & institutions (schools etc.)	Household solutions & institutions
Technology choice (current practices)	Defecation fields, shallow trench, deep trench, biodegradable bags, raised toilets, urine diverting dry toilets (UDDTs)	Communally managed toilets, family toilets	Pit latrine, VIP latrine, UDDT, Fossa alterna, Arborloo, pour-flush toilets, septic tanks, decentralised wastewater treatment systems	Previous technologies and individual simple pit latrines may be an option in low-density, longer-term emergency settlements.
Socio economic factors	- Consultation - Special needs groups - Information -hygiene training, sensitising	Previous factors and: - Monitoring (full toilets or pits) - Logistics and handling - Accountability	Previous factors and: - Financial resources and willingness to pay - Local champions	All previous factors

d) Waterless urinals

Urinals are useful for keeping liquids out of the toilet pit, thus extending the period it takes to fill the pit. Where appropriate, the urine can be reused as fertiliser for crops following existing urine reuse guidelines

e) Trench latrines and other wet toilet systems

Often excreta are buried in deep trench latrines. If water is available, wet systems such as pour flush pit latrines, may be selected. In any case, the most important aspect from a sustainability point of view is to design and place the latrines in a way to avoid groundwater contamination. Pit latrines and soak-aways for percolation into the ground should be at a suitable distance from any groundwater source, and the bottom of any latrine should be high enough above the water table (for details see Nick et al., 2012). Drainage or spillage from latrines must not run towards any surface water source or shallow groundwater source. Ideally, environmental health staff should be involved in ensuring that adequate sites are chosen and laid out to provide suitable conditions for sanitation.

Figure 7: Emergency pit lining kits to avoid collapse. A man hole provides access for desludging. Left: modular corrugated plastic. Right: new design with internal props (instead of relying on locally available wooden props included in former design (source: J. Rhode, Evenproducts, 2011).

f) Desludging and disposal

Desludging is necessary when the containers or pits of toilets are full, and is often done by a fleet of vacuum trucks. There are also manual desludging pumps. Commonly faced problems are stones, corn husks, and other materials used for anal cleansing as well as garbage that is disposed of in the toilet's pit or container which make it difficult to pump out the faecal sludge. A big gap in emergencies is the safe disposal and management of the faecal sludge once emptied from the toilet facilities.

Box 5: Rapid latrines by IFRC

The immediate emergency requires sanitation solutions suitable for fast response. The IFRC "rapid latrine", has a prefabricated superstructure that can be shipped and easily erected. It has been developed in cooperation with UNICEF, Oxfam, and equipment suppliers. The technology is included in the Mass Sanitation Module 20 (MSM20) which provides hygiene promotion and sanitation for 20,000 people. The MSM20 includes 100 rapid latrines, and 100 squatting plates, with additional rapid latrines available if needed. The squatting plates have a pour flush option. The rapid latrine is built to cater for the first 1-4 weeks, when local procurement of materials is difficult. However, there are examples, where rapid latrines have become a permanent solution as during the emergency response to the Sichuan earthquake in 2008. Design principles for the rapid latrine are:

1. Easy to assemble, clean and transport
2. Rapid construction (20-25 superstructures per day)
3. Light weight
4. Durable for 3-6 months and stable
5. Cheap

Source: Libertad Gonzalez and William Carter (IFRC), see in Johannessen (2011)

7 Solutions for the medium (recovery) to long-term stages of an emergency

In the medium (6-12 months) to long-term (>1 year) stage of an emergency the situation is stabilised and emergency toilets can be turned into more permanent structures. Ideally, the immediate solutions should be suitable to be adapted. For details on sanitation technologies in the medium to long-term stages see Harvey (2007). Some

examples of sanitation systems used in the past during the recovery or long-term stages include:

- Larger communal glass fibre systems which are affordable and light weight such as the DEWATS systems of BORDA in Indonesia.[6]
- Biogas sanitation is an option investigated by IFRC (2010) for Haiti during the reconstruction phase. These systems produce biogas which can be used for cooking thus saving fire wood (addition of animal excreta or organic waste is recommended to obtain a reasonable amount of biogas). The design must be resilient to local disaster risks.
- Fossa Alterna with two alternating pits; this technology was successfully introduced in camps in Harare (Morgan, 2007).
- Raised UDDTs have been built such as in Bangladesh by Terre des Hommes to withstand flood events (Delepière, 2011).

8 Rehabilitation and disaster risk reduction

Re-building better after a disaster reduces risks from recurring hazards such as floods. Rehabilitation in urban areas poses very different technical challenges than those in rural environments, but can also be an opportunity. An example of this is the case of Maputo, Mozambique where MSF (Médecins Sans Frontières) after the floods in 2000 put in a system of water, sanitation, drainage, waste collection and hygiene education in a suburb, and empowered a local association to manage it. In 2011, ten years later, this is still functioning and provides a safer living environment with less cholera and other water related diseases than before. Functioning drainage plays a key role in avoiding flooding of the sanitation systems (Marculino Chemane, WaterAid Maputo, personal communication in 2011).

Disasters can thus act like a "wake up" call to trigger more investment in risk reduction, which also decreases the need for response in the future. A lack of risk reduction prior to a disaster makes the response more difficult after a disaster. For example, in Haiti, the sanitation systems prior to the earthquake were inadequate where many people used plastic bags ("flying toilets") or open defecation.

The solutions developed can provide livelihood opportunities in local communities for organisations like health clubs, women clubs, artisans, operators, manufacturers and the list goes on. A prime example being the production of toilet slabs which can be set up a few weeks after the disaster event. The motivation and social mobilisation is crucial for successful reconstruction, which also involves reconstructing the local economy and society.

9 Feasibility for reuse of nutrients

The UDDT (urine diversion dehydration toilet), can enable the reuse of urine and dried faecal matter. In the past, UDDTs have been used for sanitation provision during and after the emergency situation, and this was documented for El Salvador (hurricane in 1998), Afghanistan (civil war in 1992-1995), Guara Guara in Mozambique (after floods in 2000) and Pakistan (earthquake, October 2005). The UDDTs, without reuse activities, were successfully applied in the long-term phase of the emergency with a possibility that the reuse function could be activated later if demanded or feasible (Mwase, 2006).

Refugee camps in Nepal reuse the compost from double vault VIP latrines (Ganai, 2008). In the Farchana refugee camp in eastern Chad, the NGO SECADEV overcame constraints of limited space and unstable soils by building family pit latrines with simple urine diversion. These pits can be emptied once full and SECADEV is planning to incorporate a reuse component (Patinet, 2010). Biogas was generated in Haiti[7].

Enabling environment for reuse of treated excreta

- Where growing crops is possible. There is often some kind of agricultural activity in refugee camps.
- Social acceptance is needed.
- When it is feasible to educate, train and manage the facilities properly, preferably in collaboration with local agricultural extension workers.
- Reuse is mainly a household option, but could also be practiced at a communal level if managed correctly by following the existing WHO guidelines on the safe use of excreta in agriculture. Health risks from reuse activities are lower within a single family system compared to communal toilets and where the fertiliser produced or fertilised products are sold to others.

Box 6: Compost sale in emergencies

After the earthquake in 2010, SOIL conducted a study to identify possible markets for the sale of compost generated by toilets in Haiti. Results show that a few stores were very positive about the opportunity to switch from imported chemical fertiliser to a locally produced organic fertiliser. Most significantly, none of the organisations contacted said they would rule out the future possibility of purchasing compost if they were not already using it. With compost sales alone, reuse projects are unlikely to break even at their current scale in Haiti because the cost to produce toilet compost exceeds the current market rate for compost in Haiti.

Source: SOIL, 2011

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Acknowledgements are given to the following persons for their valuable contributions:
Madeleine Fogde (SEI, Sweden), Julien Eyrard (ACF, France), Gert de Bruijne (WASTE, the Netherlands), Daudi Bikaba, Andy Bastable, Tim Forster (all three from Oxfam, United Kingdom), Elisabeth von Münch, Doreen Mbalo, Leonie Kappauf (all three from GIZ, Germany), Deepa Patel (consultant, USA)

More documents on this topic can be found on http://susana.org/working-groups/wg08 or on the blog of this working group http://susanawg8.wordpress.com/.

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sustainable sanitation alliance

SuSanA factsheet

Sanitation as a business

April 2012

1 Summary

This factsheet discusses the role of different players in the sanitation sector, such as private businesses, governmental institutions and the non-profit sector with a focus on developing countries. Several project examples illustrate activities that can create revenues for investors and local entrepreneurs but also highlight some of the challenges in delivering sustainable sanitation services to the poor.

The key messages of this factsheet are:

1. Experiences worldwide show that sanitation can be a viable business opportunity, and has the potential to provide multiple benefits to the poor. Market-based approaches seek to address the challenges of financial sustainability and to strengthen the role of the private business sector while empowering local communities and individuals to make their own informed decisions about obtaining sanitation products and services.
2. The challenge is still to identify effective, scalable, and sustainable sanitation solutions with economic potential and to allocate investment capital and funding to implement these solutions on a large scale.
3. The process of identifying these solutions needs to be a collaborative effort between experts in marketing, design and engineering, which can be effectively supported by national and local governmental agencies as well as NGOs with in-depth local knowledge.

This factsheet's target audience includes entrepreneurs, policy-makers, researchers and programme managers. It should be read together with the SuSanA factsheet on "Public awareness raising and sanitation marketing"[1]. Both factsheets are products of the SuSanA Working Group 9 on sanitation as a business and public awareness.

2 Introduction

Considering the sanitation sector as a marketplace full of business opportunities, is not a new concept. The private sector – be it internationally operating large scale enterprises, social entrepreneurial programmes or small and micro-scale businesses of masons, plumbers, cleaners, emptiers or wholesalers – has often been ignored as a reliable alternative or addition to public service providers in the sanitation sector.

As a result, particularly developing countries face major challenges in the delivery of safe sanitation products and services, which impacts most heavily on the economically poorer inhabitants.

Prior to the emergence of business models in sanitation, most traditional approaches to sanitation development have been based on subsidy driven infrastructure-focused programmes. For example: free or heavily subsidised toilets are built often with volunteer labour and imported hardware. These models "have poor records in effectiveness of use, efficiency of investments, sustainability of services, and scaling up access" (Frias and Mukherjee, 2005).

Furthermore, the sustainable impact of donor-driven sanitation models is challenged by many influential actors in the sanitation sector such as Jack Sim, social entrepreneur and founder of the World Toilet Organization (WTO) based in Singapore. He asserts that the "donor model" does not work on a large scale since "it lacks the sustainability and continuity that comes from mobilising a community to produce, market, sell, distribute and maintain their own sanitation products"[2].

Figure 1: A man selling concrete slabs in Lilongwe, Malawi (source: L. Kappauf, 2011).

In 2005 the paradigm shift from beneficiary to "potential costumer" was backed by the publication "The Fortune at the Bottom of the Pyramid" (Prahalad, 2005), which identified the base of the world's economic pyramid[3] that includes four billion people living on EUR 5.50 or less a day as a market.

[1] http://susana.org/lang-en/library?view=ccbktyp eitem&type=2&id=749

[2] In 2010 WTO received an urban innovation grant to help solve global sanitation problems: http://press.abc-directory.com/press/5779

[3] Base of the pyramid (BOP) is used synonymously with Bottom of the pyramid.

Prahalad (2005) analysed the spending potential of the world's poor as consumers and the power of business models to generate income and sustainable solutions to alleviate poverty at the bottom of the pyramid. Hammond et al. (2007) argue that the BOP constitutes a EUR 3.5 trillion[4] global consumer market which reveals "significant opportunities for more inclusive market-based approaches that can better meet the needs of those in the BOP, increase their productivity and incomes, and empower their entry into the formal economy" (Hammond et al., 2007).

Based on this context, there is now a growing willingness of all actors in the sector (such as national and local governmental agencies, NGOs, service providers and private sector organisations) to search for innovative approaches to promote, finance and support business models for sustainable sanitation.

3 Market-based approaches

Market-based approaches to sanitation seek to address the challenge of financial sustainability, while empowering a local community and individuals to make their own decisions about obtaining sanitation products and services and strengthening the role of the local private sector. Sanitation is then seen as a vehicle for businesses to provide services and earn revenues that can be reinvested to keep expanding coverage of sanitation facilities and to develop economic activity while improving peoples' living conditions.

Studies show that each Euro invested in improving access to water and sanitation[5] in developing countries is estimated to give a return of 5 to 12 EUR (Hutton et al. 2007). Moreover Hutton et al. (2007) estimated an additional benefit of 310 million working days per year for the total working population aged 15-59 years that would be gained by achieving the Millennium Development Goal on water and sanitation. These economic benefits should convince governmental agencies to invest in sanitation, create clear policies for sanitation supply and maintenance and to work with the local private sector.

The most effective anti-poverty measures are those that create sustainable and self-perpetuating local jobs. This could for instance be achieved by targeted investments in the sanitation sector in developing countries involving social entrepreneurs connecting investors with micro-entrepreneurs to serve the local market's sanitation needs. The sectors of energy (e.g. see Ashoka/HYSTRA, 2009) or telecommunication[6] could be seen as promising examples in which business opportunities within the base of the pyramid have taken off. Lessons can be learnt there and should be applied in the sanitation sector where applicable.

Social franchising approaches are promising in terms of replication and scaling-up[7]. In a franchising system, entrepreneurs with a suitable profile are identified and receive further training and capacity building in various areas, such as business development, marketing, financing, stock management and technical skills. In order to take the "sanitation as a business model" to the next level, a combined and coordinated effort from several entrepreneurs working together is needed (Devine, 2010, Sim et al., 2010).

Essential to this approach is to consider the economic base of the pyramid (BOP). The BOP does not only include the very poor (those living on under EUR 1 per day, for which most likely only subsidised sanitation products realistically can provide sanitation as an alternative to open defecation or unsafe basic facilities) but also those people that have an income of up to EUR 5.6[8] a day (UNDP, 2008). Millions of people in the BOP – especially in urban settings – are already consumers of items that can be classified as "non-essential" items, such as mobile phones, which illustrates that the poor do have purchasing power to a certain extent. In order to harness the purchasing power of the BOP, sanitation needs to be turned into a demand as Jenkins (2004) argues, "demand is created when consumers have motivation, opportunity and ability to purchase sanitation technology which suits their needs". Opportunity means having access to information, products and service, whereas ability refers to necessary resources (financial, time, skills, decision making).

Social entrepreneurs consider the BOP as a target market, and social business models have been proven to be viable, with one of the most prominent examples being the Grameen Bank in Bangladesh founded by Muhammad Yunus. Brooks (2009) defines a social entrepreneur as an individual – typically marked by innovativeness, achievement orientation, independence, sense of control over own destiny, low risk aversion, tolerance of ambiguity and community and social awareness – who adopts a mission to create and sustain social value, and recognises and pursues new opportunities to serve that mission.

Local governments, sanitation programme managers and other health and sanitation advocates need to provide strong incentives and work with effective sanitation marketing[9] tools to urge individuals to reprioritise their household budgets and include sanitation products and services such as hygiene upgrades[10] on their list of expenses. When working with the lowest income groups, social entrepreneurs, NGOs and governmental agencies need to take into account desirability, affordability and accessibility of sanitation products and services.

[4] An exchange rate of 1.43 USD to 1 Euro was used.

[5] The study scenario for the given range refers to investments linked to achieving Millennium Development Goal (MDG) 7 C.

[6] See New York Times article: Toilets and Cellphones from 24 May 2010 www.nytimes.com/2010/05/25/opinion/25iht-edcohen.html?_r=1

[7] See the Sanishop example in the SuSanA factsheet on Public awareness raising and sanitation marketing: http://susana.org/lang-en/library?view=ccbktypeitem&type=2&id=749

[8] An exchange rate of 1.43 USD to 1 Euro was used

[9] See SuSanA factsheet on Public awareness raising and sanitation marketing: http://susana.org/lang-en/library?view=ccbktypeitem&type=2&id=749

[10] Upgrades could include improvements such as more attractive squatting pans or pedestals, adding a shower or building a more robust superstructure.

4 Who does what in sanitation? Responsibilities of different actors

Collaboration between different public and private actors is crucial within the sanitation sector. The central government's involvement is important for effective policy-making and funding as well as for setting up agreements with private corporations which then implement appropriate infrastructure. Local governments can play an important part in engaging with small and medium enterprises, NGOs, social entrepreneurs and the civil society.

- In general, governments are most likely to have the mandate and human resources for organising and mobilising communities and awareness raising. However, in certain country contexts with e.g. weak political structures and high rates of corruption it might be more appropriate that other stakeholders like the private sector, NGOs, international agencies or different mass communication media such as newspapers, radio, television or internet play an important role in this process.
- NGOs are mainly financed by public funds, and need partnerships with enterprises in order to carry out projects that have the potential for scale and replication.
- Labour unions may help in complex transitions of national public sanitation bodies or programmes (Heierli et al., 2004).

Apart from the discussion of who is involved in sanitation, it is of utmost importance not only to look at single components of sanitation but to consider the whole sanitation services chain including all services that are required to be in place to deliver sustainable sanitation. The following selection shows different revenue opportunities within the sanitation services' chain[11]:

1. Production of sanitation hardware
2. Installation of sanitation systems
3. Operation and maintenance
4. Promotion and advertisements
5. Emptying of toilets and collection and safe disposal of faecal matter
6. Training and education
7. Reuse of e.g. nutrients, water, organic matter and biogas by e.g. commercial farmers

Examples of sanitation as a business with reference to the revenue opportunities (in brackets) that they include are discussed in the next section.

5 Examples of business approaches

The following examples for sustainable sanitation business approaches were provided mainly by members of the working group. They range from proven large business models (Examples in Section (a) and (d)) to small experimental models which are still in the development phase (examples in Section (c)). Giving these examples in this factsheet is not meant as a particular „endorsement" of the business model but primarily as interesting examples on how businesses around sanitation could be set up and about the challenges they face in order to achieve a sustainable system.

a) Example for (2), (3) and (4) - Installation, operation, maintenance and advertising: Public toilet management in city areas in Kenya

Since 2007, David Kuria (elected as Ashoka fellow in 2007[12]) has been working with social business models in his social enterprise EcoTact. One of EcoTact's social business products is the Ikotoilet mall, a community hub of stores and services built around a public toilet complex. People can use the facilities, as well as buy products and services available in the mall, such as shoe shining or barber booths, food stalls, phone and newspaper stands.

Figure 2: Ikotoilet at the Dagoreti marketplace (left) and close to the National Archive (right), Nairobi, Kenya (source: R. Ziegler and C. Dietsche, 2011).

The Ikotoilets are situated around Kenya with a concentration in the capital Nairobi including a number of facilities servicing urban slums. Due to inadequate sanitation provision in informal settings, slum dwellers either defecate in the open or use plastic bags ("flying toilets"). This poses negative consequences for urban planning, health and security for women[13].

David Kuria has worked together with urban slum dwellers and organised design workshops and held public health education courses for residents, private investors and local authorities to try and ensure the proper operation and maintenance of the facilities once built.

The public facilities have advertisement space that can be leased by companies for their promotion activities. The charging system of Ikotoilets differs between toilet blocks in low-income informal settlements and toilet blocks in middle or high income business areas. In middle and high income areas a pay-per-use system is applied which would be inadequate for low income informal settlements where families do not have household toilets and rely on the facilities on a regular basis. Hence in informal settlements where the Ikotoilets are served by a management committee which consists of 10-15 people from the community who

[11] However, although listed as single components here, they cannot be viewed as stand-alone components when it comes to application. They are strongly interdependent and thus have to be viewed in conjunction.

[12] Ashoka Fellow Profile of David Kuria: http://ashoka.org/fellow/4356

[13] For further information see: www.ecotact.org

also work in the micro-enterprises which are part of the Ikotoilet mall users are charged on a family sanitation flat rate. The committee members manage the flat rate system, keep the facilities clean, and perform necessary small repairs.

As of June 2011, 30 Ikotoilet buildings have been built of which three of them being in urban slums of Nairobi. Another ten in public primary schools are in the process of construction. In total the number of people being served by Ikotoilets (including the number of toilets under construction) adds up to about 30,000 people per day. EcoTact expects that in 2011 the number of Ikotoilet customers will continue to increase to 10 million customers per year compared to 6.2 million customers served in 2010.

Each Ikotoilet building provides squatting pans and flush toilets, waterless urinals and showers as well as a baby changing unit. The capital cost for one facility is EUR 14,000. Under Public Private Partnership (PPP) agreements the municipality provides the sites and approvals for the construction of the Ikotoilet buildings and thus the facilities become joint programmes displaying the authority's logo. After a period of five years, the facility is transferred to the municipality which can then operate it independently or lease it out to EcoTact again. Some of the Ikotoilet buildings are connected to biogas digesters while others are connected to septic tanks or sewers. Currently, Ikotoilets employs 150 staff members in Kenya.

EcoTact is now in the process of launching a franchise framework under the name of the "Ikotoilet Youth Franchise Incubation Model", which is aimed to generate young entrepreneurs in sanitation. This initiative is supported by the government of Kenya's Youth Enterprise Development Fund, and has stimulated demand across East Africa. David Kuria regards urban slums as the main strategic market for scaling-up,plans to spread the facilities to the almost 200 slums in Kenya, and new programmes are planned to start in Kampala in Uganda.

The Ikotoilet concept is seen as a long-term collaboration between urban communities, city authorities, and business communities in the East African region in which sanitation needs of the many are turned into returns for private investors and income for the management committee members.

b) Example for (5) and (7) - Collection of faecal sludge and safe disposal or reuse: On-site sanitation (septic tanks and pit latrines) in cities of developing countries

About one third of the world's population relies on on-site sanitation systems and will continue to do so in the foreseeable future (Koné and Strauss, 2004). As on-site sanitation technologies need regular emptying, there is a wide range of private (often informal) entrepreneurs in cities of developing countries providing services such as pit and septic tank emptying and transport of the faecal sludge. This can be manual or mechanised emptying with pumps, and subsequent transport. High emptying fees make this service unaffordable for some households thus leading to badly maintained and overflowing on-site facilities. Furthermore, faecal sludge is often indiscriminately dumped by the emptier to save costs and due to a lack of faecal sludge treatment plants. This may severely impact public health and the environment.

A case study conducted in the city of Dakar, Senegal, shows that companies struggle to be profitable if their services are focussed only on faecal sludge emptying for household on-site systems. Diversifying their services to include cleaning of sewage pipes, industrial waste services or even solid waste collection, can allow these companies to reach a return on investment upwards of 20%. Such an improvement of business opportunities might result in a drop of household emptying fees and thus significantly reducing the financial burden on the urban poor (Mbéguéré et al., 2010).

Investment and operational responsibility for existing treatment systems are often with the local authorities which have the mandate to ensure treatment of waste to protect human and environmental health. The aspect of creating value from waste has hardly been the centre of attention but this could change e.g. if fertiliser becomes more expensive (Box 1).

Box 1: Can nutrient reuse create a market for human excreta (example for (7))?

The marketing of human excreta presents a promising option for generating money with a service that is often not delivered at all or implemented deficiently in many regions of the world. Schroeder (2011) conducted a study in which he examined possible ways to dispose of human excreta from slum areas in Kampala, Uganda. The study aimed to design a logistics system that connects slums with agricultural areas requiring certain amounts of nutrients. The results of the study found that the logistics of human excreta collection should ideally be carried out by a private company in order to assure maximum efficiency and improve the system's economic sustainability. Income could be generated by the sales of sanitised human excreta as fertiliser. Monetary (or alternatively material good) incentives should be used as motivators to align the efforts of the sanitation system stakeholders at the slum level.

There are several possible approaches for creating value from excreta. The concept of "productive sanitation" is described in detail in Gensch et al. (2012) and only short examples are listed here: use of source-separated urine, struvite production, Arborloo, (co-)composting and short rotation plantations.

Encouraging the development of products from excreta and identifying and developing markets for these products will help combat uncontrolled discharge of excreta, which is imperative to achieving public and environmental health objectives. In addition, it will also trigger private enterprise involvement in scaling-up and replication of such approaches (Koné, 2010). Urban-poor households will benefit from these improved business opportunities through lower costs for services, and improved quality and reliability, and availability.

In order to develop market-based approaches with business models that provide both long term social benefit and profit

in a sustainable manner, the last link in the value chain, nutrient reuse, needs to be developed into a marketable and demanded product. To make this a reality in a sustainable manner and to "harness" the potential value of excreta, innovative entrepreneurs, businessmen, governments, donors and NGOs need to collaborate and build such a market place.

c) Examples for (1), (2) and (3): Creating jobs and income with mobile UDDTs (Urine Diversion Dehydrating Toilets) and UDDT business in India

Ecoloove is an interdisciplinary social venture[14], founded in 2008. Ecoloove was started with the aim to develop affordable ecological sanitation (ecosan) solutions for people in developing countries. A mobile ecosan system (UDDTs) was designed to be run by women living in slums in India.

The overall objective is to provide more public toilets in low income areas, lower the risk of sanitation related diseases and to create jobs and micro-business opportunities in particular for women. Furthermore, Ecoloove aims to raise public awareness about sanitation.

The first product design is a mobile urine diversion toilet built on a traditional rickshaw. A metal base structure is welded to the cycle. Panels made of lightweight bamboo are attached to the metal base structure. The roof is made of epoxy plastic strengthened by a bamboo mat. The roof lets light in without being transparent. Currently, Ecoloove is using locally manufactured buckets[15] on a shelf under the floor for collecting faeces and urine separately.

The female entrepreneurs, called "toil-o-preneurs" lease the toilets from Ecoloove at a minimal rate which is made possible by selling advertisement space on the outside and inside of the toilets. In partnership with the local NGO PLC WatSan, these women also receive training on sanitation, operating and maintaining the toilet properly.

The "toil-o-preneur", can generate income by charging small amounts of money per use 0.03 EUR (2 Rupee), running a shop for sanitary products alongside the toilet and in the future when the project scales-up selling sanitised urine and faeces to farmers is foreseen to be viable.
A trial took place in Bareja, Ahmedabad, Gujarat state in India in 2010 with 23 users and one toilet[16]. In order to increase social acceptance for their toilets, Ecoloove has implemented a constant feedback system to adjust the development to the user's need. The participating "toil-o-preneurs" have received extremely positive feedback from all parties involved – users, farmers, one NGO, and the local leaders. The main reasons for their interest were: Generating income (all stakeholders), the need of having proper toilets (all stakeholders), the option of receiving cheaper ecological fertiliser and the prevention of crops being damaged by people using the fields as toilets (farmers).

Figure 3: The interior of an Ecoloove with the "toil-o-preneur" and customers (source: A. Segtnan, 2010)[17]

A similar project model with mobile UDDTs has been carried out by the NGO Wherever the Need (WTN) in India. Since late 2009, WTN has been trialling a mobile UDDT system in Cuddalore Old Town, Tamil Nadu. The primary aim when launching the project was to discover whether mobile UDDTs could be used in an inner-city location. The challenges faced were the lack of space, the logistics of collection, storage, treatment and disposal of both urine and faeces. The secondary focus was to investigate whether these services could be turned into a viable business.

To begin with usage was low, but over time and with encouragement from WTN ground staff, more and more people started using the mobile unit. There was no charge for women to use the urinals, thus women could avoid urinating in the open where they felt vulnerable. Initially 0.015 EUR (1 rupee) was charged for defecation, this was later also changed to being free of charge. After one year, 150 people regularly used the unit daily.

Faeces are deposited in plastic crates and taken to a storage unit by a small vehicle designed specifically for this purpose. The faeces are stored in the crates for a short while and are then vermi composted. Urine is decanted into a container for storage, although to date much of it is immediately bought and used on fields. The logistics have been tested and a process agreed upon to ensure safe handling and storage.

Urine is sold to local farmers at 0.015 EUR for four litres, and the compost is currently used on a small trial field to demonstrate growing benefits. The estimated price that the compost could fetch is 0.10 EUR (7 rupees) per kilo if it were to be sold.

[14] Ecoloove is funded by the Swedish industrial designer Annamaja Segtnan through awards from competitions, institutions, investors, farmers, factory owners and donations. The organisation's portfolio includes industrial design, engineering, production, marketing, service design, business development as well as an ecosan NGO.

[15] The bucket is locally produced; it is a "no-name" product without a specific brand. It is produced in Gujarat, India at a very low price, around 0.6 EUR per bucket.

[16] See the blog entry on Friday, March 5, 2010 for photos at http://ecoloove.blogspot.com/

[17] This photo was taken from: www.ecoloove.com/product_interior2.html where you can also find out more about the recent activities of Ecoloove.

The superstructure of the mobile toilet is made of steel and fibreglass. Additionally, there have been design modifications regarding the size of future toilet units and the needs of people with disabilities and the elderly with handrails both inside and outside making access easier[18].

A subsequent trial will be carried out at six locations with one of the units being a urinal only. Monitoring, maintenance, logistics of the products (urine and faeces) and its subsequent sale have been recognised as key success factors. WTN believes that the distribution network and sale of the product is crucial and that entrepreneurs could create micro-distribution networks. WTN is considering becoming one of the networks. Elaboration on various project details such as scaled up costs and how these will be covered still needs to take place[19].

The two examples given in this section are very innovative and promising but need further development work before they can finally be scaled up.

d) Examples for (2), (5) and (6): School toilet cleaning and maintenance services, training and hygiene education

In 1996 Trevor Mulaudzi launched "The Clean Shop", a "clean-up business" for public toilets and school toilets in South African townships. This social enterprise succeeds in making sanitation a business by providing services and changing people's mindsets about hygiene and cleanliness in public schools and communities.

The Clean Shop got engaged in community projects by using schools as a distribution channel for sanitation products and services. The company bought toilet paper and cleaning material on a large scale, and then sold the products to local schools at a low price. He encouraged the school staff to retail these products to parents and the community as a school fundraising effort. The schools could compete with shops offering the same products and act as a retailer for sanitation products which were not available in the area, and thereby generate an income.

With respect to sanitation services, the Clean Shop's team of professional toilet cleaners provides training to students, teachers, and administration staff about good toilet and hygiene practices as well as training on maintaining and using the facilities correctly. The Clean Shop also offers maintenance services, such as thorough cleaning of school toilets, repairing pipes and plumbing.

In order to create a sustainable business model, the Clean Shop diversified its field of business and also started cleaning change houses, kitchens, hostels and residential flats for mining companies[20].

Figure 4: The Baranuka High School (in Lulekani, South Africa) toilet block that was built by The Clean Shop and Trevor Mulaudzi and serviced by the school (source: T. Mulaudzi, 2008)

Since the start of the business in 1996, The Clean Shop has employed over 350 highly motivated and technically competent toilet cleaners, and the businesses turn-over has grown to about EUR 100,000 per month.

On the 2010 World Toilet Day (19 November) Trevor Mulaudzi was appointed by Unilever/Domestos South Africa, as Unilever's implementing agent of good toilet facilities in public schools in South Africa. Unilever funds repair and plumbing work at school toilets and ablution blocks and The Clean Shop carries out the services. Furthermore the idea was to train parents (mostly mothers) as school toilet technicians, cleaners and hygiene education teachers who then could be hired by the schools. At the same time children are taught how to share their learning with their parents at home about good toilet manners like using toilet paper and washing their hands with soap (Unilever soap is promoted in this process).

A further example from Kenya of an enterprise with a decentralised business model and also providing similar services to those of The Clean Shop, is Community Cleaning Services (CCS) which was launched in 2006 in Nairobi as a non-profit social enterprise. CCS combines the expertise of local entrepreneurs, the household products multi-national SC Johnson and the international NGO Plan International. The combined expertise delivers what CCS terms an "innovative turnkey solution to the "software" (ongoing management and maintenance of toilets) challenges, as opposed to the toilet "hardware" or infrastructure construction challenges, of urban sanitation"[21]. CCS is currently active within the city of Nairobi.

The goal of CCS is to engage low-income urban communities to create demand for cleanliness, hygiene and sanitation which in turn creates a market for sanitation professionals to improve their livelihoods and their own communities. To achieve this goal the following two core areas are focussed on:

[18] Photos from the project: www.whereverthenead.org.uk/projects/indian-projects/mobile-unit-cuddalore/

[19] Currently there is a private donor providing funds for the first, second and one mobile toilet module in the third phase of the project.

[20] See Financial Mail article: *Civic duty. Addressing social inequity by adopting a social approach to conducting business* from 26 October 2007, http://free.financialmail.co.za/report07/shell07/ashell.htm

[21] The contact person at CCS is Joseph Njenga: joseph.njenga@comcservice.com

- Training of sanitation service providers
- Ongoing quality assurance, mentoring and marketing support

The training of sanitation service providers includes three training sub-components which are: training on cleaning, business management, sanitation marketing and awareness raising. Two groups of sanitation service providers have been focussed on by CCS to receive training, namely Mobile Cleaning Teams (MCTs) and Public Toilet Operators.

CCS has measured their impact and in their latest report in May 2011 stated that over 200 people have been trained in sanitation services provision and business management, and that over 300 community members have been trained in sanitation awareness leadership and facilitation. At the time of the report there were 10 active Mobile Cleaning Team Leaders who employed 60 professional cleaners. With respect to sanitation awareness it is estimated that 2500 community members have become active in this area after open meetings initiated by the trained CCS community members. The CCS MCTs clean on average 780 school toilets and 225 household toilets per month in low-income areas in Nairobi, and a conservative estimate puts the number of people who benefit from this at 500,000 per month.

Box 2: Support for starting up a business in Sustainable Sanitation and Water Management

CEWAS - the international centre for water management services - combines advanced education and support to young professionals to start up a business in the field of sustainable sanitation and water resource management. It builds up SMEs (Small and Medium size Enterprises) that can offer technical and managerial expertise to national and international organisations and private clients. Start-ups are supported by a core group of international experts, bringing in their expertise and the current state-of-the-art knowledge. CEWAS was started in 2009. Since then, several trainings have been carried out on sustainable sanitation, business development and business plan development as well as on presentation skills, team building, sustainability and ethics. The one year Start-Up programme including education and training personal coaching by international senior experts, a networking platform and office sharing facilities was launched in May 2010[22].

6 Outlook

The examples show that sanitation can be a profitable and viable business opportunity and offers many entry points in the value chain. In these particular examples, business was done by producing and installing sanitation products, providing maintenance or collection services, collecting user fees in public toilets and selling advertisement spaces in toilets and on vehicles. Other examples can be found for businesses in training and education and - possibly - reuse.

An observation from recent sanitation programmes is that they have been largely implemented by sanitation sector specialists, such as engineers, rather than business and marketing experts (Devine, 2010). This may be one reason that has contributed to the limited successes in scaling up projects to serve the mass market.

The sanitation sector has the potential to provide economically viable business opportunities for both public and private organisations. Although this factsheet puts a strong emphasis on private and social enterprises, the role of government must not be overlooked. Improved regulation in the sanitation sector, as well as simplification of the registration of micro-businesses in the sanitation sector, are key areas in which government can play a leading role. This would lead to facilitating an enabling environment for private sanitation suppliers.

Collaboration between private and public entities in sanitation should be encouraged with examples such as the Ikotoilets, where the municipalities provide sites and approvals for the construction and the private sector covers investment costs. Private and social businesses should be encouraged further to increase their presence in service provision in the sanitation sector. The sale of sanitation products will remain dominated by the private sector, but more social enterprises should become active in the product area so as to establish a wider distribution network to reach the people who need these sanitation products the most. NGOs will continue to play the part of advocates, innovators and implementers that work for more public awareness and social dialogue (cf. WTN).

Lastly, it has to be emphasised again that the 4 billion people that fall in the Base of the Pyramid (BOP) income bracket and are suffering from the sanitation crisis need to be viewed as valued customers and a potential market by sanitation businesses.

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Acknowledgements are given to the following persons for their valuable contributions:
Jürgen Eichholz (Saniblog, Germany), Trevor Mulaudzi (The Clean Shop, South Africa), Arne Panesar (GIZ, Germany), Claudia Powers (formerly WTO, Singapore), Katharina Kurianowski (formerly WTO, Singapore), Marius Kriening (Ecoloove, India), Dorothee Spuhler (seecon, Switzerland), Aleksandra Drewko (TU Hamburg-Harburg, Germany), Elisabeth von Münch (GIZ, Germany), Rafael Ziegler (GETIDOS, Germany).

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sustainable sanitation alliance

SuSanA factsheet

Public awareness raising and sanitation marketing

April 2012

1 Summary

This factsheet highlights the importance of public awareness raising and sanitation marketing to increase the efficiency and sustainability of sanitation improvements. It provides tools and best-practice examples for practitioners, researchers, policy-makers and those who understand the importance of sustainable sanitation and wish to disseminate up to date information.

Four key approaches to awareness raising include 1) raising overall public awareness; 2) professional marketing of sanitation to those lacking access; 3) stimulating private sector interest in the sanitation market and 4) advocating to decision makers in the public, private and civil sectors.

Most people who have access to functioning sanitation systems are not aware of the poor sanitation in vast regions of the world and fail to understand its significance in socio-economic development. Taboos surrounding the toilet and human excreta hinder global progress in this field. Therefore a stronger appreciation of the manifold society-wide benefits of sanitation and the challenges of achieving them are required in all countries.

This lack of knowledge combined with the toilet's "dirty image" results in the low priority that users and decision makers alike give to sanitation. To promote safe hygiene practices at the household and community level and to create sustained behavioural change, calls for professional marketing which is a common activity in the commercial sector.

An enabling environment requires political responsibility and the will to create a legal framework that furthers sanitation initiatives. Hence, lobbying policy makers with relevant facts and arguments can have significant impact. Only when they grasp the many cross-sectoral and economic gains which sanitation brings, will they allocate resources and create policies and strategies that strengthen public and private capacity to provide and manage sanitation services.

The twin fields of awareness raising and sanitation marketing lay the groundwork for successful advocacy and highlight business opportunities in sanitation. These approaches, moreover, make it possible to scale-up and increase the efficiency of current efforts towards improved sanitation for all.

Awareness raising aims to achieve the following:

- Create public and political awareness
- Initiate public and policy discussions
- Generate an enabling environment and policy changes that lead to action

Sanitation marketing aims to achieve the following:

- Tailor product design, availability and price to potential customers
- Use communication techniques and media appropriate to the customers' situation
- Engage people in emotional communication to create genuine demand and behaviour change
- Offer the target group a choice of products that are appealing, accessible and affordable
- Open the market to sanitation business opportunities (see Gröber et al. (2012) for details).

Figure 1: "Sanitation is Dignity" Campaign in Berlin, Germany, in 2005: The travelling exhibit and campaign asks passers-by to reflect what life would be like without a toilet (source: GTO, 2005).

2 Public awareness raising

Public awareness raising alerts the public to the issues and mobilises their support and action. It can be achieved in multiple ways: public events, workshops, exhibitions, demonstrations, radio and TV campaigns, print publications and the Internet. To maximise outreach, awareness raising activities may benefit from free publicity through media coverage.

Social media on the Internet such as the open discussion forum of SuSanA[1] can be used for low-budget awareness raising. Video clips[2] made available through YouTube as

[1] See: www.forum.susana.org

[2] For a list of relevant videos see: www.susana.org/lang-en/videos-and-photos/resource-material-video

well as messages spread by Twitter and Facebook have been used successfully in order to promote campaigns such as the "Talk Sh*t All Week" or the "World's Longest Toilet Queue" in 2010 which then evolved into the "World Walks for Water" in 2011, and the "World Walks for Water and Sanitation" in 2012[3]. This joint campaign of End Water Poverty, Freshwater Action Network and WSSCC is second only to Global Handwashing Day in importance to the water and sanitation sector.

Focussing communication activities on relevant "world days" has been shown to be very effective. Sanitation awareness can use taboos surrounding toilet issues to its advantage. Word plays, cleverly packaged messages or unconventional images can provoke emotion and attention.

Since every person defecates, sanitation is never an abstract topic. The challenge is to draw attention to this "most usual thing" while taking care not to offend or disgust the target audience leading to a repulsive reaction. Messages with fascinating, unexpected facts can communicate this "dirty" topic in a pleasant manner.

The message and the communication channel must be tailored to the target audience. It is important to be alert to the many cultural factors that affect the success of communication activities with different populations.

Social mobilisation techniques must have rich appeal in order to increase public awareness of safe sanitation as a basic need for human development. Journalists, researchers, educators and other practitioners can influence the actions of individuals through contributions like petitions and volunteering. When there is broad understanding of the importance of sanitation, public pressure on decision makers can foster greater political will, prompt more investment, and reform policy in the sanitation sector. Well-targeted awareness campaigns may also stimulate the interest of the private market to invest in the sanitation sector.

3 Examples of public awareness raising

a) WASH United: Showing diarrhoea the red card

WASH United[4] harnesses the power of sport and the role model status of sport stars to raise awareness of water, sanitation and hygiene and to catalyse social change. WASH United's first campaign focused on the 2010 World Cup in South Africa and engaged football stars to (1) tackle taboos related to sanitation and create demand for sanitation services, (2) promote hand washing with soap, (3) advocate for safe drinking water and sanitation as a human right.

Through events like football tournaments, road shows, "World Toilet Cup" games, and public screenings of World Cup matches, WASH United engaged people on the ground. The combination of attractive football-based events, the participation of international football superstars and active media engagement successfully opened up new channels for WASH issues. In both the North and the South, messages were picked up by mainstream television and radio and even in football magazines. WASH United has thus managed to reach more than 25 million people with crucial messages.

Together with WaterAid, WSSCC and other partners, WASH United is now adapting the football-based approach that has worked so well in Africa to the number one sport in South Asia: Cricket. Activities in South Asia will begin with an innovative large scale campaign in India leading up to the 2012 ICC Twenty20 World Cup[5] in Sri Lanka.

Figure 2: Left: WASH United Champion Didier Drogba from Ivory Coast (FC Chelsea, London) on an awareness raising poster for Africa. Right: Indian cricket star Irfan Pathan on a poster for possible upcoming cricket-based activities (source: WASH United, 2011).

b) Sanitation is Dignity: Awareness raising campaign of the German Toilet Organization:

In 2005, the German Toilet Organization (GTO) created the "Sanitation is Dignity"[6] campaign to raise awareness of people unaware of or unaffected by the sanitation crisis. GTO encourages the public to join the campaign and lend their voice to the cause.

As a part of the campaign, GTO developed a travelling exhibit entitled "Where would you hide?" for display in public places, at conferences or in government buildings. Life-size poster board cut-outs feature people crouching to defecate in public while trying to hide behind everyday objects such as flower pots or umbrellas in order to maintain their dignity. This captures the attention of passers-by while information panels and flyers provide the facts. A campaign toolkit was created to make outreach even more effective.

With the support of UN-Water, exhibit materials have been translated into all UN-languages and adapted to various cultural settings. Available for organisations to use at their

[3] See: http://toiletday.org/, http://worldtoiletqueue.org/eng/ and http://www.worldwalksforwater.org/eng/
[4] www.wash-united.org
[5] See: www.wash-united-cricket.org and http://www.t20worldcup2012.com/index.html
[6] http://www.sanitation-is-dignity.org/node/12

own events, "Where would you hide?" so far has travelled to approximately 50 different locations and resulted in extensive coverage in local, national and international media.

The strength of this campaign is its strategy of playing with the taboo. It employs a well-conceived presentation to create a mix of surprise, humour and thoughtfulness to initiate discussion. The campaign continues to be available to other organizations through the GTO.

c) World Toilet Organization Activities

When Jack Sim founded the World Toilet Organization (WTO) in 2001, the name in itself proved to be a successful marketing tactic as it has the same acronym as the World Trade Organization. This cause smiles and makes the name hard to forget. Sim has continued to break taboos about toilets, using humour and passion in his countless speeches and media features.

Figure 3: Jack Sim from WTO calls himself "the toilet man" in a Time Magazine Hero of the Environment 2008 photo. He stresses that humour can be used as an effective entry point for discussing sanitation (source: WTO, 2008).

Every year the WTO organises the World Toilet Summit which is widely covered by the global media. Unlike sanitation conferences that focus on the Millennium Development Goals (MDGs) and lack of access to sanitation, the Summit addresses a wide range of toilet issues that affect industrialised countries and the developing world alike. The Summit was launched in Singapore in 2001 and has since travelled to Seoul, Taipei, Beijing, Belfast, Moscow, New Delhi, Macao, Singapore, Philadelphia and Hainan. The 2012 host is Durban, South Africa. Organisers work with the global media throughout the year, launching summits with special events, holding press conferences before and during summits, and accommodating major TV stations, radio, print publications, wire agencies, social media and various traditional media.

Sim and his WTO colleagues worked closely with the Vanguard documentary team from Current TV to film the "The World's Toilet Crisis"[7]. The production team travelled to India, Singapore and Indonesia to understand why people do not use toilets and what is being done to end the practice of open defecation. The documentary is highly graphic and often difficult to watch but also very persuasive. When human waste is not properly collected and treated but accumulates in streets, open fields and water, it is a human and health disaster. The film is an eye-opener for most people in industrialised countries. It has demonstrated that sanitation is a compelling media issue and the film continues to be used for educational programmes, public screenings, and political events.

d) World Toilet Day - 19 November

Celebrated on 19th November, World Toilet Day has played an increasingly important role in sanitation awareness raising. Launched in 2001 by the World Toilet Organization (WTO), it has caught the imagination of sanitation activists and the global media alike and has grown through self-generated and crowd-sourced awareness activities by a wide range of organisations worldwide. These have included demonstrations in Washington DC for "Sanitation as a Human Right", press conferences organised by school children in Berlin, a minister cleaning market toilets in Sarawak, Malaysia; a sanitation concert in Moscow, stand-up comics in London and Singapore, Crisis Talks by End Water Poverty, the Golden Poo Awards and The Big Squat in universities worldwide.

The multi-national corporation Unilever partnered with WTO to celebrate World Toilet Day 2011 with the global roll-out of "Domestos Toilet Academies", starting with a pilot in Vietnam[8]. These academies will offer month-long courses to toilet entrepreneurs and help provide sustainable solutions to sanitation that benefit communities and stimulate local economies.

e) The Drive to 2015

An example of awareness raising at the highest political level is the United Nations' initiative "Sustainable Sanitation: The Five-Year-Drive to 2015". On 20 December 2010, the UN General Assembly adopted a resolution calling upon the UN Member States to "redouble efforts to close the sanitation gap".

Figure 4: Logo of the "Drive to 2015" campaign, launched in June 2011, which builds on the earlier logo of the International Year of Sanitation in 2008.

The resolution established a global push to mobilise political will and financial and technical resources towards the MDG sanitation goal. The resolution is notable for its call for the end to open defecation, the sanitation practice that most threatens public health as well as its broader consideration of the sanitation chain including waste water management. It

[7] http://current.com/shows/vanguard/92471289_the-worlds-toilet-crisis-vanguard-trailer.htm

[8] www.unilever.com/mediacentre/pressreleases/2011/UnileverandWorldToiletOrganizationpartnerfortheWorldsFirstToiletAcademy.aspx

also includes consideration of the entire sanitation chain, including wastewater management[9].

UN Secretary-General Ban Ki-moon, along with the UNSGAB Chair, His Royal Highness, the Prince of Orange UNICEF Executive Director Anthony Lake, Ugandan Minister of Water & Environment the Hon. Maria Mutagamba and the Vice Chair of UNSGAB Uschi Eid, launched on 21 June 2011 the "Sustainable Sanitation: Five-Year Drive to 2015", a push to speed up progress on the Millennium Development Goal target of improving global sanitation by 2015. The Drive will include a broad advocacy campaign with a strong emphasis on ending open defecation and provide a comprehensive guide for planners on implementing this goal along with other advocacy material. A direct linkage is established with the Sanitation and Water for all initiative.

4 Sanitation Marketing

Sanitation marketing is a type of social marketing. Social marketing plans and implements programmes designed to bring about social change using concepts from commercial marketing[10]. It applies tools and techniques developed for commercial marketing to persuade people to adopt certain practices and behaviours that improve quality of life (UN-Habitat and Sulabh 2006). Sanitation marketing programmes often create favourable conditions for business opportunities.

Devine (2010) sees the potential of sanitation marketing to create demand and to scale-up supply for improved sanitation, mainly by demonstrating to people that a clean toilet and better hygiene practices will improve their quality of life. The objective of sanitation marketing is to empower potential customers to make conscious, informed choices. The approach assumes that poor people are not "beneficiaries" but rather potential customers of sanitation products and services. It fosters the development of private businesses that supply goods and services and helps the sanitation sector become financially and institutionally sustainable (Jenkins and Sugden, 2006).

Sanitation marketing focuses on toilet adoption as key to promoting safe and adequate sanitation. However, people may be unwilling to invest in household toilets due to institutional, financial, or socio-cultural reasons. Campaigns may be designed to change specific attitudes and behaviour so as to lead to improved health and hygiene, social and economic well-being and environmental performance (UN-Habitat and Sulabh, 2006). Human decision making is largely based on emotional rather than on rational factors. Campaigns promote attractive products, link products to social status, and create aspirations that result in strong social pressure to make sanitation access a highly desirable good. Products need to be emotionally appealing and at a price that the customer is willing to pay.

Although sanitation marketing is still considered an emerging field, it has made significant strides in the past few years. The Water Supply and Sanitation Collaborative Council's (WSSCC) Global Sanitation Fund is supporting sanitation marketing in countries where WSSCC works. The Water and Sanitation Programme (WSP) of the World Bank, has recently released a "Sanitation Marketing Toolkit"[11]. Illustrated with examples from India, Indonesia, Tanzania and Peru, it offers practical guidance on rural sanitation programmes, including design, implementation monitoring, and scaling up.

The 2.5 billion people currently living without access to sanitation represent potential customers. With encouragement and assistance, the private sector can develop new local, regional and national businesses and create local jobs.

Box 1: Community-Led Total Sanitation (CLTS) and sanitation marketing

CLTS was introduced by Kamal Kar and the Village Education Resource Center (VERC), a partner of WaterAid in Bangladesh in 1999. During a facilitated triggering the community members analyse their sanitation situation and decide to take collective steps to make improvements and finally become open defecation free (ODF) and through their own efforts they build sanitation facilities without any hardware subsidies. CLTS is a bottom-up process towards behaviour change and sanitation adoption that is led by the community as an entity rather than on an individual household basis. The participatory approach plays on people's emotions such as pride and disgust, and "triggers the community's desire for change, propels them into action and encourage[s] innovation, mutual support and appropriate local solutions, thus leading to greater ownership and sustainability" (Kar and Milward, 2011).

CLTS has been successful in reducing open defecation, but the approach is criticised by some for the low quality standard of many of the constructed latrines. CLTS is mainly focused on the demand side and neglects the supply side of sanitation products and services. Sanitation marketing approaches aim to overcome the supply gap and offer possibilities to climb-up the sanitation ladder towards more improved sanitation. Sanitation marketing approaches might not be the appropriate initial step for people who still practice open defecation. Consequently there is now a growing interest in combining or integrating CLTS and sanitation marketing. Currently WSP is combining CLTS and sanitation marketing at scale in the Scaling Up Rural Sanitation programme (Devine and Kullmann, 2011).

Further information: Community-Led Total Sanitation (CLTS) Institute of Development Studies (IDS), Brighton, UK, http://www.communityledtotalsanitation.org/.

5 Examples of sanitation marketing programmes

a) Two examples from Cambodia: IDE's "Easy Latrine" and WTO's Sanishop

Only 18% of rural Cambodians have access to improved sanitation (WHO/UNICEF, 2010), and this lack of access contributes to the country's poor public health. Many villagers

[9] More information about the Sanitation Drive can be obtained at www.sanitationdrive2015.org.

[10] Weinreich, N. K. What is social marketing? USA: www.social-marketing.com/Whatis.html.

[11] www.wsp.org/wsp/toolkit/toolkit-home

view purchasing sanitation equipment as an unnecessary luxury due to a lack of knowledge, combined with the expense and difficulty of installing traditional latrines (Heierli and Frias, 2007).

The "Easy Latrine" model is a well-designed, affordable product with an appropriate marketing strategy that raises awareness and encourages families to invest in a household toilet.

International Development Enterprises (IDE) started the project in Cambodia with one core assumption: people consider toilets a decidedly unpleasant topic that is more likely to induce uncomfortable giggles than provoke innovative thinking. The IDE Cambodia Country Team worked together with the design firm IDEO to design a low-cost, easy-to-install pour flush latrine system that villagers could build themselves using cheap, locally available materials. This has stimulated demand and strengthened the supply of latrines. Each toilet costs about EUR 24 and more than 3000 have already been purchased and installed by villagers (WSP, 2010)[12].

Thanks to its integration of product design, social strategy, and sustainability, "Easy Latrine" won the prestigious "Best in Show Award" at the 2010 IDEA Awards[13] for international design excellence.

When people install their own latrines, they have a sense of ownership and pride. Therefore, the likelihood of proper use and maintenance of the facilities increases tremendously. The "Easy Latrine" model, however, does not yet offer a product range which allows people to choose on the basis of individual tastes and budgets. The introduction of additional options for customers will strengthen the programme.

A second example from Cambodia is **SaniShop** which is a low-cost micro-franchise, implemented by the World Toilet Organization (WTO) to train local entrepreneurs to become producers of sanitation products and sales agents. In operation since October 2008, this strategy complements the work of governmental agencies, local NGOs and international donors.

Figure 5: Logo of SaniShop

In Cambodia, WTO provided technical assistance and worked with small businesses to develop, manufacture and market latrines for sale in Kampong Speu Province. WTO lent its expertise in sanitation marketing, product research and development, quality assurance and private sector development. The business model involves simultaneous demand and supply side interventions; it stimulates demand for latrines among rural households while building and strengthening the capacity of the private sector in production, distribution and sales to adequately respond to that demand.

The social franchise business model is scalable, replicable and ensures good quality. In Kampong Speu Province, the target population is low income rural dwellers who have never owned toilets. Project partners carried out research to learn how much money the typical rural household was able and willing to pay. With this information, households without toilets had to be convinced that they needed a toilet and how they could own one.

The Sanishop model also provides business and technical skills training to local suppliers and masons and introduced a new actor into the supply chain - the *sales agent* who strengthens marketing activities and mobilises communities. WTO facilitated the adoption of a low cost latrine option modified from an award-winning design and a pricing structure that enables all supply chain actors to make money while keeping the product affordable for the customers.

On the demand side, WTO designed social and commercial marketing strategies that address behaviour change as well as consumer demand. The project devised a payment scheme that allows poorer households to buy components one at a time. Project support includes monthly sales agents meetings to monitor progress and share lessons learnt. Household expenditures on toilets were found to range from EUR 24-67 (with March 2010 exchange rate, 1 USD is 0.74 EUR). These expenditures included both the infrastructure (toilet) and the super structure (external shelter).

b) Global Scaling Up Handwashing Project by Water and Sanitation Programme (WSP)

According to the World Bank's Water and Sanitation Programme (WSP), "marketing has been more successful than anything else in changing the behaviour of people when they can see direct personal benefits" (WSP, 2010).

A market-based approach to sanitation has four principal advantages over the traditional donor-based model in which latrines are given on a heavily subsidised basis or even for free:

1) Sanitation marketing helps achieve behavioural change. People willing to pay for a latrine will most likely use and maintain it.
2) Unsubsidised programmes based on sound business principles are financially sustainable and can be taken to scale.
3) Marketing focuses on both the hardware (the toilet) and the software (sanitation and hygiene education). This combination is likely to bring about public awareness and behavioural change that causes consumers to value, use, and maintain their latrines.
4) Compared with donor-based approaches, marketing is much more cost-effective and can be easily monitored (UN-Habitat and Sulabh, 2006).

[12] Exchange rate from March 2010: 1 USD was 0.74 EUR

[13] IDE (2010) Flush with success: IDE wins top design award for innovative latrine in Cambodia, International Development Enterprises, Winnipeg, Canada, www.ide-canada.org/OurStory/News/2010-06-29-idea-award, http://www.fastcodesign.com/idea-2010

The WSP handwashing project in Peru, for example, targets mothers of young children and aims to improve the health of populations at risk of diarrhoea and acute respiratory infections. Children under five represent the age group most affected by diarrhoeal diseases and respiratory infections, which lead to more than 4,000 child deaths a day (WHO, 2009).

6 Sanitation marketing: The six P's

Marketing experts traditionally work with four criteria: Product, Price, Place, and Promotion. Based on experience in the sanitation marketing sector additional P's such as People (Heierli and Frias, 2007) and Politics or Partnerships (e.g. Outlaw et al., 2007) have been introduced into the sanitation marketing mix. These factors need to be clearly understood in order to reach new customers and influence their actions effectively (see Kappauf (2011) for an example in rural Malawi).

Figure 6: Sanitation marketing mix: The six P's. People and Politics are specific for sanitation marketing, whereas the other four P's are standard in all marketing activities (source: L. Kappauf, 2011).

Product: The product refers to the tangible or intangible product an organisation wants to promote. It can be a physical item, such as a household toilet, or a service, like installation or repair of facilities or pit-emptying. The product may also be intangible, such as evoking human desires and emotions and promoting behaviour change. A household toilet is hardware that embodies the "software" of emotional values and beliefs: pride, comfort and cleanliness, safety and modernity. Taken together, the hardware-plus-software "product package" needs to be something the customer would like to purchase.

The challenge for the social marketer is to show the target audience that they have a genuine problem, and that the product being offered provides a good solution. To be able to persuade people, the marketer has to conduct thorough research to understand customers' perception of the problem and the reasons that have kept them from finding a solution.

One key learning point for sanitation practitioners is that a range of products and services should be offered to respect the various wishes, needs and budgets of different households. Jenkins and Sugden (2006) point out that "choice is the one thing that the poor lack, their behaviour being dictated by the circumstances in which they find themselves". A broad sanitation product and service line helps to empower people regardless of their economic situation as they can choose a product according to their individual needs and tastes.

Price: The price to the consumer includes more than just the monetary costs - time, effort, amount of behavioural change that is needed, risk of social embarrassment or disapproval – are also costs for the customer to obtain the product. Price is crucial for the success of the product sale: If an individual perceives that costs outweigh the benefits and the perceived value of the offering is low, they will not buy it. In contrast, if the benefits are perceived as greater than their costs, chances of trial and adoption of the product is much greater.

Costs have to be sufficiently low – in relationship to the household income – and differentiated according to quality of materials used and workmanship. If sanitation marketing programmes aim to reach the poor, appropriate payment options for toilets, such as instalments have to be offered.

Place: Marketers talk of place when referring to the ways and means through which the product reaches the customer. This is both through physical distribution channels (e.g. manufacturers, warehouses, trucks, and retail outlets) or channels through which the consumers' perception can be changed (e.g. doctors' offices, village meetings, shopping malls, mass media, in-home demonstrations).

Successful sanitation marketing requires study of the activities and habits of target groups and their experiences and satisfaction with the existing delivery system. By understanding these patterns, marketers can find better ways to engage with their customers, and more efficient means to reach them.

Sanitation programme managers need to make sure that the supply chain of products, information and services is accessible to potentially every household. This can be a challenge especially in very rural settings where materials and trained workers such as masons are difficult to find.

Promotion: Promotion is an umbrella term for the integrated use of tools that help raise awareness for the product and create and sustain a demand for it. This includes advertising, public relations, personal selling, entertainment vehicles, mobile cinemas, radio shows, public service announcements, paid ads, coupons, media events, competitions, awards, street theatre, editorials, use of role models, "Toilet Ambassadors" and the like. The main goal of promotion activities is to disseminate product information that gets customers' attention and persuades people to buy the product.

Sanitation promotion needs to raise awareness of toilet products and their retailers and stimulate people's desire for a household toilet. If a promotion campaign is successful, households will be convinced that it is worth investing in a toilet and motivated to obtain one.

Promotion of improved sanitation and hygiene behaviour is not synonymous with sanitation marketing. Rather it is only one aspect of the complex marketing mix, although the most prominent and visible aspect.

People: The addition of "People" to the marketing mix refers to the social dimension of demand creation. It involves social norms, people's aspirations and social mobilisation. By introducing this fifth P-factor, Heierli and Frias (2007) focus on "the paramount importance of community action, social pressure and government regulation and intervention". This element must take all socio-cultural and religious implications into consideration.

Mosler (2011 and 2012) presents integrated research on a psychologically-based assessment that shows the complex factors determining human behaviour decisions and introduces a systematic approach to identifying these factors.

Politics: This sixth "P" highlights the importance which legislation and policies have on the context in which sanitation marketing is implemented (Outlaw et al., 2007). For example, it would be useful to have a political consensus to support sanitation improvements among government ministries involved with water, sanitation, health and education. Similarly, partnerships among decision makers in public, private and civil organisations create further synergies for all involved.

7 Conclusions and future challenges

A variety of innovative strategies for raising awareness of the sanitation situation and for marketing products and services have evolved in many parts of the world. At the same time, there are numerous challenges that need to be addressed.

There is a strong tendency in sanitation marketing project reports to highlight only solutions that work. It is unfortunate that these reports often lack self-criticism and failure analysis as this makes it difficult for outsiders to get objective information about programmes. For mutual exchange and strengthened ties among organisations, implementers should not hold back on sharing their learning curves and limitations (for example, this could be done via the open SuSanA discussion forum).

Another challenge on the political and institutional level is to reach consensus on effective sanitation marketing strategies and then base policy on successful practices. In urban areas especially, there is already a strong desire for household sanitation. Institutional, regulatory, and local governance issues, however, hinder the workings of the market so it rarely offers solutions appropriate to consumers' demands (Jenkins and Sugden, 2006).

Sanitation marketers need to conduct extensive research on the preferences of target groups and work together with suppliers who will develop the right products for local requirements. Marketers need to transform low public enthusiasm due to negative perceptions and experiences into positive awareness and market demand. This is time consuming and requires persistent effort.

Sanitation programmes and projects that operate in isolation fail to engage actors that are the closest to households such as local governments which may be not be productively involved. Sometimes by-passed by current programmes is also the private sector, which may already be serving customers' sanitation needs (Jenkins and Sugden, 2006). Therefore managers of sanitation projects need to collaborate closely with governmental agencies while engaging private markets in planning and in production of goods and services.

The sanitation sector must get a sound understanding of customer needs and ways a toilet can be made a desirable household good. "The challenge is to offer both the poor and the non-poor a range of desirable and affordable options while persuading them to change their priorities so that improved sanitation becomes an attractive 'must have' for every household" (UN-Habitat and Sulabh, 2006). By talking to both broad income groups, a thriving industry can be developed, when capacity is strengthened, training is built up, credit accumulates and additional services for small businesses are elaborated, truly sustainable sanitation solutions can be created.

Further areas of research and demonstration are required.

- So far, market-based approaches have shown some good results for segments of the population who can afford the products. However, there still remains a very poor part of the population – the bottom of the pyramid – who cannot afford most products offered. Therefore, it is necessary to reach them effectively.
- Evidence has shown that micro credit can be a dangerous tool; there is a need for further studies to ensure that its use in sanitation marketing avoids exploitation and further household indebtedness.
- Many sanitation systems are still often not technically and environmentally sustainable, e.g. because proper faecal sludge management for septic tanks and pit latrines is lacking.
- The phasing and junctures between CLTS (Community-Led Total Sanitation) programmes and introduction of the sanitation marketing approach also requires additional study.
- Finding market-driven motivations for treatment and reuse of human excreta by private operators in developing countries.

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Acknowledgements are given to the following persons for their valuable contributions:
Juergen Eichholz (Saniblog, Germany), Surveyor Efik (Climate Change Network, Nigeria), Thorsten Kiefer (WASH United, Germany), Ajit Seshadri (The Vigyan Vijay Foundation, India), Jack Sim (World Toilet Organization, Singapore), Saskia Castelein (WSSCC, Switzerland), Denise Scrase (WTO, Singapore), Doreen Mbalo (GIZ, Kenya), Elisabeth von Münch (GIZ, Germany).

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sustainable sanitation alliance

SuSanA factsheet

Operation and maintenance of sustainable sanitation systems

April 2012

1 Summary

The aims of this factsheet are to introduce concepts of operation and maintenance (O&M) for sustainable sanitation systems and to give examples of O&M with their strengths and weaknesses.

Effective and efficient O&M is crucial for the sustainable implementation and long-term functioning of sanitation systems. However, issues related to O&M services are often neglected in the design and set-up of sanitation systems, and thus non-functioning O&M services are a widespread challenge in particular in developing countries and countries in transition.

The guiding principles for the design of sustainable O&M services are:

- The level of O&M is closely linked to ownership of a facility and the basic understanding of the technology and its functions.
- Every technology that is implemented in a sanitation system chain requires proper O&M to function.
- Different technologies at different steps in the sanitation chain need different people and different responsibilities for O&M.
- Clearly defined roles and accountabilities as well as appropriate support and training are essential for the management of O&M services.
- Institutional responsibilities as well as effective mechanisms for cost recovery are needed to ensure sustainable O&M.

To further explain the need for sustainable O&M this factsheet reviews examples of sanitation systems in various settings such as schools, in households, at public toilets, at institutional level in management of sewers etc. In case of decentralised solutions, O&M is the most crucial criterion for selection of a sanitation system during the technology selection process.

The factsheet is targeted at practitioners, researchers and policy makers as well as development practitioners who are less familiar with the topic of O&M of sanitation systems.

2 Introduction

Appropriate sanitation facilities can provide critical improvements in community health, education, poverty, environmental quality and many other interconnected issues. However, maximum benefits will only be achieved when the sanitation facilities operate continuously and at full capacity in compliance with acceptable standards of quantity and quality. Therefore, O&M tasks must be carried out effectively and efficiently.

Figure 1: Two staff members from a service provider are emptying the faeces vaults of household UDDTs in Ouagadougou, Burkina Faso (source: S. Tapsoba, 2009)[1].

Sadly, the O&M phase of sanitation systems usually receives little or no attention unlike the design and construction phases. Particularly in developing countries and countries in transition, O&M of decentralised sanitation systems is neglected to a great extent. As a consequence, poor or non-functioning sanitation systems may pollute the environment and affect people's health. Without proper O&M, even well designed and constructed infrastructure breaks down relatively quickly.

Reasons for non-functioning O&M services

Reasons for non-functioning O&M services include lack of ownership or delegated responsibility for O&M, lack of skilled labour, high operating costs, excessive repair and replacement expenses. Additionally, the technical options chosen are not always the best suited to the local environment in which they shall be operated. Other reasons are closely related to the set-up of projects, which often focus only on construction of hardware instead of management components because hardware installations

[1] For more photos from this project which was funded by the EU, and the link to the SuSanA case study see: www.flickr.com/photos/gtzecosan/sets/72157625719409533/with/5364060126/

can be implemented faster and with fewer complications than management systems. Consultation with the local stakeholders and users regarding the most appropriate system for the local conditions often does not take place adequately.

In most cases where the provision of sanitation services have failed, the root causes have been poor management, lack of planning, and failure to generate sufficient revenue to operate and maintain systems (Bräustetter, 2007).

It is obvious that the efficient and effective management of the system is essential for its proper functioning (Oldenburg et al., 2009). It is therefore indispensable that O&M of sanitation systems is seen in a holistic conceptual framework in sanitation planning. Tasks and responsibilities have to be made very clear and divided among the involved stakeholders e.g. between the municipality, CBOs (community-based organisations), users and the private sector. Governments and external support agencies need to recognise the importance of integrating O&M components in all development phases of water supply and sanitation projects (Brikké and Bredero, 2003).

3 What is O&M?

O&M in general refers to all activities needed to operate, maintain and manage a sanitation system, including the collection, transport, treatment, reuse or final disposal of the different sanitation products (Tilley et al., 2008).

According to Sohail et al. (2001), *operation* refers to the daily activities of running and handling infrastructure. It involves the technical and service activities required to run the infrastructure, as well as the correct handling and usage of the facilities by users. In the sanitation context, operation additionally includes the planning, control and performance of the collection, treatment and disposal or reuse of the excreta or wastewater flows.

Maintenance on the other hand involves the activities required to sustain existing assets in a serviceable condition (WHO, 2000) and includes three types according to Brikké (2000):

- *Preventive maintenance*: Systematic routine actions needed to keep the installations and equipment in a condition that will ensure they can be operated satisfactorily, function efficiently and continuously, and last as long as possible at lowest cost.
- *Corrective maintenance*: This range of activities starts with minor repairs and replacements as dictated by the routine examinations up to corrections of serious damages and malfunctioning.
- *Crisis maintenance*: Maintenance which is undertaken only in response to breakdowns or public complaints.

Effective and efficient operation and maintenance requires clear organisation and financial management with explicit responsibilities.

4 Every technology needs O&M

All technologies require some form of O&M, no matter if they are low or high tech. It can generally be presumed that increased levels of complexity of a sanitation system will also increase the demand for O&M. For example, the addition of pumps and other technical devices will increase the need for regular skilled maintenance and parts replacement. However, the most important issue to keep in mind is that the whole sanitation system (Figure 2) needs to be taken into account. O&M must be considered at each functional step from the user interface to the final reuse or disposal of the sanitation products.

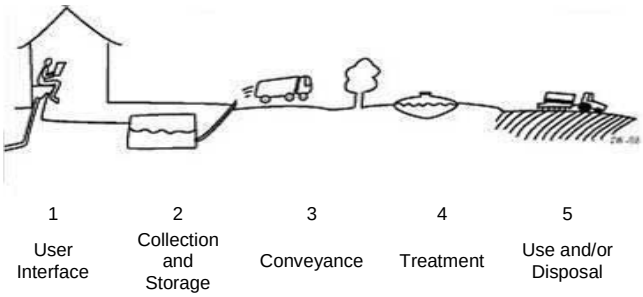

Figure 2: Representation of the five functional groups of a sanitation system. Each functional group requires O&M that must be planned for and linked to a clearly defined responsible party (source: J. Wijkmark, VERNA).

Planning for and implementing a functional O&M procedure requires consideration and examination of the technical and institutional needs of each step in the system. There are a variety of technologies that can be used for each functional group in the sanitation system and each of these technologies will have their own O&M requirements (Tilley et al., 2008). For example, at the collection stage a complex vacuum toilet system would need specific O&M that would differ in technical complexity from the emptying and servicing schedules for urine diversion dehydration toilets (UDDTs).

The responsibility for O&M of each functional item may be assigned to different stakeholders. For example, maintenance of the toilet (user interface) is often the responsibility of the household, while the treatment process is usually run by a municipal authority. Clear delineation of O&M tasks and responsibilities is critical for achieving a sustainable system.

Regardless of the technology chosen, achieving proper O&M depends on integrating its requirements in the processes of planning, designing, implementing and managing. Particular emphasis should be given to the coordination of the respective responsible stakeholders, such as government, private agencies and users. The selection of technical designs and supporting institutional structures must always be matched to local conditions, both with respect to technical and socio-economic feasibility, and the management capacities and willingness of users and service providers (IRC, 1997).

5 Funding of O&M

Sustainable O&M requires planning and budgeting to carry out the necessary tasks. Decisions on who should fund sanitation O&M and how, receives far less attention than design and construction activities (Sohail et al., 2001). Traditionally, municipalities and utilities are responsible for the O&M of centralised wastewater treatment systems but research in the 1990s in India and Thailand (IRC, 1997) has already pointed out that municipal budgets often fail to earmark funds for O&M of sanitation systems. Funds are thus rather spent on activities which are more visible than regular maintenance of existing infrastructure.

It is recommended to allocate a separate budget line in municipal budgets for routine O&M including funds for major replacements, upgrades and extensions. Sourcing this budget requires financial resources and clearly defined roles and responsibilities along the sanitation chain which should be defined from the planning stage onwards.

Funding for day-to-day operation and basic maintenance (i.e. hiring a caretaker) can be sustainably sourced through revenue generating activities, as shown in the examples in Section 7 of this factsheet. This can be either directly or indirectly associated with the sanitation service, but needs to be clearly defined prior to implementation. Examples in this factsheet include user fees, cost recovery through pit emptying and total service packages. Another example comes from the Aga Khan foundation in India which assists communities in establishing shared bank accounts where the community members deposit funds for O&M of shared infrastructure (AKPBSI, 2007).

However, crisis maintenance and large scale repairs may require substantial funding beyond day-to-day turnover and can place high demands on limited budgets. Funds are not always readily available for this, in which case, microfinance institutions may be used to enable access to credit.

6 Responsibilities for O&M

For a well working sanitation system it is important to clarify and agree on roles and responsibilities already during the planning stage. During planning and design, division of responsibilities and definition of tasks and accountability require ample consideration and agreement between stakeholders. Creating conditions in which responsibilities can be implemented as intended, may require awareness raising, motivation and incentives both for the agencies and the users (IRC, 1997).

Furthermore, there are more stakeholders in the sanitation system beyond the municipality. Small scale providers, communities and households also play an important role in O&M. The choice of the management model is influenced by several framework conditions like capacity of community organisations, community skills, capacity of the private sector, etc. (Brikké, 2000).

In larger towns a town-wide management system may be installed for the overall coordination. In Vienna (Austria) for example, a municipal department is responsible for O&M of the sewer system while a holding company operates the central treatment plant through a mandate from the municipality. Decentralised systems on the other hand may have localised daily operations but should be monitored by higher level institutions. For example a school sanitation system may be managed by the school management but monitored by a national authority.

7 Development of service chains in practice

The following examples describe the set-up for O&M for some small-scale sanitation systems to demonstrate how O&M can be organised in different ways.

a) The Kalungu Girls Secondary School (Uganda)

The boarding school of the “Sacred Heart Sisters” is located near Kalungu, a small village in Southwest Uganda. Around 450 girls between 14 and 18 years are attending the school and about 50 teachers and sisters are employed. Further staff members are responsible for diverse housekeeping duties, like O&M of the sanitation system, gardening, animal keeping, etc. A detailed description of the system is available in a SuSanA case study (Müllegger et al., 2009).

The sanitation system of the school, which is in operation since 2003, consists of:

- 45 single vault urine diversion dehydration toilets (UDDTs) for the pupils,
- One UDDT for teachers and visitors,
- One drying shed for further dehydration and storage of faeces,
- One horizontal sub-surface flow constructed wetland for treatment of greywater and blackwater.

<u>Responsibilities for O&M activities</u>

O&M activities are entirely managed by the school. The school administration has employed a caretaker who is responsible for most of the O&M activities. Furthermore, students are fully involved in O&M. They are organised in groups which have different tasks such as cleaning the toilets, removing containers from the UDDT vaults and fertilising of plants. Teachers are responsible for training and awareness creation among pupils.

Figure 3: Drying shed for faecal matter from UDDTs at Kalungu School, Uganda. The caretaker has to take the containers with faeces from the UDDTs to this shed (source: EcoSan Club, 2009).

A detailed description of the O&M responsibilities for collection and storage, pre-treatment, transport, treatment and use are given by Müllegger and Freiberger (2010a).

Income generation

Since the sanitation system has been implemented, the school became famous for its innovative sanitation concept. Delegations from all over the country and from abroad, are coming to see the school toilets. The number of students increased to their maximum capacity from 350 to 450 over the last few years. Furthermore, the school administration even introduced a visitor's fee of 20 to 40 EUR, depending on the type of visiting delegation. This fee is used to maintain the sanitation system.

b) Lessons learnt from the ROSA project funded by the EU (East Africa)

Sanitation systems in which the products of the UDDTs can be treated and used on-site are the simplest examples of closed loop systems. However, in many cases, like densely populated areas, storage and reuse on site is not possible, therefore collection and transportation systems have to be implemented. Thus within the frame of the ROSA project (Langergraber et al., 2010) one focus of research was on O&M of resources-oriented sanitation systems (ROSA stands for "Resource-Oriented Sanitation concepts for peri-urban areas in Africa").

The main goal was to develop sustainable O&M management strategies for peri-urban areas. The following is a summary of the research results from Nakuru (Kenya) and Arba Minch (Ethiopia). More information on O&M research in ROSA is available in Müllegger and Freiberger (2010b) and also in the SuSanA case studies on the ROSA project.[2]

Willingness to pay

A baseline study carried out in Nakuru showed that 86% of the surveyed residents are interested to use UDDTs if they do not have to be responsible for O&M (Muchiri et al., 2010). This figure was later confirmed with further results showing that stakeholders - mainly landlords and owners of UDDTs - preferred to use a private operator and were willing to pay for this O&M service.

Collection and transport, involvement of the private sector

MEWAREMA (Menengai Waste Recyclers Management), a local CBO in Nakuru, is engaged in solid waste collection and composting. They used to offer services for collection, transportation and composting of faeces and urine for a fee of 1 to 3 EUR depending on the amount to be collected and distance of transport. This fee was per trip or per emptying event and was negotiated with the clients.

However, this excreta collection system is currently not in place anymore. Due to various reasons, MEWAREMA stopped offering sanitation services, which left toilet owners not knowing what to do with the full containers in their single vault UDDTs. The follow-on project from ROSA (called CLARA and also EU funded) will attempt to improve the situation and will look for sustainable solutions to have at least a working emptying service in place.

In Arba Minch by 2010, the ROSA project team had constructed and supported seven Arborloos, 15 UDDTs, and 30 Fossa Alterna toilets for households. Two solid waste collection associations - the "Wubet le Arba Minch Solid Waste Collectors Association" and the "Engan New Mayet Compost Production Youth Association" - using donkey carts are engaged in transporting and treating human faeces and urine. About 50% of households that currently have a UDDT make use of the collection service. The users are paying 0.3 to 2 EUR per trip or emptying event, depending on the amount of urine produced and distance to the composting site. The main problem is the cost of the urine/faeces transportation by donkey carts. This is due to the large volumes of urine and the long distance to the composting site.

Treatment and reuse

In Nakuru the collected material was to be co-composted with organic solid waste at the dump site and afterwards sold to NAWACOM, an umbrella NGO for local CBOs involved in composting. They buy compost from local producers, further process the material, pack it and sell it as "Mazingira organic fertiliser" to farmers. However, NAWACOM has encountered problems in creating a market for organic fertiliser, moreover they refused to buy faecal co-compost due to hygiene reasons. Within the frame of the CLARA project it is planned to develop a concept for the co-composted material, for example working together with tree nurseries.

In Arba Minch the faeces, urine and organic solid waste is used for co-composting by the "Engan New Mayet Compost Production Youth Association". Since no local market existed at the start of the project, demonstration plots were installed to convince farmers to use faecal compost, and the compost was given to them for free. Since the beginning of 2010, co-compost is sold for 4-8 € per 100 kg. Prices depend on the client's ability to pay, whereby small scale farmers pay less. Compost, which is not sold, is used by the association for their own tree nursery and vegetable farm.

Financial considerations and up-scaling

The main challenge in involving private businesses is to make the business profitable. In Nakuru and Arba Minch, existing companies involved in solid waste transport have been involved in O&M services of sustainable sanitation systems. This reduced the financial risk for the companies compared to new companies exclusively offering services for e.g. UDDTs. Grambauer (2010) made a business plan for MEWAREMA in Nakuru and concluded that the emptying of UDDTs can only be profitable when a minimum number is exceeded. This number is dependent on the specific local boundary conditions and cannot be generalised.

[2] There are 12 case studies on the ROSA project in Kenya, Ethiopia, Uganda and Tanzania: www.susana.org/case-studies (enter "ROSA" into the search field). Three of these case studies are about installations in Nakuru: www.susana.org/library?search=nakuru

Figure 4: Sieved co-compost at the composting station of "Engan New Market Compost Production Youth Association" in Arba Minch, Ethiopia, ready to be used in the tree nursery or sold as organic soil conditioner (source: EcoSan Club, 2009).

c) The "*Sanitation as a Business*" program (Malawi)

The "Sanitation as a Business" program of Water For People, as described by Bramley and Breslin (2010) aims to combine the provision of new toilets with the introduction of O&M business for sanitation systems. The business concept starts with the household purchasing a “composting toilet” (Fossa Alterna or UDDTs) on loan from a sanitation entrepreneur. The entrepreneur constructs the toilet and afterwards collects the compost or dried faeces from the toilets. The household repays their loan with the compost. After the loan is repaid the household receives small, regular payments for the compost they produce.

The entrepreneur further treats the compost and finally sells it to farmers, thus creating an income. Since the main aim of the entrepreneur is selling the final product, i.e. the compost, he or she has to make sure that the toilets are producing their raw product in a good quality, i.e. that the households are using the toilets in the right way and that the toilets are properly maintained. The sanitation entrepreneur wants to attract large-scale compost buyers and thus needs to find new customers, i.e. build new toilets on a loan basis as described above.

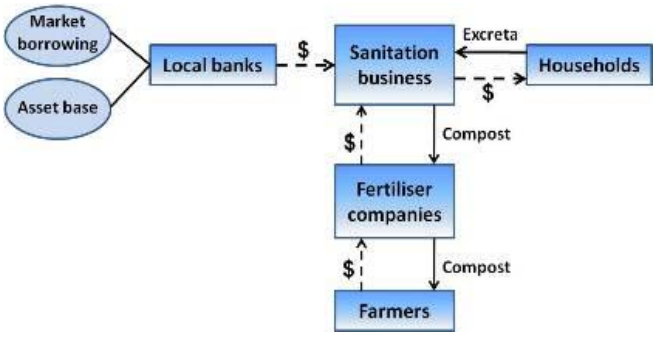

Figure 5: The rural "Sanitation as a Business" model in Malawi (source: Bramley and Breslin, 2010).

d) Institutional management of condominial sewers, Brasilia, Brazil

Since 1993 the federal district of Brasilia (population of 2.1 million) has been implementing condominial sewerage systems as a low-cost means of achieving universal sanitation coverage. These simplified sewerage networks serve more than 650,000 people and have been built in the city of Brasilia, as well as the surrounding peri-urban neighbourhoods and satellite cities. The basic function of the condominial sewers is to collect mixed wastewater from homes and transport it to a centralised treatment plant. Household connection pipes are grouped into block sewers before they feed into street sewers which are then pumped to treatment plants. The system is cheaper than conventional sewerage since pipe sizes are smaller and sewer laterals are installed under sidewalks or yards instead of streets (Melo, 2006).

The initiative for construction and expansion of the condominial sewerage system came from the Brasilia Water and Sewerage Company (CAESB) with the strong support of the local authorities. CAESB is responsible for construction and maintenance of water and sewerage systems within the city, as well as the wastewater treatment plants. CAESB oversees all activities related to planning and implementation of the systems, including organising neighbourhood meetings and establishing an elected body of residents responsible for facilitating agreements and inspecting the works. Once the system is in place, responsibility for maintenance of the branch pipes is divided between the users and the utility.

Households are offered three alternatives for routing the branches of the condominial sewers: through the backyard, front yard or sidewalk. The backyard and front yard options are cheaper to construct, but also mean that responsibility for maintenance of that part of the system falls on the household. Users opting to assume maintenance responsibility of their connection receive a 40% discount on the standard user fees. The remainder of the network is the responsibility of the utility.

One inspection box was installed for each connection to the network which allowed for easy access for monitoring and removal of blockages. Comparison of the condominial and conventional sewerage networks in Brasilia found that there were fewer maintenance incidents per customer for the condominial system. It is speculated that this is because the condominial branches are less prone to obstruction or that users are better placed to resolve simple blockages on their own. Success of the condominial system in Brasilia is also due to the ability of the utility (CAESB) to make firm policy decisions and clearly communicate them to their customers.

e) Public toilet served by a privatised water utility in Naivasha, Kenya

The provision of public toilets at markets, bus stops and other public places in Kenya is under the responsibility of municipal councils and the corresponding Ministry of Local Government. The use of the toilets is usually free of charge. The quality of services is generally very poor and insufficient in terms of daily cleaning and maintenance, resulting in odour, dirty toilets, no repairs and broken water supply pipes.

One of the main reasons why municipal councils do not show any interest in these facilities is the lack of revenue produced by them. In response to this problem, the newly structured and reformed water sector with the Water Services Trust Fund has started to provide financial support for improved access to water and sanitation in areas without adequate services (Onyango and Rieck, 2010).

The Naivasha public toilet was financed by the Water Services Trust Fund is owned by the public Regional Water Services Boards and run by the local water services provider (privatised water utility). The utility has contracted a private operator to run and operate the toilet on a day-to-day basis. The public toilet consists of flush toilets connected to a biogas plant which discharges the pre-treated wastewater to a sewer.

Figure 6: Naivasha public toilet with water kiosk. In front is the water kiosk that functions as an operator room. Customers pay at the side window, where the two people are standing. Behind them the gents section of the toilet can be seen (source: C. Rieck, 2008)[3].

The operator is obliged to pay for the water bill (a subsidised water tariff), sewer discharge fee, energy, rent and other expenses like toilet paper as well as minor repair works. The earnings and the expenditures made by the operator allow the employment of two permanent staff members to run the facility. At the same time the utility receives revenue through the water tariff, rent and a small amount of biogas sales which is sufficient for maintaining the facility.

Consequently this service model of shared responsibilities, with operation being carried out by private entrepreneurs and maintenance under the responsibility of utilities seems economically viable and promising in terms of good quality of service delivery.

f) Sustainable sanitation in Kyrgyzstan, Central Asia

In 2006, UDDT technology was introduced in Kyrgyzstan to establish starting conditions for nationwide introduction of sustainable sanitation in Kyrgyzstan (Jorritsma et al., 2009).

Since then, more than 100 individual UDDTs have been installed in different parts of the country. The methodology was as follows: (1) knowledge transfer and gathering of practical experience, (2) construction and monitoring of demonstration objects, and (3) creating publicity and tools for up-scaling. The projects focused on demonstrating, testing, and monitoring.

The barriers and level of acceptance were analysed two years after the start up. The following issues were identified to be crucial for the acceptance of UDDTs (Jorritsma et al., 2009):

- smell prevention is assured,
- persons who use the toilet were also involved in the construction of the toilet,
- all persons who use the toilet were trained to do so,
- number of vaults for storing faeces should be two,
- the higher the financial contribution of the UDDT owner, the higher the acceptance of the toilet, and
- UDDTs are favoured in areas with high groundwater tables.

Many critical issues related to O&M do not become apparent in the first few years of an implemented project but rather much later, sometimes after the project monitoring has stopped.

In some families in Kyrgyzstan, women were reluctant to embrace the new sanitation system because it requires regular cleaning. They had previously never cleaned their pit latrines – the need to clean the UDDT had to be well explained in awareness raising campaigns and trainings.

The handling of urine and faeces by the household for the application to plants provoked some scepticism. People were especially reluctant to apply the UDDT products to edible plants because of perceived health and hygiene risks. The local NGO could solve these problems by raising more awareness for the reuse aspects and by organising a farmer who was willing to take the toilet products.

Another success factor that was identified for O&M was that the Kyrgyz NGO KAWS worked together with existing community based water users unions (CDWUU) in each village and supported the introduction and up-scaling of sustainable sanitation from the beginning. CDWUU provides trained expert staff that helped people to construct their own toilet. Furthermore, CDWUU have a pump and offer the service to remove the urine from the tanks and apply it on the fields. They also offer the service to maintain the toilet facility.

The urine diversion seat most commonly used is made of concrete and must be re-painted from time to time. If there is a smell problem, the staff members from the CDWUUs are able to diagnose the root cause of the problem and solve it. For all these services, they require a small fee to cover their costs. Even poor people pay these fees to have a well maintained toilet. Some CDWUUs started recently to construct resource centres in the villages where they can even better support the construction and the O&M of the sanitation facilities.

[3] For more photos of this project see: www.flickr.com/photos/gtzecosan/sets/72157623254082278/with/4918863019/

Figure 7: Cleaning a UDDT in a public cultural house in Stara Zagora, Bulgaria. Project was implemented by Earth Forever Foundation and WECF (source: WECF, M. Torres, 2008).

Such an institution which is accepted and recognised by the community and which assists with the O&M tasks ensures the long term success of sustainable sanitation.

Figure 8: Inspection of the faecal chambers of a UDDT school toilet block in Nizhyn, Ukraine, constructed by the local NGO Mama86 (source: WECF, C. Wendland, 2010).

8 Conclusion

The attention given to O&M of sanitation systems especially in developing and transition countries is usually little or no attention compared to the design and construction phases. The result of this is poor or non-functioning sanitation systems which pollute the environment and affect people's health. This situation has been attributed to several reasons which includes among others; lack of ownership and skilled labour, high maintenance cost, and unsuitable technical options due to lack of consultation with the local stakeholders and users.

It is therefore important that O&M of sanitation systems is considered holistically during sanitation planning, designing, implementing and managing with clearly laid down tasks and responsibilities divided among the stakeholders along the whole sanitation chain. In doing this, it is equally important to allocate separate financial resources for routine O&M on sanitation systems. These financial resources must be explicitly determined from the planning stage and can be sustainably sourced through direct or indirect revenue generating activities.

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Acknowledgements are given to the following persons for their valuable contributions:
Jonathan Parkinson (IWA, UK), Elisabeth von Münch (GIZ, Germany).

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sustainable sanitation alliance

SuSanA factsheet

Sustainable sanitation and groundwater protection

April 2012

1 Summary

Groundwater is a very important resource for human life accounting for nearly 60% of the world's drinking water supply, while in arid and semi-arid zones this rate may even reach 100%. Groundwater has comparatively low development costs, is a high quality local resource, for which only simple water treatment is necessary, and for small systems requires only simple distribution systems.

Groundwater quality and sanitation are often linked as pollution of groundwater from unsafe household sanitation systems through nutrients, pathogens and organic micropollutants (including emerging contaminants) can occur.

There are many tools to prevent groundwater pollution: land-use planning plays an important role in protecting areas that are vulnerable by restricting the use of these areas. Water Safety Plans can play a fundamental role for communities to protect groundwater quality. In larger frameworks such as transboundary aquifers, Integrated Water Resources Management (IWRM) schemes are required to protect recharge areas, even if they are distant from the points of abstraction.

Sanitation solutions need to be adapted to the regional conditions in order to be sustainable. Accessible and safe sanitation and good groundwater quality are critical elements for sustained growth in developing countries that require policy and legal support systems to remain effective. This includes developing educational curricula (focussing on groundwater and sanitation) as well as institutional capacity building programmes.

Failure to improve general sanitation conditions and thereby contaminating groundwater endangers the economic growth potential of a region. This may impact negatively on the overall economic output due to increasing costs in the health, labour and production sectors. Sanitation and groundwater issues including capacity development need to be addressed on all political levels of government.

2 Why care about groundwater

Groundwater makes up 97% of the world's freshwater (excluding inland ice and glaciers) and is an important source of drinking water. Groundwater accounts for nearly 60% of the world's drinking water supply, while in arid and semi-arid zones this rate may even reach 100%.

Groundwater is a highly valuable resource, which is not only used for drinking water supply purposes but also exploited for agricultural use. In Yemen, for example, only 10% of extracted groundwater is used for drinking water purposes, whereas the other 90% is used by the agricultural sector.

Why is groundwater so precious? Compared to surface water bodies, groundwater resources are better protected against pollution and evaporation during dry seasons, therefore they represent a more important and efficient form of water storage. Furthermore, the development costs are usually comparatively low; as groundwater is a local resource which normally needs only simple water treatment and for small systems requires only very simple distribution systems. Natural groundwater, unaffected by human activities, is free of pathogens and in many areas free of undesirable chemical substances.

In arid and semi-arid countries groundwater is very often the sole resource for agricultural irrigation. All these facts turn groundwater in most areas of the world into an affordable, reliable and an inevitable key element of sustainable human development.

Figure 1: Unprotected well at close distance of a pit latrine in Lusaka, Zambia (source: K. Mayumbelo, 2006).

3 Introduction to groundwater pollution

Historically it was widely believed that groundwater is generally pure and safe for drinking purposes even without treatment. However, in the past few decades, cases of disease outbreaks due to the consumption of untreated, contaminated groundwater have increasingly been reported. For example, 630 outbreaks were reported in the period 1971-1994 in the USA alone (Craun et al., 1997). Of these, a total of 356 outbreaks were caused by contaminated

groundwater systems (i.e. 58% of total waterborne outbreaks), 30% of which were due to contamination of the distribution and treatment system while 70% were due to groundwater contamination. The most common disease in these outbreaks was acute gastroenteritis.

Groundwater contamination occurs when substances are introduced into the aquifer environment due to human activities such as urbanisation, industrial and agricultural development. All of these activities use water and produce wastewater, which may potentially pollute groundwater resources. When the contaminant concentration reaches a certain level the potential uses of groundwater are restricted and the groundwater is said to be polluted.

There are two types of sources of groundwater contamination which can be classified according to their origin. Single-source contamination can be localised and can easily be identified; whereas contamination from multiple sources or non-point sources is wide in scope and is more difficult to control. The major sources of groundwater contamination are poorly-designed septic tank systems, poorly constructed pit latrines, leaking sewers, unsanitary dumpsites, unlined chemical landfills, intensive agriculture and wastewater disposal ponds. Other causes include spills and leaks; mine drainage; poorly constructed or abandoned water, oil and gas wells; and road de-icing salts.

In some instances, contaminated groundwater is localised; however, in many cases a single source contamination may spread a considerable distance from the source, depending on the type of contaminant and the hydrogeological conditions.

In areas with human settlements, groundwater pollution should be prevented by sanitation systems. The main objective of a sanitation system is to protect and promote human health by providing a clean environment and breaking the cycle of disease. In order to be sustainable, however, a sanitation system should also be economically viable, socially acceptable, technically and institutionally appropriate, and protect the environment and natural resources.

The main task of a sanitation system is to contain and sanitise human excreta which contain pathogens in order to prevent the spread of diseases. A sanitation system consists of more than toilets and pits dug in the ground to collect excreta and effluents. It comprises the whole chain of household facilities, collection, transport, treatment and final destination (either disposal or reuse). Each of these components has the potential to cause pollution to the groundwater. In dealing with pollution generated by sanitation systems, the following pollutants are of importance: pathogens, chemicals and organic micropollutants.

4 Pathogenic pollution

Pathogens cause diseases such as cholera, hepatitis A and diarrhoea. In those countries where groundwater is the sole source of drinking water, prevention of faecal-oral transmission should be a highly prioritised public health outcome. Once pathogens have infiltrated into the groundwater, e.g. through manure heaps, pit latrines, leaking sewerage systems or over-irrigation with untreated wastewater, it takes different amounts of time for different types of pathogens to die off. During this time, groundwater travels a certain distance depending on the permeability of the aquifer (i.e. the groundwater body). In addition to natural die-off, pathogen removal is also a result of adsorption and filtration through the soil and sub-surface media. A hydrogeologist will be able to estimate the filtration capacity of the media, or alternatively a simple laboratory test can be undertaken to estimate this.

In many European countries source protection concepts have been based on a rule that most pathogens are reduced by 99% within 50 days of transit time in the aquifer. Where drinking water wells are located close to a pollution source (e.g. cesspits without any further treatment), travel times of the groundwater may be much shorter than 50 days. Therefore, water users face increased health risks. It should be noted here that the “99% reduction in 50 days” guiding value should be taken simply as a rough guideline, and actual reductions will depend on the specific context. In fact, important variations exist (Table 1).

Moreover, since the die-off of microorganisms tends to occur logarithmically over time, the complete removal of microorganisms does not only depend on the die-off rate, but also on the initial concentration. For example, when die-off dictates that in 50 days 100 microorganisms die per litre, a concentration of 1000 microorganisms per litre will only be reduced to 10 organisms per litre after 50 days, and therefore, in such case, removal is incomplete.

Reviewing the epidemiological evidence concerning the relationship between pathogen dose and response, the evidence for the most commonly used indicator (*E. coli*), appears significant at doses greater than 10^3 *E. Coli* per 100 ml (Cave and Kolsky, 1999). The significant dose varies widely for different pathogens occurring in human excreta (bacteria, viruses, protozoa, helminths[1]), especially in the tropics. It is estimated that diarrhoeal diseases, resulting from a lack of adequate water and sanitation services, have killed more children in the 10-year period 1992 to 2002 than all people lost to armed conflict since World War II (WEHAB 2002).

The most detailed assessment is the consideration of human health risk targets for a number of microorganisms. The Australian Guidelines for Water Recycling (2006) use disability adjusted life years (DALYs) to convert the likelihood of infection or illness into burdens of disease, and set a tolerable risk of 10^{-6} DALYs per person per year. It is impractical to set human health-based targets for all microorganisms that might be present in wastewater; therefore, the guidelines specify the use of reference pathogens instead: Campylobacter for bacteria, rotavirus and adenovirus for viruses, and Cryptosporidium parvum for protozoa and helminths (Australian Guidelines for Water Recycling from 2006).

[1] Helminth eggs are usually not an issue in terms of groundwater pollution since they are filtered out in the unsaturated zone (soil).

Table 1: Concentration reduction of a number of microorganisms. Die-off rates were taken from literature (based on Pedley et al., 2006).

Organism	Die-off rate (1/d)	Concentration after 50 days (initial = 10,000 cells/mL)	Reduction (%)	Reference
Coxsackievirus A9	0.019	3867	61.3	Matthess et. al. (1988)
Echovirus 24	0.12	25	99.8	Jansons et. al. (1989a)
Hepatitis A virus	0.1	67	99.3	Nasser et. al. (1993)
Poliovirus 1	0.48	<1	100.0	Keswick et. al (1982)
Rotavirus	0.36	<1	100.0	Pancorbo et. al. (1987)
Simian Rotavirus	0.83	<1	100.0	Keswick et. al (1982)
F-specific RNA bacteriophages	0.025	2865	71.3	Nasser and Oman (1999)
Bacillus subtilis spores	0.14	9	99.9	Meschke et. al. (2001)
Cl. Perfingens spores	0.071	287	97.1	Meschke et. al. (2001)
E. coli	0.083	158	98.4	Schijven et. al. (2000)
E. coli O157:H7	0.32	<1	100.0	Rice (1992)
Faecal coliforms	0.83	<1	100.0	Keswick et. al (1982)
Faecal streptococci	0.066	369	96.3	Bitton et. al. (1983)
Klebsiella spp.	0.031	2122	78.8	Dowd and Pillai (1997)
Salmonella typhimurium	0.3	<1	100.0	Bitton et. al. (1983)
Shigella dysentariae	1.7	<1	100.0	McFeters et. al. (1974)

It must be noted that it requires professional experience and knowledge of the subsurface conditions to estimate the minimum distance in the soil aquifer system, which results in a travel time of 50 days. If there is doubt, always use a conservative estimate and account for larger distances. Flow velocities are strongly dependant on local heterogeneity of the aquifer. For instance, safe setback distances[2] may vary from several tens of meters in areas with thick clay cover to more than 5 km in karstic aquifer systems. Also, flow velocities and transport paths may change in connection with strong rain events, especially in karstic systems or fractured bedrock (Hrudey et al, 2003).

5 Chemical pollution

Beside pathogens, human excreta contain organic matter, nitrogen and phosphorus. Urban wastewater has a high organic content (Figure 2), which is relatively easily oxidised under aerobic conditions. Where the water table is deep, oxygen and micro-organisms in the unsaturated zone of the aquifer may remove (degrade) much of the organic matter.

Below the water table, further degradation of organic matter will consume the dissolved oxygen present in the groundwater. The quantity of oxygen dissolved in groundwater is less rapidly renewed than in the unsaturated zone (soil). Thus additional infiltration of organic matter leads to depletion of dissolved oxygen in groundwater by microbial degradation potentially exceeding the limited oxygen supply.

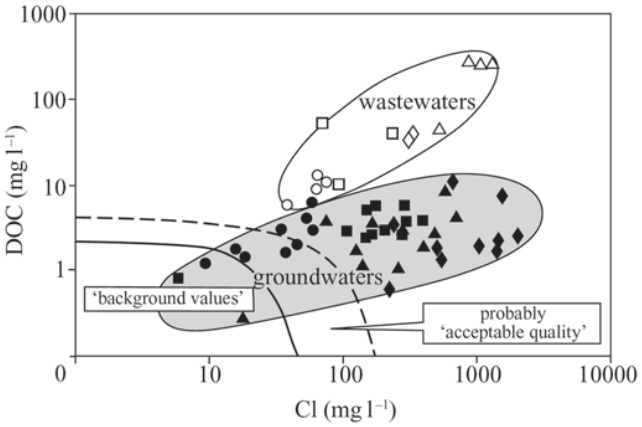

Figure 2: Range of increased chloride and Dissolved Organic Carbon (DOC) concentrations in groundwater from wastewater infiltration research areas (Foster and Chilton, 2004).

The more and more anaerobic (i.e. lacking oxygen) the groundwater environment becomes the more microorganisms are forced to utilise other substances, other than oxygen, for degradation of organic matter and thereby release their metabolism products into the groundwater. This results in a fundamental change in the groundwater chemistry, including increases of dissolved ammonia, manganese, iron, hydrogen sulfide, methane and possibly also metalloid substances such as arsenic.

[2] A safe setback distance is defined as the minimum distance that a drinking water well must be separated from a pit latrine or septic tank

a) Pollution due to nitrogen compounds

The nitrogen (N) cycle is complex; the predominant wastewater and animal manure related nitrogen form entering the (un)saturated zone from untreated sewage is ammonium while from treated sewage and from chemical fertilisers it is nitrate. The main mechanism for the transformation of N from wastewater that has infiltrated in the soil is denitrification, whereby first ammonium (NH_4^+) from wastewater is oxidised into nitrate (NO_3^-, called nitrification). Then, further in the aquifer, provided that anaerobic conditions prevail, nitrate is reduced into nitrogen gas (N_2, called denitrification), which is stable and ultimately may escape to the atmosphere.

When aerobic conditions prevail, nitrate may be the final product, which, at elevated concentrations (>50 mg/l), can be harmful to humans, especially babies. Worldwide, in developed and developing countries alike, many water supply wells show increased levels of nitrate above the WHO guideline value of 50 mg/l. This can be due to fertiliser application or mismanagement of human and animal excreta, but also due to natural conditions.

Nitrate is in itself relatively non-toxic, however, upon ingestion, it is partially converted by bacteria in the mouth to nitrite. The formation of nitrite is especially important as it reacts with haemoglobin, the oxygen carrying constituent of red blood cells, to produce methaemoglobin which cannot transport oxygen (ARGOSS, 2002). Methaemoglobinaemia (also known as “blue baby” syndrome) occurs mostly with children under three months of age. This was reported in only 2000 cases between 1945 and 1972, most of which were not fatal (Cave and Kolsky, 1999). In the period 1986 to 1996 however, 3,000 babies and young children from Romania’s rural areas were hospitalised with acute infantile methaemoglobinaemia. 3.5% of these cases were lethal (EEA and WHO, 2002).

However the above mentioned number of deaths is still low in contrast to those caused by diarrhoea and associated diseases (Cave and Kolsky, 1999). The actual problem with nitrate in groundwater used as drinking water is its persistence under aerobic conditions; it takes advanced, high cost treatment processes to remove nitrate from contaminated drinking water. Thus long term accumulation should be prevented.

b) Pollution due to phosphorus

The main source of phosphorus in wastewater is inorganic orthophosphate and organic phosphorus. Due to anaerobic digestion, the latter is usually transformed into orthophosphate. Phosphorus transport in groundwater exists[3], however health threats occur only indirectly. Phosphate in aquifers is usually bound to iron-oxides (Dzombak and Morel, 1990) or precipitates as phosphate minerals, like hydroxy-apatite, vivianite, variscite or strengite.

Subsurface transport of orthophosphates has been generally considered negligible because of its high propensity for precipitation and adsorption to the afore mentioned oxides and minerals. However, it is increasingly recognised that phosphorus retention characteristics of soils and sediments vary greatly according to geological and environmental conditions, and are also impacted upon by land use activities such as livestock production, manure application, and sewage sludge disposal (Siddique and Robinson, 2003; Geohring et al., 2001). These activities have been reported to result in high soil phosphorus accumulation and subsequent release of environmentally significant concentrations to subsurface flows as well as to surface runoff.

Such soils have been linked to accelerated eutrophication of freshwater bodies: Phosphate is a limiting factor in algae growth in surface aquatic ecosystems. This means, if there is not enough phosphate, algae growth is reduced, while the more phosphate there is, the more algae growth can take place. Excessive algae growth can lead to the depletion of oxygen from decaying algae, the reduction of fish populations or the predominance of single fish species, and the production of toxins (microcystins) from certain algae species which can impact on human and animal health.

c) Pollution due to other anthropogenic induced pollutants

In some settings, due to the infiltration of wastewater, toxic compounds like arsenic are released. For example, below the city of Hat Yai in Thailand, the increase of arsenic in groundwater due to the reductive dissolution of iron oxides is well described (Lawrence et al., 2000). Of the various routes of exposure to arsenic, drinking water probably poses the greatest threat to human health. The international Agency for Research on Cancer (IARC) has classified arsenic as a Group 1 human carcinogen. Its undesirable health effects include skin cancer, cancers in the lung, bladder and kidney, and peripheral vascular disease[4].

Serious and long lasting groundwater contamination is known to result from chemical substances like chlorinated, hydrocarbons, BTEX, polycyclic aromated hydrocarbons (PAH), which are often introduced via leakages or spillage events. Where such industry chemicals are discharged into the wastewater, the drainage system is providing an additional entrance pathway to groundwater.

6 Pollution due to organic micro pollutants

Organic micropollutants or so called “emerging contaminants” are now frequently being detected in wastewater and the environment in concentrations up to several µg/L, although they might have been present already for decades (Ternes, 2009). Innovative analytical instrumentation enables the identification and quantification of organic micropollutants down to the lower ng/L and ng/kg range. Prominent examples of emerging contaminants are pharmaceuticals, estrogens, ingredients of personal care products, biocides, flame retardants, benzothiazoles, benzotriazoles or perfluorinated compounds (PFC).

Tens of thousands of different chemicals enter sewer systems or on-site sanitation systems and eventually wastewater treatment plants (WWTP) and/or groundwater.

[3] See: http://toxics.usgs.gov/highlights/phosphorous_migration.html

[4] Arsenic can also occur in groundwater naturally (Bangladesh is a well documented example).

Organic micropollutants are usually quite small (molecular weight predominantly varies between 50 and 1000 Da)[5], therefore regular municipal WWTPs or on-site sanitation systems do not remove these polar persistent organic pollutants.

Pollution of groundwater and drinking water by emerging contaminants is well documented; however human health risks are low in most cases. Many of these contaminants are continuously discharged to the environment, therefore the most important question "Which are the most hazardous or unwanted emerging contaminants?" arises. Definitive answers cannot be given yet. Criteria for answering this question might be related to the ecotoxicological (in aquatic or terrestric environment) and toxicological relevance, the potential to bioaccumulate, as well as the potential to contaminate groundwater and drinking water.

Adverse effects by individual emerging contaminants, like "feminisation" of fish, can occur down to a few ng/L, as reported for 17α-ethinylestradiol and tributyltin. Besides endocrine disrupters, pharmaceuticals (such as carbamazepine, diclofenac, fluoxetine, propranolol) have been shown to cause effects at environmentally relevant concentrations. Current research is providing a growing list of "predicted no-effect-concentrations" (PNEC) which constitute the lowest concentration where a specific emerging pollutant was observed to have an effect on any organism.

7 Protecting groundwater from pollution

The difference between groundwater resources as a whole and the source of groundwater for use can be explained through its management: When groundwater is well managed, the **resource** as a whole is protected for current and future uses; while we protect a currently used groundwater **source** in a defined area with specific and often very specific measures regarding land use.

a) Source protection

The best way to protect groundwater is to prevent contaminants from entering the aquifer which pose a threat to water quality and are hazardous to human health. One practical way to achieve this is land-use planning. In order to prevent groundwater contamination, drinking water protection areas are delineated around production wells or springs (see Figure 3). Usually, for large-scale drinking water supply, classification of these areas involves three levels of restrictive use, allowing fewer human activities with increasing proximity to the groundwater extraction site (DVGW 2006):

- The first and immediate area is to protect the production wells or springs and their immediate environment from any contamination and interference.
- The second area is delineated at the line from which groundwater travels 50 days until it reaches the production well or spring. It protects the groundwater from pathogens such as bacteria, viruses, parasites, protozoa and worm eggs. Other contaminants which do not degrade during the flow time to the production well are banned from use in this area.
- The outer area protects the groundwater from persistent contaminants like pesticides, radioactive substances or non-degradable chemicals (DVGW, 1995). Where households are located within this zone, their sanitation system should be either an ecological sanitation solution or a system where the wastes are removed from site.

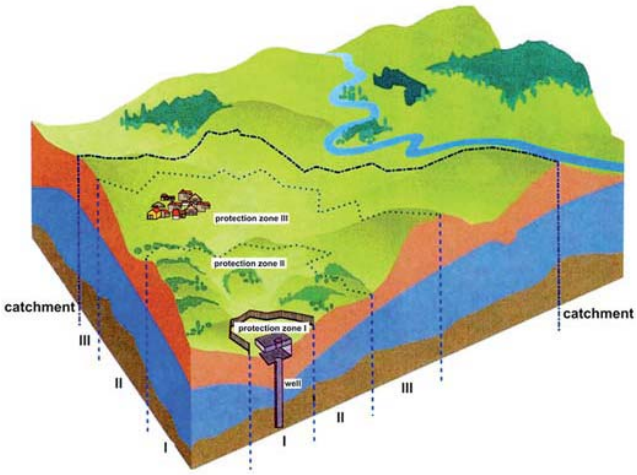

Figure 3: Protection areas in a catchment where the well is in Zone 1 on the left side (source: © Bayerisches Landesamt für Umwelt (LfU))

In villages or towns in developing countries without any water supply or sanitation systems a classification of the three zones is difficult to implement. In such places the citizens regularly obtain their drinking water from local dug wells, springs, nearby streams or boreholes, often polluted by mismanagement of human and animal excreta. Under these circumstances another approach such as developing local Water Safety Plans (WSP) may be implemented. These plans will include approaches for the protection of the water sources used for drinking water, and include developing options for sustainable and affordable sanitation systems which prevent further infiltration of pollutants from human excreta into the groundwater. WSPs also importantly include operational controls, incident and emergency management and importantly treatment.

b) Resource protection

An empirical model to map aquifer vulnerability has been developed by the USA National Water Well Association and the Environment Protection Agency. The DRASTIC approach refers to hydrogeological units incorporating major factors which affect and control groundwater movement (Depth to groundwater table, net Recharge, Aquifer media, Soil media, Topography, vadose zone media Impact and hydraulic Conductivity of the aquifer). These factors form the acronym DRASTIC and give their rated and weighted input to the numerical DRASTIC index (USEPA, 1987). This index, in combination with the mappable hydrogeological settings, creates a groundwater vulnerability map. The approach helps to prioritise monitoring and protection measures.

Internationally other methodologies have been developed for the same purpose, such as South Africa's "Ground Water

[5] The unified atomic mass unit or dalton (Da) is a unit that indicates mass on an atomic or molecular scale.

Protocol" (DWA, 2003) which is a procedure that development and local government agencies are required to follow when planning new sanitation projects. The approach is risk-based, taking into account the contaminant load, the vulnerability of the aquifer, and the strategic value of the aquifer.

c) How to protect the groundwater resource

An integrated water resources management (IWRM) approach is needed in the urban context as it explicitly recognises the complex sets of interdependent relationships which exist within and between human and environmental systems. One guideline of an IWRM approach is that water decisions should be made at the lowest appropriate scale.

Rees (2006) elaborates that for every setting the different roles which water management organisations might play and the different functions which agencies might perform along water supply chains must be defined (i.e. from resource management, bulk supply and transport, treatment, distribution, waste/excess water removal). The IWRM approach, when applied in an urban context, recognises intersectoral competition for resources (physical, social and financial). This involves the creation of an institutional framework; within which water relevant roles and functions are performed at an appropriate spatial scale, and which helps to ensure that decision makers have incentives to take the social costs of their actions into account.

In moving towards an integrated resources protection approach, water uses in a certain area must be understood and taken into consideration. One concept is described by Falkenmark (2004) "Human activities and ecosystems depend on the same water, i.e. the rainfall over the catchment [Figure 4]. This makes the catchment a useful landscape unit for an integrated approach where a balancing between humans and nature can be carried out." A management task is to "orchestrate the catchment for compatibility". The intentional trade-offs which usually occur have to be socially acceptable, making multi-stakeholder dialogues an essential component of catchment management.

From the groundwater resource protection point of view, the catchment needs to provide a recharge area which is part of the ecosystem mosaic and free of human activities. Ideally, the area in which humans consume water for domestic and industrial use should be situated downstream of the recharge area while agricultural activities may lie even further downstream, allowing for use of nutrients from domestic water and sanitation.

8 Productive land use and groundwater protection

If a given area for agricultural production is to be used most efficiently, crop harvests need to be increased by fertiliser application. Local conditions limit the maximum amount of fertiliser that can be applied. This is determined by plant uptake depending on the crop specimen and by effective field capacity depending on the soil type. Fertiliser application exceeding this amount will cause a leaching to the groundwater. Poor timing and inappropriate dosing of fertiliser or application on sandy soil may cause leaching of nitrates into the groundwater.

Figure 4: Catchment with its water fluxes (ET = Evapotranspiration, discharge = surface and subsurface outflow) (source: Falkenmark, 2004).

Most synthetic fertilisers consist of a combination of phosphorus (P), nitrogen (N) and potassium (K). While phosphorus and potassium are prone to sorption processes in the soil (so that they become immobile being fixed to organic or inorganic soil matter), nitrogen reaches the groundwater (in the case of leaching) at the same time as the percolating water. Therefore, in order to prevent high nitrate concentrations in groundwater over the longer term and eutrophication of surface waters, regulations on fertiliser application should be developed and enforced. Organic fertiliser, which produces less leakage of nitrate into the groundwater (UBA 2002) is preferred over synthetic fertiliser, and soil should be managed in a sustainable way. Erosion, leakages of nutrients and loss of humus should be avoided.

Figure 5: In densely populated areas infiltration of wastewater threatens groundwater resources in Senegal. Note also the water pipe in the drain which is a common but unsafe practice (source: BGR, 2005).

9 Policy recommendations

The following recommendations were developed by the participants of the international symposium "Coupling groundwater protection and sustainable sanitation" which took place in Hannover, Germany in 2008 (BGR 2008).

- Both, groundwater protection and sustainable sanitation represent basic tasks for all development planning. Every new settlement should take groundwater resources into account and the protection of aquifers should have a high priority. Past planning approaches often failed and innovative sanitation planning including participatory and demand driven approaches should be adopted. Land-use planning, based on a holistic approach and therefore economically, socially and ecologically sound, is required to protect precious resources like groundwater.
- There are a wide range of sanitation solutions available which need to be adapted to the regional conditions in order to be sustainable. To fulfil the five sustainability criteria, a sanitation system has to be not only economically viable, socially acceptable, and technically and institutionally appropriate, it should also protect the environment and the natural resources. Geoscientific aspects have to be considered during sanitation planning, including climate, hydrogeology, soil characteristics and geo-morphology.
- Wastewater is considered a potentially valuable resource; however, its uncontrolled and unregulated utilisation must be prohibited. Guidelines for the safe reuse of excreta and wastewater have been published by WHO (2006), including the multi-barrier approach; these guidelines and concepts need to be incorporated in practise and imbedded in all implementations.
- Additionally, the reuse of wastewater, human excreta and greywater in agriculture requires further studies and implementation policies in developing and developed countries.
- Efficient political structures, policies and legal arrangements are essential. This includes developing curricula (focussing on groundwater and sanitation) for educational systems as well as capacity building programmes. Neglecting the improvement of general sanitation conditions and thereby contaminating groundwater endangers economic output due to increasing costs in the health, labour and production sector. Sanitation and groundwater issues including capacity development have to be addressed on all political levels.

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Acknowledgements are given to the following persons for their valuable contributions:
Christian Olt (formerly GIZ, Germany), Jan Taat (Xavier University, Philippines), Rabani Adamou (FAST, UAM, Niger), Michael Klaus (National Environmental Protection Agency, Afghanistan), Ian Pearson (consultant, South Africa), Declan Page (CSIRO, Australia)

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Produced on behalf of SuSanA by:

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

BMZ Federal Ministry for Economic Cooperation and Development