**Division 44**
Environment and Infrastructure

sector project
ecosan – ecologically and economically sustainable
wastewater management and sanitation systems

# ecosan – closing the loop

**Proceedings of the 2nd international symposium,
7th –11th April 2003, Lübeck, Germany**

Eschborn 2004

# Foreword

Two and a half years after the first ecological sanitation conference in Bonn, the Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH and the International Water Association (IWA) jointly organised and held the 2nd International Symposium on ecological sanitation "ecosan – closing the loop" in April 2003 in Lübeck.

Having assumed my new position as Director Environment and Infrastructure at the GTZ shortly before, my colleagues entrusted me with the moderation of the opening session of this symposium. The contributions made during this session from a wide range of representatives of governmental and non-governmental organisations underlined in an impressive manner both, the seriousness of the current crisis in supplying sanitation and its inter-relationship with the water crisis. The description of currently ongoing wastage and deterioration of our natural resources, in contract to the motivation and vision of the speakers and participants in constructively addressing innovative views and solutions was rather impressive for professionals and newcomers to the subject. Already the opening session made quite clear that a vibrant international dialogue on the many facets of ecological sanitation already exists, not just in the direction North- South, but equally South-South and North-North. It became quite clear that appropriate, holistic and sustainable sanitation alternatives must be implemented as soon as possible --- and worldwide.

The "ecosan community" has come a long way since the first ecosan symposium, organised by the GTZ in October 2000 in Bonn, in establishing an active international network, and in drawing interest and attention from around the world. This was evident from the fact that for the second symposium the number of participants had doubled and we had to extend it from two to five days due to the large number of interesting papers submitted for presentation and discussion.

The first ecosan symposium was held with the aim of establishing a status what has been achieved and to define necessary international actions to further promote innovation in sanitation including the contribution of German technical co-operation to this work. This symposium highlighted the need for an improved system of knowledge management, an increase in the number of pilot projects, particularly in urban areas, and a strengthening of the international ecosan network. As a result, in May 2001, GTZ started a new supra-regional research and development project, ecosan, financed by the Federal Ministry for Economic Co-operation and Development (BMZ), which turned needs identified during the first symposium into its main activities.

Since then, with the active support of the GTZ ecosan project, the international ecosan network has become a dynamic and productive community involved in a wide range of activities around the world. It was a pleasure during the 2nd International Symposium to see this network continue to grow and include, for example, representatives of the United Nations Environment Programme (UNEP) and the European Commission participating and signalling their interest in becoming involved in ecological sanitation. Ecosan has also begun to attract the attention of national policy makers, as demonstrated by the keynote address of The Hon. Maria Mutagamba, the Ugandan Minister of State for Water expressing her governments' interest in ecosystem-based sanitation solutions and her strong conviction that these would contribute to the development of Uganda.

Apart from expanding and supporting the ecosan network, this second symposium provided experts from a wide range of disciplines with the opportunity for a professional exchange. The attendance of 350 enthusiastic experts from a wide range of disciplines from 60 countries ensured that the exchange was fruitful and addressed the complexity of the transition to new sanitation concepts. A further goal of the symposium was to develop a set of recommendations for the up-scaling and further development of ecosan, which the conference adopted as the "Ten Lübeck Recommendations for Action" on the final day.

Overall, the conference proved to be an important contribution of the German Federal Government to achieving the Millennium Development Goal of halving the number of people without access to adequate sanitary systems by 2015.

Since the symposium, the interest in ecological sanitation has continued to grow further. The electronic ecosan-Newsletter, produced on a quarterly basis by the highly motivated staff of the GTZ ecosan sector project, is sent to over 4700 subscribers and requests for further assistance are received by the ecosan team on a regular basis.

With these proceedings we want to provide a comprehensive overview of current activities, ideas and debates within the growing global ecosan network targeting a successful, worldwide re-orientation towards ecological sanitation in both the North and the South. We regard our work as an essential contribution to sustainable integrated management of water and other natural resources and for achieving the Millennium Development Goals. Continuing this work in the spirit of the symposium, the GTZ sector project will support and strengthen this network. We are committed to further support this worldwide activity by co-operative development and implementation of pilot projects, particularly in urban areas. We want to be successful by including international and local partners, and through the active dissemination and exchange of theoretical and practical know-how and information on existing and new ecosan-related developments. On behalf of the GTZ ecosan-team I cordially invite any party interested in productive co-operation to contact us and take part!

But before that, I wish you an interesting and inspiring reading!

Arno D. Tomowski

Director Environment and Infrastructure

In December 2003

# Acknowledgments

The GTZ ecosan project team would like to take this opportunity to thank the many organisations and individuals who helped us realise what was not only a professionally fruitful, but also an immensely enjoyable exchange during the 2nd International Symposium on ecological sanitation. We would like to offer our particular heartfelt thanks to the following:

The International Water Association for the co-organisation of the conference, and particularly Håkan Jönsson, Ralf Otterpohl, Joachim Behrendt, Torben Lohmann and the members of the working group on ecological sanitation who organised the peer review process of the full conference papers.

The members of the symposium scientific committee, who kindly gave of their valuable time and energy for the evaluation and selection of the papers for presentation before the symposium, and their active participation in the peer review process of the full papers afterwards.

The German Federal Ministry for Economic Co-operation and Development for their financial support for the organisation of the symposium in Lübeck as well as for their continued support and encouragement of the GTZ ecosan project.

The co-sponsors of the symposium – the Technical University Hamburg-Harburg, the Swedish Urban Water programme, our close partners in EcoSanRes, the Water Supply and Sanitation Collaborative Council, UNESCO and the German Association for Water, Wastewater and Waste (ATV-DVWK) – for their contributions, ideas and close co-operation.

The members of the programme and organisational committee, who worked hard to prepare the symposium and equally hard behind the scenes in Lübeck ensuring that everything went according to plan.

The editing group for their hard work, patience and support in the preparation of these conference proceedings.

And finally to all the participants, who, with an abundance of energy and positiive engagement made the five days in Lübeck such a memorable experience for us. This conference gave many of us the chance to “close the loop” with colleagues from a diverse range of backgrounds and a wide range of experience, allowing us all to learn from one another.

To you all we would like to express our sincere gratitude

## Symposium scientific committee

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Ralf Otterpohl (IWA, Germany)
Arno Rosemarin (Stockholm Environment Institute, Sweden)
Jana Schlick (Planco Consulting GmbH, Hamburg, Germany)
Christine Werner (GTZ, Germany)

## Editing group

Christine Werner
Viviana Avedaño
Silke Demsat
Irmi Eicher
Lucía Hernández
Christiane Jung
Simone Kraus
Inés Lacayo
Kalidas Neupane
Andreas Rabiega
Martin Wafler

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Division 44 – Environment and Infrastructure
sector project ecosan

Responsible:
Christine Werner
e-mail: christine.werner@gtz.de
Internet: http://www.gtz.de/ecosan

**Edited by:**
Christine Werner
Viviana Avendaño
Silke Demsat
Irmi Eicher
Lucía Hernandez
Christiane Jung
Simone Kraus
Inés Lacayo
Kalidas Neupane
Andreas Rabiega
Martin Wafler

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# Welcoming address

**Wolfgang Schmitt**

Managing Director
Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH
Postfach 5180, D-65726 Eschborn, Germany
e-mail: Wolfgang.Schmitt@gtz.de

Ladies and Gentlemen,

Excellency,

on behalf of the GTZ, I would like to cordially welcome you all to this 2nd international symposium on ecological sanitation. We at the GTZ believe that this conference, and others like it, will make a major contribution to finding solutions for the water and sanitation crisis currently facing us all.

It gives me a great deal of pleasure to be addressing such a large and varied audience gathered upon the invitation of the GTZ and the International Water Association. It really is very encouraging to see so many people interested in sharing their experiences and learning more about innovative sanitation solutions.

My special thanks go to those who have spared no effort in travelling great distances to participate in the symposium. It is also extremely encouraging to see the range of nations represented here among the participants. It highlights that in this most urgent field of developing and implementing appropriate, sustainable sanitation alternatives, there already exists a vibrant dialogue, not just in the direction North-South, but equally South-South and North-North.

The GTZ is pleased to be able to contribute to the intensification of these exchanges and help address the pressing need for ecologically sound sanitation.

We are extremely interested to learn about the experience of experts and practitioners from all countries, from abroad and within Europe, concerning the latest developments and experience in the application of ecosan, that we understand as a holistic new approach to wastewater management and sanitation based on the systematic closure of local material-flow cycles in order to close-the-loop between sanitation and agriculture.

Why have we decided to hold the conference in Lübeck?

The aim of our ecosan-project is to contribute to the development and global dissemination and application of ecosan approaches and establish these internationally as state-of-the-art techniques – in both developing and in industrialised countries. In Lübeck we have an example of a closed-loop oriented urban eco-settlement, which has gained international recognition since the World Exposition EXPO 2000.

Also in Hamburg, and its neighbouring areas there are other such examples of closed-loop sanitation systems that will be visited in the course of the excursion planned for Wednesday. More such sites are to be found in Denmark and Sweden, the neighbouring countries These will be visited during the post-conference study tour which will begin right here in Lübeck directly after the conference.

The existence of closed-loop oriented sanitation systems in industrialised nations should underline the fact that ecosan isn't an approach intended only for poorer countries, but that these concepts should be implemented in every nation.

In comparison with the first ecosan-symposium that we held in October 2000 in Bonn, the number of participants has doubled and we had to extend the conference to five days. I am very glad to see this huge increase in interest that ecosan is attracting, especially on the subject of sustainability in the field of water sciences, hygiene, energy and nutrition.

As the managing-director of the GTZ, I would like to give you a brief introduction of who we are, what we do and where we see the focal areas and our tasks for the future.

The Deutsche Gesellschaft für Technische Zusammenarbeit is a service enterprise for development cooperation with worldwide operations. Established in 1975, the GTZ is owned by the Federal Republic of Germany. Our organization operates as a non-profit private-sector enterprise with a development-policy mandate to improve and sustain the living conditions of people in partner countries and to conserve the natural resources on which life depends.

A major client of the GTZ is the Federal Ministry for Economic Cooperation and Development and I would like to extend my thanks to the BMZ for making this conference possible. The GTZ also supports development and reform processes on behalf of other German ministries and partner-country governments.

The cooperation with international organizations, such as the World Bank, European Union, United Nations Organisations and the African and Asian Development Bank is steadily increasing.

The private sector is also of growing importance to development cooperation. Public Private Partnership is the name given to cooperation between GTZ and the private companies in projects that combine beneficial development impacts with commercial gain for the enterprises involved.

Currently, the GTZ works in 131 partner countries and supports 2,703 development projects and programmes. All this is done with 10.977 staff members, 78% of them international employees.

One main focus of the German Technical Co-operation is the Water Sector. To date there has been much progress in the areas of fresh water supply, watershed and resource management, but unfortunately considerably less in the sound management of wastewater and excreta. It is therefore one of the factors that sets limits on human existence and development.

The supra-regional research and development project ecosan is financed by the Federal Ministry for Economic Co-operation and Development. The idea for the project arose 3 years ago out of other GTZ water-based programs and the recognised need to develop new economically feasible and ecologically sustainable sanitation solutions.

The great dynamics and diversity of our ecosan-project from the very beginning has contributed to a worldwide network of organisations and projects. Alone within the framework of German cooperation, ecosan-projects are currently being prepared or implemented in more than 20 countries. The Swedish International Development Cooperation Agency, which will be represented through several project representatives here in Lübeck, was the first actively promoting agency starting about ten years ago with ecological dry sanitation programmes.

We have learnt a great deal from them and our strategic partnership over the last few years has been very productive. Meanwhile we have integrated other household wastewater aspects into the ecosan-concept such as greywater treatment, biogas-technology and now, in China, for example, even waterborne ecosan-concepts will be integrated into new settlements in a Chinese-German eco-city-project.

The term “Ecological Sanitation” stands for ecologically and economically sustainable sanitation systems. It does not refer to a specific technology. We use it rather to describe a whole range of technologies and institutional arrangements, which address both the issue of water scarcity and better sanitation. “ecosan” covers closed-loop systems of wastewater management, which con-

centrate on the principles of recycling water and nutrients as well as reducing the need for fresh water and is a holistic alternative to conventional sanitary systems.

The ecosan-concept fits perfectly into the Millennium Development Goals for 2015 set at the UN Summit of 2000. The goals most relevant to water are to stop the non-sustainable exploitation of water resources and to develop strategies, which enable an affordable and reliable water supply at a regional, national and local level.

At the Johannesburg World Summit on Sustainable Development in August/ September 2002 one declared goal was to guarantee the provision of clean drinking water and adequate sanitation, necessary to protect human health and the environment.

In this respect, a declaration was made agreeing to halve the proportion of people without access to safe and affordable drinking water (as outlined in the Millennium Declaration) and the proportion of people who do not have access to basic sanitation by 2015. This will require actions at all levels to:

a) Develop and implement efficient household sanitation systems;

b) Improve sanitation in public institutions, especially schools;

c) Promote safe hygiene practices;

d) Promote affordable and socially and culturally acceptable technologies and practices;

e) Integrate sanitation into water resources management strategies.

At the World Water Forum in Kyoto two weeks ago ecosan emerged as a significant tool to help us meet the Millennium Development Goals. As a result, new partners have committed themselves to ecosan, while others have increased their resolve to ensuring an increased recognition for ecologically sound sanitation alternatives.

The number of international ecosan-partners is steadily increasing. The World Bank – Water & Sanitation Programme has decided to expand their group of experts significantly.

The United Nations Environment Programme will hold a meeting to elaborate strategies dealing with new ecosan approaches in October/ November of this year and we are pleased, that the Executive Director of UNEP has designated Mr. van de Guchte, to give a keynote speech on his behalf at this symposium.

I am also very glad to welcome Mrs. Maria Mutagamba, the Ugandan Minister of State for Water, who will give an opening speech to this symposium, as Uganda is one of the leading countries worldwide in the promotion of ecosan as a standard approach for sanitation.

I am also glad to welcome further high-ranking personalities from the United Nations Development Programme, the Centre for Science and Environment in India, the International Water Association, the Swedish Urban Water, the Stockholm Environment Institute the German Federal Ministry for Economic Cooperation and Development and last but not least, Kreditanstalt für Wiederaufbau, KfW, the German Development Bank, who will all be holding keynote addresses.

The coming five days will be filled with presentations from experts and practitioners with the focus on development work in both rural and urban areas. Social problems of participation and hygiene will be considered as well as the economic aspects.

Another goal of the symposium is to develop recommendations for action for the implementation of ecosan at a larger scale in rural and urban areas. These recommendations will be the subject of the side event on Tuesday evening and will be discussed and adopted in the panel discussion on Friday with the final recommendations then being made available for publication.

In closing I would like to take this opportunity to acknowledge the sterling work of our ecosan project team. In a relatively short period of time they have engaged in intensive international cooperations in a large number of countries, in many different fields of specialisation and are rec-

ognised as enthusiastic members of the international ecosan network. They have achieved this thanks to their hard work, their enormous creativity and their 100% commitment to spread and introduce the concept of closed-loop sanitation around the world. We at the GTZ are proud of their achievements to date.

I would also like to take this opportunity to extend our most sincere thanks and appreciation to all our partners who have helped us organise this symposium. I would like to thank the BMZ for their constant support of the GTZ ecosan-project, and their particular input into the organisation of this conference.

I would also like to express our gratitude to the International Water Association, the Technical University Hamburg-Harburg, EcoSanRes, Urban Water, the Water Supply and Sanitation Collaborative Council, the Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall and UNESCO – an international array of partners, all of whom have willing helped us in our organisational efforts for the symposium. I would like to say to you all that your close cooperation is greatly appreciated.

And finally let me thank both the ecosan “movement” that has proactively developed and spread an alternative water-wastewater concept worldwide, and all the participants that have gathered here. I wish you all success in all your efforts and hope we all have a very interesting, successful and productive symposium.

# Ecosan – what kind of advocacy is needed

**Maria Mutagamba**

Minister of State for Water
P.O. Box 7122
Kampala, Uganda

Thank you very much chairperson for this session, our hosts this morning, participants, ladies and gentleman.

I am more than honoured today to be here to give the Keynote Address at this ecosan conference, and especially at this time, immediately after the 3rd World Water Forum in Kyoto.

Let me introduce myself. I am Maria Mutagamba, Minister of Water in Uganda.

Before I continue, I am sure that each one of you is an expert on ecosan, so I will give you the theme of my speech. It is sanitation and hygiene, and how sanitation and hygiene are connected to my portfolio as Minister for Water.

The previous speaker said, we must look at sanitation as an aspect of water resource management. Sanitation is therefore of key importance to my sector.

Poor sanitation has been recognized as a global problem, and as such it is everybody's responsibility. The World Health Assessment Report of 2000, published by the World Health Organisation and UNICEF, clearly pointed out that over 300 million people in Africa (that is over 40% of the African population) are without access to adequate sanitation. For the case of Uganda, the story is not any better. 50% of the population are without adequate sanitation and hygiene facilities. That is half of the population of Uganda, so for every ten people you see, five of them do not have access to sanitary facilities.

With such a crisis, what measures can we take?

In Africa we mainly use an on-site (i.e. decentralised) form of sanitation, the pit latrine. It is the most widely used type of sanitary facility.

Other practices exist however. For example if one cannot go out at night, (and one must always go outside to use a pit latrine) it is common practice to defecate in a container which is then emptied somewhere outside in the morning.

Then there are those who use what we call "flying toilets", where one defecates in a plastic bag and then disposes of it, often into garbage bins or into running water, which is very dangerous.

Of course we have tried other improved methods, such as ventilated improved pit toilets, but these are not very common. We have tried to install them in urban centres, health centres and a few schools, however only a small section of the population is covered by these.

We also have septic tanks for water flush toilets. These are basically used by people who have the financial means to construct their own houses and are connected to a water supply allowing them to flush their toilets. So when they flush the water goes into the septic tank rather than into a central sewerage system. Sewerage systems only serve around 12 towns in Uganda, estimated at around 10% of the population.

Due to the low availability of water and the fact that they are a relatively new concept, we are faced with the problem of emptying the septic tanks wherever we develop towns. How and where do we empty them? In areas like Kampala where there is a treatment plant it is comparatively easy, as the tanker only has to travel a distance of 10 km or so to the plant. But how about those areas outside Kampala, a 100 miles or so away, where can they dispose of the contents of their septic tanks? That remains a problem. And it is a problem that our planners and you

people here are going to help us solve. Without a doubt it is a global concern.

We have the National Water and Sewage Corporation, I have my team here with me, they are the people that actually take care of the areas that are connected to the sewage system. And even there we still have a problem, as you know the sewage system dates from the 1960's and some parts are worn out and need replacement. Here we hope to learn and exchange ideas. We need to learn from those who have tried alternative solutions it and succeeded, we need to learn from your success stories in order to build ours. So for us it is a learning experience, especially in ecosan.

How are we going to translate what we hear and see here into an implementable and sustainable plan of action. Of course the current sanitary practices I have already mentioned are costly in terms of both their impact on health and the environment. They pollute and contaminate our water resources. In areas of high population density there is also a problem of space, as each family requires and area to dig their own pit latrine, and in areas with a high water table most of the faecal matter finds it's way into the water resources. When that pit is full a new one is made, rather than emptying the old one, and then another and another. You need to have plenty of land for this. But what should communities do when they live in areas with sandy soil conditions where the pit caves in, or with hard, rocky soil conditions where you cannot easily dig a pit?

In order to overcome the problems caused by a high water table, people have learnt to build what we call "storage toilets". Instead of digging a pit and going downwards, they build upwards, constructing a vault to contain the excrement. That however also often proves to be unsuitable, as seepage tends to leak through the vault walls because the excrement is above ground. This happens because they fill up much faster, and the liquid tends to find a way out. What often happens then is that people just remove a brick or two and empty the contents onto the surface, causing an additional hazard.

Septic tanks are also not a good solution as they are not affordable to the majority of the people and are expensive to construct, maintain and empty. The sewage system does not cover the larger parts of the urban centres that have already been earmarked for development. It is expensive infrastructure but it must be done.

So what do we do with all these problems facing us?

This dilemma has led us to embrace ecosan and critically look at the various lessons learnt. Not with the aim of scrapping or doing away with what we already have in place but to some how develop it further. So ecosan has come as a blessing and I think it can work.

However we have encountered some problems with it, the biggest being the attitude and behaviour of the people. In Uganda we have various communities and cultures. There are communities who have never believed in using a toilet. Especially the women who actually believe that if they use a toilet they may not be able to conceive. These communities need to be educated on these issues. During colonial times many toilets were built in these areas and the people misunderstood their purpose and did not accept them. We need to find a way of changing such attitudes and persuading them to use them.

It becomes even more difficult when you begin to tell the people that they must separate the liquid fraction from the solids, which they may not understand or accept. They believe what a person does in the toilet is their own private business and say that we are intruding a bit too far into their private lives, almost as if we are trying to supervise them there. The ecosan toilets we started off with in these areas had to eventually be locked up because they were being abused (or misused). The people just didn't know how to use them, and they became a problem in the area.

So how can we translate this information and get the message across?

We have to sensitise people and train them on what needs to be done. For us this is a new

concept, a new approach to sanitation, and there is a need for a great deal of work. Therefore, while the technical people are busy developing various technologies, the rest of us, especially we politicians need to carry out advocacy work. However we also need to be trained for that, we need information that will help us sensitise the masses out there.

For instance, I've been in politics since 1989 and I have never seen or heard any of my colleagues, or even myself, going up on a platform to seek a vote on an issue of sanitation. Never! I have talked about water, I have talked about schools but never about sanitation, because it is taken for granted, it is somewhere there in the background.

We have to make it a political issue. We have got to do political advocacy, starting with individual efforts. We in government ought to be able to develop policy.

I am active in central or national government level but it is at local government level where issues should be identified. For a long time we have been planning from the top down and making the people at local level unsure of their role and abilities. Because they do not understand what we are telling them it makes it difficult for them to sustain the projects. So we are appealing to local government to start to initiate programmes or identify issues on sanitation and draft proposals and policies, and then to forward them to the top to make them national policy coming originally from the local areas. This will let them see that it's their issue not just a central government issue.

Then at a national level we can be able to communicate to our colleagues in cabinet and in parliament ensuring that they do not marginalize issues of sanitation. I should add that a large number of them do not understand or have even heard of ecosan, and to be frank I only heard about it when I became a minister.

So for us policy makers who do not know much about ecosan, I hope the experts here can translate the information into political messages that we can take to our people.

And then having talked about political advocacy, there are still some other areas where we can advocate, for example in the private sector. A previous speaker from the GTZ spoke of PPP (Public Private Partnerships), and I'm pleased to say that in Uganda something is happening in this regard. Two or three companies that have championed the introduction of ecosan have been very generous even by donating some sets to schools for demonstrations. So here the private sector is able to participate and demonstrate the construction of ecosan toilets.

And of course the private sector would like to go into an area that is profitable so they are looking at the tariffs that are involved. At the moment sanitation as a service is not so lucrative. Very few companies are going into sanitation. In fact, an investor came to me proposing that I negotiate with the Minister of Finance for a concession on taxation for materials needed so that they can make the sets cheaper and more affordable. The private sector is willing to take the lead and we must be able to assist them with the concessions they require in order for them to offer a service that is affordable.

Other industries that can benefit from this are the fishing industry and the manufacturing industry. For example, the soap manufacturers from hygiene promotion, and the beverage industry because their products eventually end up in the system. They cannot only contribute to the problem but to the solution also.

Another aspect for advocacy is through education. In Uganda at the moment, four ministries, namely water, education, health and local government, are handling sanitation issues. It would be good if we could get ecosan principles to be taught in our schools because children are a good medium of transmission as an entry point. Then we can encourage the private sector to make these ecosan sets available to the schools because schools can monitor and supervise their utilization and people can learn through that.

Another area is the religious institutions because religious leaders already have a forum through their followers in churches or mosques. They can teach ecosan, and even better if a set is available. The message would be carried even faster as people would come initially out of curiosity and then eventually get to appreciate the concept and take something home with them. More people would be converted to our gospel of ecosan through the religious institutions.

And then there are the cultural leaders. I come from a country where people believe in their kings or cultural leaders. We can use them as mobilisers to convey the message to their subjects who believe whatever they say. They can advocate for ecosan and grey water reuse for agricultural purposes and so on. Sanitation has always been viewed as something dirty so the idea of using dirty water for growing vegetables will first be shunned by the people. We need widely accepted mobilisers who can convince them that the vegetables are not going to be dirty. After all, they have been eating vegetables grown from where there used to be toilets, utilising the same nutrients. That is the kind of message our cultural leaders should convey.

Having looked at national efforts we can look at global efforts. We have been at various international forums, such as the World Summit on Sustainable Development in Johannesburg, where we raised our voices for sanitation. We have to continue making our voices heard. There is the G8 summit taking place in June and we have got to be there to let everyone know that sanitation is the key to liberating our people, the 2,4 billion people who are not served. Sanitation is the key to liberating these people from the vicious cycle of disease, poverty and hunger.

In Africa the African ministers responsible for water and sanitation will be meeting in South Africa, five days from now, to follow up on the commitments made in Johannesburg and Kyoto. As a way forward I request that we each find a way of sending a message to the African leaders to solidify sanitation issues into the NEPAD and AU agendas in order to divert the crisis that seems to be looming.

It has been mentioned that 6000 children are dying everyday because of poor sanitation. That catastrophe is equivalent to 20 Boeings crashing everyday. If that happened none of us would have been able to travel to be here today, but it's happening with poor sanitation.

So with those few words, ladies and gentlemen, I want to emphasise that sanitation, especially ecosan, requires a great deal of advocacy and here we are to amplify the message.

Thank you very much.

# Why the flush toilet is ecologically mindless and why we need a paradigm shift in sewage technology

**Sunita Narain**

Director, Centre for Science and Environment
41 Tuglakabad Institutional Area
New Delhi 110062
e-mail: sunita@cseindia.org

*A few years ago, attending the Stockholm Water Symposium, we had an invitation to a banquet from the king of Sweden. But instead of dining in splendour, my colleague, Anil Agarwal and I were inspecting toilets in some remote parts of the city. I was not sufficiently convinced of our mission as we opened the hatch of these "alternative" toilets bins where the faecal matter was being stored before composting and were regaled with information about how urine could be separated in the toilet and used directly for agriculture. Our friend, Uno Winblad, toilet crazy like Anil then took us to supermarkets in Stockholm city where there were a range of toilets – from water saving, to electric and of course, urine separating toilets. Anil who hated shops, was delighted and I began to understand the links.*

*The flush toilet and the sewage system – which I always believed was the epitomy of personal hygiene and environmental cleanliness – were a part of the environmental problem and not the solution. I came to understand from our research, the technology is quite simply, ecologically mindless.*

## The crisis of sanitation

*"Sanitation is more importance than independence," said Mahatma Gandhi. It is clearly a critical issue, linked as it to human health and dignity. It is estimated that over 80 per cent in rural India and 50 per cent households in urban India have no access to sanitation.*

The health costs are enormous. Dirty water kills more babies than any other substance in the world. A World Bank study estimates that there were 2.06 million deaths of children in 1999 in India, of which 90 per cent were in poor rural households. If all households had clean fuel, private (clean) water, private toilet it would reduce infant child mortality by roughly 1 million -- half the deaths. The sanitation mission is clearly too small a price a pay for saving precious human lives.

But sanitation is a double-edged sword. It is a vital part of the solution of human well being but it is also a part of the problem of human health. This is because modern sanitation based on the excessive use of water as a carrier medium and for disposal, adds to the problems of water scarcity and water pollution.

## Growing water crisis

There are growing conflict over water in many parts of the world. There is also desperate scarcity of water, which is taking an enormous human toll. There is intense competition between competing needs of water in agriculture, industry, drinking and recreation. The conflicts between rural and urban settlements for water are real. Urban settlements are water guzzling and wasteful but powerful enough to source water from longer and longer distances. Water shortages now plague most large and small cities of India. Many cities get water for less than 20 minutes in a week. In rural India, the crisis is exacerbated by the fact that all traditional and community systems to manage local water resources have been lost over time.

But it is important to realise that water shortage is not about lack of water per se. A fascinating instance is Cherrapunji, located in the northeastern state of Meghalaya in India. This place could easily be known as the wettest place of earth, with rainfall levels of 14 meters annually – 14,000 mm. But it still suffers from acute shortages of drinking water because of lack of systems to hold and capture the rain that falls in the region. On the other hand, the desert city of Jaisalmer, which gets less than 100 mm of rainfall has been on major caravan routes for trade and has no recorded history of being evacuated for lack of water. Water scarcity is therefore, equally about the mindset of conservation and careful use. It is about the ability of humans to value each raindrop of rain.

It is important to note that to confront the water crisis of the world we need policies and practices that augment, minimise and recycle the resource. It is on this yardstick, when we measure the modern sewage system, we will find it is **ecologically mindless and inequitous**. This is because:

- **It is natural resource intensive**: It uses materials, energy and generates waste. It has high environmental and health costs.
- **It is highly capital intensive**: It divides the urban population into rich and poor, that is, between people who can afford the expensive urban services and those who cannot.

## Flush and forget mindset

Consider how first a large amount of clean water is used to carry away a small quantity of human excreta. In India, flushes are designed to be particularly water-wasteful so with each flush over 10 litres of clean water goes down the drain. We build huge dams, irrigation systems and what not to bring water to urban areas. Then this water which is flushed down the toilet goes into an equally expensive sewage system, all to end up polluting more water – invariably rivers and ponds. Most of our rivers are dead today because of the domestic sewage load from cities. We have turned our surface water systems into open sewage drains. This is **hydrocide** – deliberate murder of our water bodies.

This heavy use of surface water leads to growing conflicts between urban and rural users. It also leads to overexploitation of surface waters. But then the discharge of domestic sewage leads to heavy pollution of rivers and urban groundwater aquifers.

The solution is to invest in huge river clean up programmes -- the Ganga Action Plan or the Yamuna or the National River Action Plan -- to treat sewage, which incidentally is from the flush toilets of the rich and not the poor. The expensive river action programmes, are sanitary engineers dreams. The thrust of these programmes is to divert sewage, which earlier flowed directly into the river, to a treatment facility.

We need to understand this political economy of defecation. The more water you use, the more investment is needed in cleaning it up. In big cities of India, 22900 mld of wastewater is collected through sewers and of this only 5900 mld is treated in sewage plants. Rest of the human waste is disposed off untreated in water bodies. An estimated 26 per cent of large city waste treated. Waste of smaller settlements is not even collected, let alone treated. Less than 50 per cent of urban dwellers in large cities, less than 14 per cent in smaller cities have access to sewage systems.

The political economy of sewer systems is extremely atrocious in poor developing countries. Hardly any poor city is able to recover its investments in sewer systems. As a result the users of these sewer systems get a subsidy. But almost all users in poor cities are the rich. Thus, sewers only lead to a subsidy for the rich to excrete in convenience. The poor always remain the 'unserved' in this waste disposal paradigm. In addition, the government has to invest in sewage treatment plants whose costs are again rarely recovered from the rich users of flush toilets.

## Sewers cost us the earth

Worse, it is virtually impossible for governments to play catch with the targets of building and treating sewage plants. We chase targets hopelessly and remain miles behind the volume of sewage being generated. In a rapidly urbanising situation, the city would soon outgrow the sewage treatment capacity created at a high cost. Further investments will be needed all over again.

Take Delhi, as a typical instance. Yamuna is Delhi's main sewage drain. Yamuna enters Delhi at Wazirabad – where the city draws its water supply – and after this an estimated 1800 million litres per day (mld) of untreated sewage flows through 18 drains into the river. In the last four decades, the total sewage output has increased rapidly. Untreated sewage has grown even faster. In 1999, the Central Pollution Board estimated that Delhi produces over 2,547 mld of sewage of which only 885 mld is collected through the sewage network for treatment and the bulk – over 75 per cent flows into stormwater drains and then into the river. By late 2000, treated sewage had increased to 1333 mld as had the quantity of sewage. With this done, over 50 per cent of the city sewage was dumped into the river. By 2005, Delhi plans to triple its present sewage treatment capacity at a cost of Rs 750 crore. But even this, if built and operational, will be less than what is needed.

The even if Delhi builds all the sewage treatment plants, it will still not have the sewage to treat. Why? The city's sewage drains are choked and silted. The government admits that the present capacity of the sewage treatment plants is not being utilised and when it builds new treatment facilities, sewage never reaches these plants. On the other hand, sewage from these choked and broken lines is diverted to functioning lines and, as a result, the treatment plants at the end of these lines are overloaded leading to untreated sewage flowing into the river. Thus, there is an ironic situation. While some plants are overloaded, some are underutilised. The bill to refurbish the sewers is roughly Rs 500 crore, according to the government. Over and above this is the capital cost of the new sewage treatment plants.

Over and above this is the cost of maintaining and running sewage plants and ensuring that the released effluent meets quality standards. Even if the government were to bear the full capital costs of sewage treatment plants, few urban municipalities have the financial resources to bear the expensive operating costs. As a result, sewage treatment plants, even when built, often stand idle.

In urban areas, drinking water is a small component of the total water use. It is sewage and other waste disposal needs that require maximum water input. This huge demand for water for our cities comes at very high political cost as tensions between urban and rural users for water are reaching flashpoint.

## Paying "full costs"

Worse, the political economy of defecation is such that no democratic government will accept the hard fact that it cannot "afford" to invest in modern sewage systems for its citizens.

Instead it would continue to subsidise the users of these systems, in the name of the poor, who would not be able to afford the systems otherwise. The cost to build sewage treatment plants is externalised through these environmental programmes. The logical policy would be to accept the cost and then to impose differential pricing so that while the rich pay for the cost of the capital and resource intensive sewage and waste disposal technology, the poor pay for the cost of their disposal system, which is invariably unconnected to the sewerage system and hence low cost.

For the poor even today, there is no free lunch. They pay — through their labour or with cash — for the meagre stinking water they get. In truth, they pay for it through worsening health. The

relatively rich, in stark contrast, are grossly subsidised for the water they receive. Take Delhi. It costs the city public utility between Rs 9-10 per 1000 litres to treat and distribute water in the city. Its citizens pay 0.35 paise per 1000 litres — less than 4 per cent of the cost. Bangalore citizens pay the most: Rs 5 for 1000 litres. But their water cost is Rs 40 for the same quantity, so they pay 12 per cent of the cost. Compare this to bottled water, where we pay Rs 10 for each litre for the clean water.

But this we know is only half the story. The main cost is not in providing clean water, but in taking back the flushed dirty water in the sewage systems and treating it before discharging it into rivers. We know that sewage and drainage costs can be as high as 5-6 times more than the cost of water supply. And with increasing chemical pollution, water treatment costs are only going to increase.

The "socialist" framework in our countries forces political leaders to keep water and waste pricing affordable by large sections of urban populations. In this situation, private investment also looks for an easy way out. The answer is for them to invest in water services and to leave the costly business of cleaning up the waste to government agencies.

In the meantime, the use of sewer systems would have totally destroyed the aquatic ecosystems in the developing world, posing enormous threats both to public health and aquatic biodiversity. Literally, no small or medium river today is clean. Every river that passes through a city or a town becomes a stinking sewer.

All this makes water-borne sewerage a waste disposal paradigm that is extremely expensive because of its high economic, environmental and public health costs. And as a result it has very high political costs.

## Going against the laws of nature

Sewer systems totally destroy nature's nutrient cycle in which nutrients collected from the land should be returned back to the land. With the use of sewers, this "waste" gets dumped into our aquatic systems. Therefore, while our nutrients in food come from agricultural lands, sewer systems dump the nutrients contained in human wastes into waterbodies. Over time, our agricultural lands get depleted of nutrients, which then need intensive artificial fertilization. The lack of these micronutrients not only becomes a limiting factor in plant productivity but the resulting lack of these nutrients in human food becomes a threat to human health.

### A story of two cities: Roma and Edo

The water culture of people is an important indicator of their level of civilization. Take the two ancient cities, Rome and the town of Edo, which grew into the mega-metropolis of Tokyo. The people of Rome brought their drinking water with the help of long aqueducts, which today are regarded as architectural marvels of the bygone Roman civilisation. But the people of Rome lived on the banks of the river Tiber. They had no need to bring water from afar. Unfortunately, they did not know to dispose off their human wastes and like the modern Western civilisation they ended up polluting the river, thus forcing them to go far in search of clean water. This makes Roman aqueducts not a symbol of intelligence but one of great environmental stupidity.

On the other hand, Edo, which too was situated on several streams, ensured that all its human wastes were collected and returned to the farmlands. Its neighbouring rivers remained clean and it tapped its water from them through an extensive piped water supply.

But today we are all children of Rome and not Edo. We have turned our backs to our water bodies and if we don't have money to clean our mess, then we will have nothing but polluted waters.

## Desperate for an alternative paradigm

Clearly we need to look for an alternative, cost-effective, non-sewage paradigm of human waste disposal. The capital-intensive, material-intensive urbanisation process of the West works only for rich countries, not poor countries.

But while our scientists think about going to the moon, the toilet is not in their vision at all. There is absolutely no thinking about the need to find environment friendly sewage systems in our countries. We need massive investments in R&D for non-sewage alternatives. While investments in sewer systems run into billions of dollars every year despite all the problems they create, research investments in non-sewage alternatives hardly exist.

But who will ask for an alternative paradigm? The entrenched interests and mindsets of our sanitary engineers being what they are, there is no demand for change from this community. But change, we must.

In this context we need to learn from what is happening across the world. There is a growing concern for ecological sanitation and this is giving rise to innovations from the concept of sewerless cities using new technological systems which use extremely low amounts of water or no water at all, and, in which all the wastewaters and the solid wastes are recycled.

These modern systems are built on the traditional science of recycling and composting human waste. But in a way that uses the best of modern science and technology to “sanitise” waste and match the convenience and public hygiene of the modern flush toilet.

Therefore, ecological sanitation is a paradigm that we must explore in all earnestness. But *we must make sure that the new technologies take into account cultural constraints* otherwise they are unlikely to succeed.

*The most important issue is that these “alternative” technologies must be for the rich and not just for the poor.* If ecosanitation technologies are “cost effective” technologies to serve the ‘unserved’ poor, these will only be an interim alternative, one to be discarded as soon as people become rich. We have to remember that it is the rich person’s flush that is the biggest environmental culprit today.

# Challenges in the sanitation sector after Johannesburg

**Manfred Konukiewitz**

Head of Division for Water, Energy, Urban Development, German Federal Ministry for Economic Cooperation and Development (BMZ)
e-mail: konukiew@bmz.bund.de

Honourable Minister,

Dear colleagues, dear guests,

I would like to welcome you on behalf of the Federal Ministry for Economic Co-operation and Development, and in particular I warmly welcome all those, who have come from abroad to this beautiful city of Lübeck.

I would also like to welcome you on behalf of the Minister Heidemarie Wieczorek-Zeul and the Deputy Minister Uschi Eid. I know both of them would have liked to be here today, but you will understand that very important political issues keep them fixed to our capital. These are of course very critical, very intense times, where also people and politicians involved in development issues are very much in demand and have very difficult decisions to confront. So please understand, that they can't be here, and I hope you will be satisfied with my presence, a simple bureaucrat from a Ministry. As you don't expect a very thoughtful lecture from a bureaucrat, let me just give you three points that have come across my mind, three thoughts:

Firstly: I think we have seen a political breakthrough in Johannesburg with the introduction of the Sanitation Target that the World Community, the United Nations, has now adopted to halve the proportion of people without access to basic sanitation by the year 2015. And I must say it was a breakthrough because of the special problems associated when we talk about sanitation.

Maria Mutagamba has been very explicit on this. It has not been easy to bring the sanitation issue to the top of the political agenda. It has in fact been very hard work and I must say that we have been quite successful. We as organizers of the Bonn International Conference on Fresh Water were proud that we managed to persuade the conference to put the Sanitation Target right on top of its agenda.

And I remember the evening when we actually reached an agreement in Johannesburg. It was a very difficult conference; we had to fight very hard. I have respect for those partners who resisted, because their hesitation to agree to global targets also had good reasons. But I think in the end they came around and agreed to have this as one of the leading targets of the developing community around the world, to bring sanitation to the poor in particular in the developing countries.

I think this was a breakthrough, and also in Kyoto we witnessed that this has really changed the minds at least in the developing community. People are now talking about sanitation just as they are talking about water supply. Let's remember that years ago this was not the case.

Secondly: I think that after Johannesburg, with the decision to have this new target, we started to think about what will it take to reach this target.

The development community has now started to work really hard on what it will take to implement the targets. The World Bank has just prepared what I think is one of the most important documents in a new report that will come out of the meeting of the Development Committee next weekend.

It is a progress report and a report on the critical next steps in scaling up for all the Millennium Development Goals: Education for all, Health, HIV/AIDS, Water and Sanitation.

We are being told in this document that in fact the Sanitation Target is the most ambitious target

of them all and that only 16% of the developing world is really on track to meet it. This is the lowest percentage for all of the Millennium Development targets.

For instance for the Water Supply Target, to halve the proportion of people without adequate access to water, the figure is 37%. It is still a quite low, but it is a much better figure when we compare it to the figure of the Sanitation Target.

Why is this a special challenge? Of course the focus in the past years has been on water supply. How does the water come into the household? And the focus has not been on the sanitation issue. I think this is not unusual. If we look at developments in Europe in the 19th century, it has not been different. But still it is a very critical issue because we have heard that sanitation is really the key to improve health and to improve general well being.

My third point refers to cultural dimension, and Maria Mutagamba has told us everything that we need to know about it. When we say that one of the obstacles in solving the sanitation problem is the cultural factor, we mean the need for people to change their habits. That makes it more difficult to make progress. If addressing the sanitation problem were simply about investment, we would know much better how to solve it, but it is also about changing peoples minds, and this is much more difficult.

It is very important that we have so many of you working on the ecosan approach. The ecosan approach is one of the keys to realistically achieving the sanitation target. I think Sunita Narain has already given all the figures that need to be known about this - that if we tried to provide everyone in the world with a flush toilet, we simply would not have enough water for it.

Another interesting cultural factor is that in Germany we faced real difficulties after Johannesburg in translating the sanitation target into German. It is about access to basic sanitation but how can you translate "access to basic sanitation"? It was very difficult because we don't have a word in German for sanitation. We have the word "Abwasser", but that means "waste water", so in German, "sanitation" and "waste water management" are almost identical in lingual terms. One newspaper proudly reported on the Sanitation Target by saying that: "*The United Nations decided that everyone should be connected to a sewage pipe*"!

That was the reference to the Basic Sanitation Target , but when you work in countries in Africa and Asia, you know that this has nothing to do with a sewage pipe. And a sewage pipe is a solution, which is very expensive and which is affordable only in countries in Europe or in North America.

So this tells you a little about the cultural difficulties in translating this approach and how the ecosan approach is really helping us, also in the North, to understand the cycle and the ecological implications. And I fully subscribe to what Sunita Narain said: "*It is not just a technology for the poorest of the poor, but it is also a technology for the richest of the rich*".

In closing I would like to say that we are very proud to have such a dedicated team at the GTZ led by Christine Werner to work on the issue of ecological sanitation. We are committed to co-operation, to development co-operation in the water and sanitation sector. We have one of the largest development cooperation programs of all bilateral donors, and our government has committed itself to spend in the next years 350 million euros annually on water and sanitation.

Thank you for being here, and I hope you have a very good meeting.

# Ecosan – experiences and conclusions from the KfW's perspective

**Wolfgang Kroh**

Senior Vice President
Kreditanstalt für Wiederaufbau (KfW)
Postfach 111141, D-60046 Frankfurt, Germany

Dear Mr. Schmitt,

Dear Mrs. Narain and Mr. Konukiewitz, distinguished colleagues,

About two and a half years ago, in October 2000, I was holding an opening speech at the first International Symposium on Ecological Sanitation which took place in Bonn. At that time, I expressed my interest for this new approach on sanitation which was still new to me and my colleagues from KfW. Since then, we have witnessed various activities from different promoters on an international scale and we have become much more familiar with the concept of ecosan. The GTZ ecosan project has contributed largely to this. Therefore I would like to congratulate my colleagues from GTZ for their efforts undertaken so far.

This week, we are here in Lübeck to follow up on the progress made during the last years and to discuss the challenges lying ahead for a broader introduction of ecosan approaches. In my speech, I would like to give you first of all a general overview on KfW's activities in the water and, especially, sanitation sector. Secondly, I would like to present to you our point of view with regard to the experiences made so far with the ecosan concept. To finish my speech, I will draw a few conclusions from these experiences.

As a public-owned governmental development bank, KfW is committing each year funds of around 40 billion EUR to promote the German economy as well as the developing countries. In the framework of German Financial Co-operation, KfW is committing around 1.5 billion EUR of investment loans and grants per year. With some 260 million EUR dedicated per year towards water supply and sanitation projects and programmes, German Financial Cooperation is the world's second largest bilateral source of financing in this sector.

Currently, we are supporting over 25 countries in the water and sanitation sector. Our efforts focus on the Middle East and North Africa, various countries in sub-Sahara Africa, the Balkans and Caucasian region, but parts of India and China as well as countries like Peru and Bolivia are also covered by our activities.

The overall objective of our activities in the water and sanitation sector is to contribute to the realisation of the relevant International Development Goals including the Millennium Development Goals, i.e. to halve the proportion of people without access to safe drinking water as well as to basic sanitation. This can only be achieved if the access of the poor to water and basic sanitation is going to be improved dramatically. Taking into consideration the prevailing water shortage in many regions of the world on the one hand and the limited availability of the poor to pay for services on the other hand, it is needless to say that these goals are very demanding making new and innovative approaches necessary.

Presently, we are therefore focusing on the approach of integrated water resources management taking into consideration the whole water cycle – including wastewater treatment and reuse - on the one hand and the competition for water between human use, agriculture and industry on the other hand. We are following this approach not only through project and programme financing, but also through the sector dialogue with the governments and project sponsors of our partner countries. An appropriate design of sectoral framework conditions is obviously cru-

cial for the sustainability of investments.

Within the sanitation sub-sector, the spatial focus of our activities is on urban and semi-urban areas. We are aware that conventional, centralised wastewater treatment systems do not represent a universal solution for all situations and places. Conventional systems are usually cost-intensive and quite often, proper operation of the sanitation system poses problems due to capacity constraints of the operators. Therefore, we are actively promoting the introduction of new, alternative approaches to sanitation. Such projects include water and nutrient re-use schemes with different levels of decentralisation and technological standards.

Please let me give you a few examples:

- In our rural water supply and sanitation projects, predominantly in Africa, we promote traditional on-site sanitation systems using faeces in agriculture.
- A number of urban wastewater projects, which include the re-use of treated wastewater, are currently under preparation, amongst others in Tunisia, in Jordan and in Yemen.
- Concepts for using sewage sludge in agriculture have been successfully developed in Turkey. The implementation of these concepts has generated positive results.
- A plant for purifying pre-treated wastewater to produce drinking water went into operation in Namibia in 2001.

Details on these as well as other projects will be presented tomorrow by my colleagues, Uwe Stoll and Bernd Schönewald.

Dear colleagues, since the first ecosan symposium held in Bonn in October 2000 KfW is following with interest the activities of the GTZ-ecosan project as well as of other promoters of the ecosan approach. Furthermore, KfW is currently preparing ecosan related project components as part of German Financial Co-operation projects to assist in gaining experience with these concepts, often together with our colleagues from GTZ. Pilot projects for urban or semi-urban areas, which are most relevant for German Financial Co-operation, are being prepared for Yemen, Egypt and Zambia. In the case of Yemen, experts will study alternatives for solutions to realise the International Development Goals including ecosan approaches. This example will be presented to you on Thursday by Mr. Oldenburg from the consultancy firm Otterwasser GmbH.

Obviously, we cannot yet draw conclusions from these pilot projects since none of them is being implemented yet. However, taking into consideration ecosan projects promoted by other organisations in different parts of the world, we would like to highlight two aspects which will be crucial for the broad application of ecosan approaches and for which we do not yet see solutions: the integration of ecosan concepts in urban areas and the acceptance of ecosan systems by decision makers as well as customers. I will illustrate the latter aspect in more detail in a minute.

As you may know, German Financial Co-operation is following a comprehensive approach with regard to the sustainability of its project and programmes: apart from ecologic and social sustainability, financial and economic sustainability are essential for the success of projects and programmes. Thus, by identifying and designing projects and programmes, all of these aspects have to be taken into consideration. Of course this holds also true for any ecosan project or project component.

Ecosan oriented projects, by its definition, should be ecologically sustainable. Contrarily, as regards social and financial sustainability, we see challenges especially in the following:

- A low level of accepting ecosan approaches by the relevant decision makers. Existing standards in most countries presently do not allow the introduction of such approaches. Furthermore, in developing countries, decision makers strongly prefer standards and project concepts which are applied in the industrialised countries. Engineers often visited universities in these countries and thus are familiar with conventional techniques. They are reluctant

to accept new approaches.

- A low level of acceptance by the customers, since they would generally be faced with an elevated handling time and / or higher handling costs in comparison to conventional systems. This is due to the fact that ecosan systems are by its definition decentralised systems posing a higher burden on the end users.
- With regard to financial feasibility, systems already existing in a project area need to be taken into account for any new investment, may it be a replacement of or an extension to the existing system. Thus, it will usually not be financially feasible to replace an existing conventional system by an ecosan system in case the existing system has not yet been fully depreciated. Since most of the bigger cities do have existing conventional sanitation systems, also in the developing countries, these systems can only be gradually replaced.

Dear colleagues, please let me draw a few conclusions from what I have mentioned:

1. In order to have ecosan systems introduced on a large scale, their functioning and acceptance would still have to be proven. To achieve the latter, it is of utmost importance to successfully hold the dialogue with politicians and other decision makers. Therefore, I would like to recommend you to sacrifice some time during this symposium to discuss, how the political – as well as the legal – framework conditions could be improved in order to allow for a broader realisation of the ecosan approach.
2. We feel it to be unlikely that ecosan systems are going to be introduced in developing countries on a large scale as long as they have not been introduced and operated in the industrialised countries in a much wider scale, showing clearly the advantages to the existing conventional systems, especially in urban and semi-urban areas.
3. Even if all other challenges with regard to the implementation of ecosan approaches have been overcome, we are convinced that a comprehensive realisation of these approaches will still take at least some 30 to 50 years time. Until then, conventional systems and ecosan systems would exist in parallel, even within one city or community.

Notwithstanding the above said, it is clearly in our interest to promote the development and improvement of adapted and sustainable solutions with regard to sanitation problems. Therefore, KfW will continue to follow closely the further development of ecosan approaches. We will also continue to actively support the ecosan project of GTZ in implementing pilot projects. As soon as sufficiently tested solutions exist, we will be more than happy to study the possibilities for a broader introduction of ecosan concepts into Financial Co-operation projects.

Distinguished colleagues, please let me finish my short speech in wishing you interesting and fruitful discussions during this week and a successful Symposium. My colleagues and I are at your disposal for the ensuing discussion.

Thank you very much for your attention!

# Reasons for and principles of ecological sanitation*

**Christine Werner,**
**Papa Abdoulaye Fall,**
**Jana Schlick,**
**Heinz-Peter Mang**

GTZ ecosan project
Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH
Dag-Hammarskjöld-Weg 1-5, 65726 Eschborn, Germany
e-mail: christine.werner@gtz.de

**Keywords**

Global water crisis, water supply and sanitation, Millennium Development Goals, closed loops, ecological sanitation, nutrient recycling, wastewater reuse

**Abstract**

In order to achieve the Millenium Development Goals and the Johannesburg Plan of Implementation, new holistic sanitation concepts are needed, focussing on economically feasible closed-loop ecological systems rather than on expensive end-of-pipe technologies. Ecological sanitation systems are approaches that advance a new philosophy of dealing with what is presently regarded as waste and wastewater. They are based on the systematic implementation of the reuse and recycling of nutrients and water as a hygienically safe, closed-loop and holistic alternative to conventional solutions. Ecosan systems enable the recovery of nutrients from human faeces and urine for the benefit of agriculture, thus helping to preserve soil fertility, assure food security for future generations, minimize water pollution and recover bioenergy. They ensure that water is used economically and is recycled in a safe way to the greatest possible extent for purposes such as irrigation or groundwater recharge.

## World water crisis and millennium development goals (MDG)

Water problems with respect to increased scarcity and degraded quality are now present in various parts of the world and are becoming increasingly serious. All signs suggest, that it is getting worse and will continue to do so, with the most recent UN World Water Development Report talking about the serious world water crisis we are facing. The world economy has grown steadily in recent decades, bringing widespread prosperity and lifting many millions of people out of poverty, particularly in Asia. Nevertheless, there are still 1.1 billion people who lack access to a safe water supply, and 2.4 billion with no access to basic sanitation. In the next 25 years, the world's population is projected to grow by about another 2 billion people, most of whom will be born in developing and emerging market economies and will be living in urban areas. Without a concerted effort, many of these people will be doomed to poverty. The limited progress in reducing poverty has many causes. Some of the most dramatic ones are directly related to our present situation of wastewater management and sanitation, which consists of using surface and groundwater as a sink for human excreta and wastewater, resulting in increasing health hazards, environmental and water pollution, the steady degradation of natural resources and also the permanent loss of nutrients and organics from the soil sphere.

Water treatment and supply are often granted a much higher priority than wastewater collection and treatment, despite that fact that sanitation deserves a greater emphasis due to the impact that poor sanitation has on everyday lives, especially on those of the poor. It is the poor who suffer most from the decreasing quality and growing scarcity of water, and from the burden of

*This paper has been peer reviewed by the symposium scientific committee*

water related diseases and the degraded and dangerous environment.

Untreated excreta and wastewater contains organic matter, plant nutrients, trace elements and micronutrients as well as pathogenic bacteria, viruses, helminths, endocrine substances and medical residues. If they are badly managed they are a major source for the spread of deseases and environmental harm; yet if well-managed they can make a positive contribution to local resources.

Currently more than 90 % of wastewater and excreta worldwide is either only poorly treated or not treated at all at discharge. In addition to the problem of the pollution of water sources, such as rivers and aquifers, poor wastewater management also often leads to pools of stagnant water which may become breeding grounds for insects, with children playing on wet ground or near such pools being exposed to the dangers of infection. The pools may also become evil-smelling and unsightly. Badly designed or operated on-site sanitation is also contributing to groundwater pollution and contamination of the local environment. Sludge emptying is often ignored or the sludge is disposed of in the surrounding environment without precautions for the hygienic safety of the population.

In 2000, the estimated mortality rate due to hygiene related diarrhoea and other water and sanitation related deseases (schistosomiasis, intestinal helminth infections etc.) was about 2.2 million. Worldwide, over 2 billion people were infected with schistosomes and helminths, of whom 300 million sufferred serious illness, most of them children under the age of 5.

A large amount of investment has been made in water supply and sanitation over the last two decades, however the resulting health benefits have been limited by an inadequate focus on hygiene and sanitation and have often even been counter-productive as the improvement in the water supply has resulted in larger wastewater flows.

In light of the fact that humanity and the global environment continue to suffer, different conferences and summits have been organized and resolutions adopted to explore and draw up solutions which may lead to sustainable development. Thirty years ago, in Stockholm, agreement was reacxhed on the urgent need to respond to the problem of environmental deterioration. Ten years ago, at the United Nations Conference on Environment and Development, held in Rio de Janeiro, it was admitted that the protection of the environment, and social and economic development are fundamental to sustainable development, based on the Rio Principles (Agenda 21). To achieve such development, a new programme, the Plan of Implementation, including Millenium Development Goals (MDG), was adopted in Johannesburg in September 2002. According to this programme, poverty eradication, which is one of overarching objectives of, and essential requirements for, sustainable development, could be reached by rapidly increasing access to basic requirements such as clean water, sanitation, adequate shelter, energy, health care, food security and the protection of biodiversity.

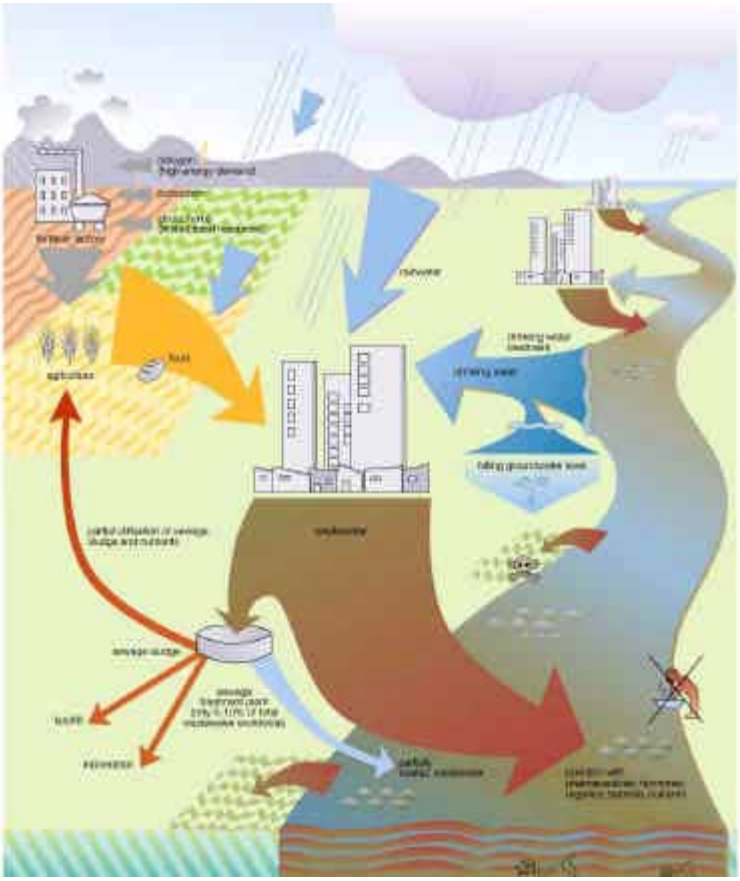
The set target for water and sanitation is to halve the number of people without access to safe drinking water and those without adequate sanitation. This new commitment to give sanitation the same priority as water supply is a very positive development. It is however, also a very big challenge, which for both economic and ecological reasons requires a revolution in our wastewater and excreta management strategies.

## The problem with conventional wastewater management and sanitation

Present conventional forms of wastewater management and sanitation fall either under the category of either waterborne systems or pit latrines. The design of these “flush and discharge” or “drop and store” technologies was based on the premise that excreta is a waste and that waste is only suitable for disposal. It also assumed that the environment could assimilate this waste. ”Modern” water-carriage sewer systems are actually a relatively new technology, which

only began to spread in European cities from around the end of the 19th century, when piped water supply systems lead to an increased water consumption and subsequent wastewater production. Stagnant water pools and streams of wastewater in the streets of the cities lead to outbrakes of cholera and other diseases.Sewer systems were gradually introduced. Later, when this resulted in the heavy pollution of waterbodies, mechanical wastewater treatment plants, biological treatment and tertiary treatment for the removal of nutrients (which is now the present state-of the art in wastewater treatment), were added in order to reducetheir eutrophication.

At first glance, conventional sanitation systems therefore seem to present advantages, as they allow, at least when functioning correctly, a relatively well assured hydraulic transport of excreta, used water and rainwater away from urban areas. Polluted surface waters in urban areas, which are a source of health and environmental problems, are also avoided. The hygienic situation of inhabitants in urban areas is thereby improved. This is however not correctly applied in many countries, especially where the urban populations are increasing rapidly, as these technologies are very expensive in investment, maintenance and operation. These are not problems limited only to developing countries, as the most recent UN-report revealed, with the water quality in Belgium being so poor that it is ranked last in the water quality assessment given in the WWDR. This is due to severe groundwater pollution, high industrial pollution and the fact that Belgium was cautioned by the European Court for directly discharging the wastewater of the more than 1 Mio inhabitants of Brussels directly into a small river.



- unsatisfactory purification or uncontrolled discharge of more than 90 % of wastewater worldwide
- pollution of waters by organics, nutrients, hazardous substances, pathogens, pharmaceutical residues, hormones etc,
- unbearable health risks and spread of disease
- severe environmental damage and eutrophication of the water cycle
- consumption of precious water for transport of waste (water carriage waste disposal systems)
- high investment, energy, operating and maintenance costs
- frequent subsidization of prosperous areas, neglect of poor settlements
- loss of valuable nutrients and trace elements contained in excrement due to discharge into waters
- impoverishment of agricultural soils, increased dependence on fertilizers
- combined central systems are predominant in organized wastewater disposal, resulting in problems with contaminated sewage sludge
- **linear end-of-pipe technology**

**Figure 1:** Shortcomings of conventional wastewater management systems

If considered more closely, conventional waterborne sanitation reveals shortcomings of even greater importance than their high costs. As water is used as a medium to transport the wastes, these systems are becoming increasingly more difficult to apply in regions of aggravating water

scarcity, in arid zones and in poor countries. The high water-consumption connected with our sanitary systems is incompatible with arid countries in the long term and is already leading to an irreversible exploitation of non-renewable water resources. Drinking water is therefore becoming an expensive property only available to the financially well off who are usually in good health. However, clean water is too precious to be flushed down the toilet and it is not the most pleasurable experience to operate a water flush toilet, when the water supply only operates a few hours per week. Additionally, even if these systems may contribute to a healthier environment in the cities located upstream, they do the contrary for those living downstream, as even the state of the art multistage wastewater treatment facilities do not eliminate the pathogens and many other substances contained in the effluent. If rain falls, in combined sewer systems the diluted wastewater is generally conveyed directly into the rivers as the treatment plant is designed only for a limited influent. In recent research there is an increasing awareness regarding the effects of endocrine substances contained in human excreta that can, for example, have an effect on altering the sex of male trout. The effects of pharmaceutical residues in the effluents and their impact on environment and humans living downstream and obtaining their drinking water from the same river are also being discussed.

The search for appropriate solutions has become a pressing problem, particularly for arid and semi-arid zones. With increasing population density and the resultant groundwater pollution, conventional decentralized disposal systems, such as latrines and seepage pits, are also not viable alternatives. In many densely populated areas, the contamination of groundwater by nitrates for example is several times greater than the maximum level recommended by the WHO for drinking water and represents a serious mortal danger to babies. Shallow groundwater is still a major source for local and reliable water supply, especially for the poor in rural and peri-urban areas. The design of the conventional “drop and store” pit-latrines (and of most other on-plot systems) however deliberately aims to retain only the solids and infiltrate as much of the liquids into the sub-soil as possible. As these liquids contain all the soluble elements of the excreta as well as the viruses and pathogens, this type of sanitation can be considered a highway to groundwater contamination.

In theory, these pits latrines should be emptied when they are full and the content should be treated before being put on the land. In practise however, old pits are often abandoned with people preferring to build completely new pit latrines, as emptying the pit is an extremely unpleasant job. However digging a new pit, and building a new superstructure each time the old pit is full is very expensive, and it is very difficult for the homeowners in densely populated areas, where plots are small and tend to be already crowded with many previously abandoned old pits. In addition, many conventional latrines smell and are a breeding place for flies and other insects and are inconvenient to use especially for children, girls and women, as they have to be built at a distance from the house.

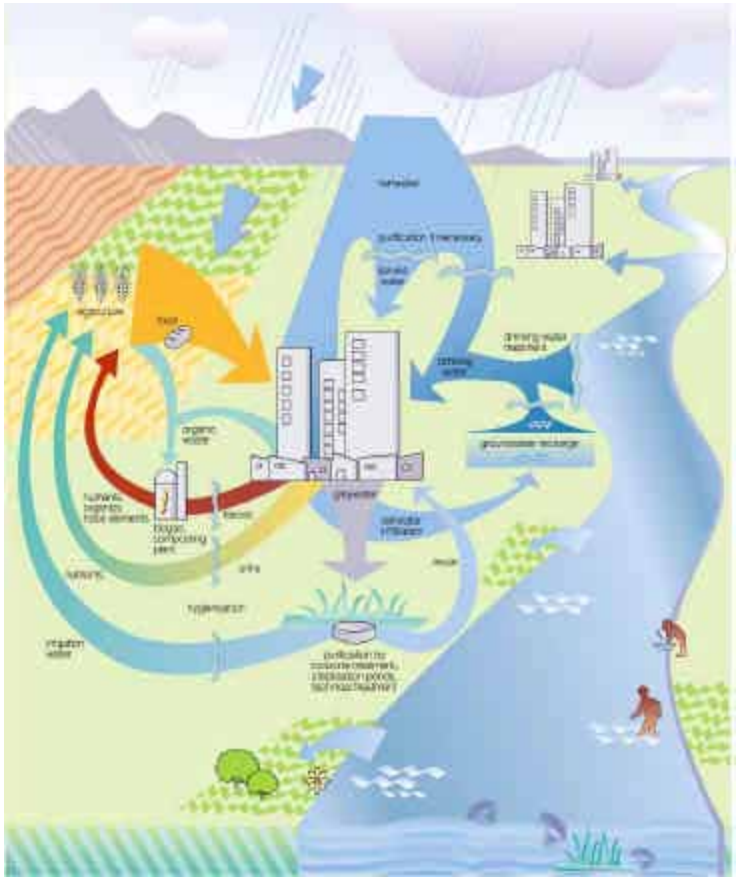
The fundamental problem however, and probably the most important, is that conventional wastewater disposal systems directly impair soil fertility as the valuable nutrients and trace elements contained in human excrement are not usually rechanneled back into agriculture. Even where sewage sludge is put to agricultural use only a small fraction of the nutrients are reintroduced into the living soil layer. Most are either destroyed (e.g. by nitrogen elimination) or enter the water balance, where they pollute the environment. Frequently, the use of sewage sludge from central wastewater systems is also restricted as it contains too high a concentration of heavy metals and other hazardous substances, often as a result of intermixing household with industrial wastewater and with rainwater from contaminated streets.

In fact, our conventional wastewater systems are largely linear end-of-pipe systems where drinking water is misused to transport waste into the water cycle, causing environmental damage and hygienic hazards. If we continue to promote these technologies in order to meet the MDGs, the overall result would be worse than our present situation as the hygienic situation of

our waters would be further deteriorated and even more resources would be dissipated and introduced into water bodies.

## Advantages of ecological sanitation

An alternative approach to avoid the disadvantages of conventional wastewater systems is ecological sanitation, 'ecosan' for short. This is based on an overall view of material flows as part of an ecologically and economically sustainable wastewater management systems tailored to local needs. It does not favour a specific technology, but constitutes a new philosophy in handling substances that have so far been seen merely as wastewater and water-carried waste for disposal.



- improvement of health by minimizing the introduction of pathogens from human excrement into the water cycle
- promotion of recycling by safe, hygienic recovery and use of nutrients, trace elements, water and energy
- conservation of resources through lower water consumption, substitution of chemical fertilizers, minimization of water pollution
- preference for modular, decentralized partial-flow systems for more appropriate, cost-efficient solutions
- possibility to integrate on-plot sanitation into households, increasing user comfort and security for women and girls
- preservation of soil fertility
- improvement of agricultural productivity and hence contribution to food security
- promotion of a holistic, interdisciplinary approach (hygiene, water supply and sanitation, resource conservation, environmental protection, town planning, agriculture, irrigation, food security, small-business promotion etc.)
- **Material-flow cycle instead of disposal**

**Figure 2:** Advantages of ecological sanitation

Systems based on this approach are used for the systematic closure of local material flow cycles and thus ultimately enable recycling systems as are already in common use for solid waste. They also restore a remarkable natural balance, that is between the quantity of nutrients excreted by one person in one year and that needed to produce his food (7.5 kg nitrate, phosphorous and potassium for 250 kg grain). Ideally, ecosan systems enable an almost complete recovery of all nutrients and trace elements in household wastewater and their reuse in agriculture - after appropriate treatment. In this way, they help preserve soil fertility and safeguard long-term food security.

As an integral alternative, a hallmark of ecosan is its interdisciplinary approach that goes beyond the narrow domestic water supply and technological aspects to subsume agricultural use,

sociology, hygiene, health, town planning, economic/small-enterprise promotion, administration, etc. in system development.

In practice, the ecosan strategies of the separation and separate treatment of faeces, urine and greywater, for example, minimize the consumption of valuable drinking water and treats the separate wastewaters at low cost for subsequent use in soil amelioration, as fertilizer or as service or irrigation water. Rainwater harvesting and the treatment of organic domestic and garden wastes and of animal manure may also be integrated into ecosan-concepts.

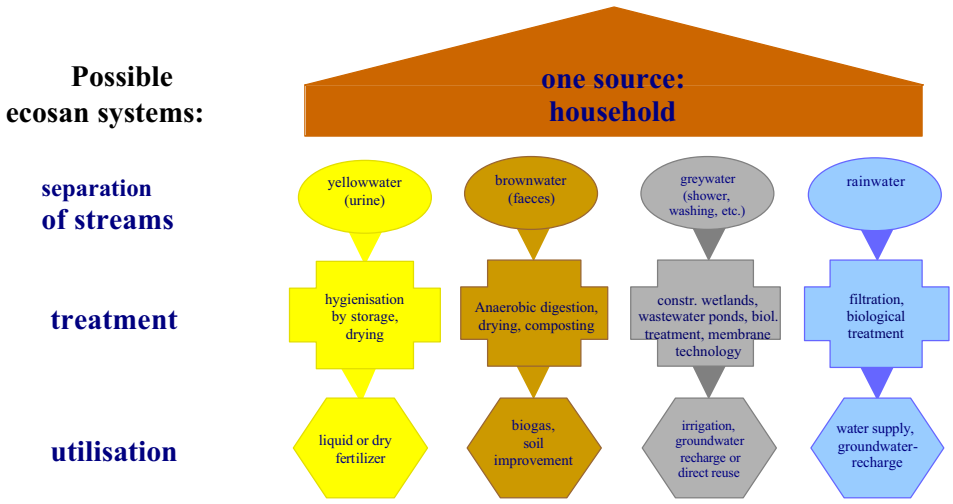



**Figure 3:** Separation of substances and examples of possible ecosan elements

Of particular importance here are innovative logistics to return nutrients to farmland, marketing strategies for the recovered nutrients and directions for their safe application in agriculture. New ecosan schemes may also entail setting up service enterprises and hence implementing income-generating measures for the construction and easy and safe operation of the installations as well as the collection, treatment and marketing of recyclates.

Closing local nutrient cycles by retrieving and using nitrogen, phosphorus, potassium, trace elements and organic components contained in excrement are even more important considering some of the disadvantages of mineral fertilizers. They are too expensive in many parts of the world or are unavailable to local farmers, and their effects on soil and food quality are in dispute. Additionally, large amounts of energy and finite fossil resources are used to produce them. An example of this is phosphorus: It is currently estimated that reserves will be exhausted in about 60 years at the present rate of consumption. Also in this regard, ecosan is a decisive factor for environmental protection and resource conservation, sustainable food production and a stable future in food and health.

Individual, successful and promising examples of ecological disposal systems already exist in various countries, but a great deal of research and development work still needs to be done before ecosan is established internationally as a way of solving the many different problems. Also, applications to date have tended to concentrate on rural areas, with experience in urban and peri-urban areas still being quite limited. Faced with rapid world-wide urbanization there is a pressing need for solutions in conurbations.

Split-stream collection, treatment and reuse of the different partial flows of wastewater offer new possibilities for more specific and cost-efficient solutions. These partial flows can be characterised as blackwater (faeces and urine with or without flushing water), yellowwater (urine with or

without washing water), brownwater (blackwater without urine) and greywater (domestic water without faeces and urine).

| fraction | characteristic |
|---|---|
| 1. faeces | • hygienically critical<br>• consists of organics, nutrients and trace elements<br>• improves soil quality and increases water retainability |
| 2. urine | • less hygienically critical<br>• contains the largest proportion of nutrients available to plants<br>• may contain hormones or medical residues |
| 3. greywater | • of no major hygienic concern<br>• volumetrically the largest portion of wastewater<br>• contains almost no nutrients (simplified treatment)<br>• may contain sprent washing powders etc. |

**Figure 4:** Characteristics of substances

The human faeces obtained after separation show valuable soil improvement qualities (an improved structure and an increase in the water retention capacity). They are treated, if necessary together with organic waste and according to local conditions (climate, power demand and sociocultural acceptance etc), using the processes of either dehydration, composting, stabilization, soilisation or fermentation. Thus, the organics and nutrients contained in faeces can be used in concentrated and hygienically safe form as a dry fertilizer, compost or fluid fertilizer. Dependent on the type of treatment, energy can be produced if necessary in the form of biogas after anaerobic digestion.

The urine, or yellow water, contains the highest proportion of natural nutrients (nitrogen, phosphorus and potassium), which are directly available to plants and equally effective as mineral fertilizers. Urine contains approx. 90% of the total nitrogen, 55%% of the total phosphorus and a substantial portion of the potassium contained in human excrement. A partial flow separation and use of the urine is particularly advisable due to its low volume and the high concentration of nutrients it contains. In order to obtain the yellow water fraction devices such as urine separation toilets or waterless urinals can be used.

The greywater from washing, rinsing, showers etc., while representing the largest fraction of the total wastewater flow, has only a very low nutrient content. Therefore, it can be treated to a high quality using simple techniques such as unventilated gravel filters and biofilm procedures and is thereafter ready for reuse. This water can be put to particularly good use in agricultural irrigation (especially in water scarce regions), but may also be used for groundwater recharge or discharged into surrounding watercourses.

Thus, diverse technologies can be used in ecosan systems, from simple low-tech to sophisticated high-tech solutions. These currently range from compost toilets or urine-separating dry toilets, to water-saving vacuum sewage systems, possibly with separate collection and subsequent treatment of urine, faeces and greywater through to membrane technology for material separation and hygienization. Generally, precedence is given to appropriate modular and decentralized facilities, but in very densely populated areas centralized systems may still be needed. The essential advantage of the modular components is the optimal adaptation to the local social, economic, ecological and climatological conditions. As a result they represent a comparatively rapidly realizable alternative to conventional systems.

The implementation of sustainable sanitary approaches such as ecological sanitation “ecosan” systems is one of the most relevant solutions for sustainable development and goes towards

the Poverty Reduction Strategy (PRSP) initiated in 1999 and supported by the World Bank Group and the IMF. Ideally, ecosan systems enable the recovery of all nutrients which help to restore soil fertility and thus to assure food security and minimize water pollution, thereby improving the situation for farmers, and particularly for women, in at least two ways. The first is the improved yield of vegetables and other crops strengthening their income. The second is the possibility of building ecosan toilets indoors even in very poor areas, as these toilets, when well managed, have no flies and no odour. Thus, also very cheap ecosan toilets can function well indoors even in poor peri-urban areas. Indoor toilets improve the security situation, which is especially important for women and girls at night. Furthermore, they also save much time, as the women can help the children to the toilet with only a minimal delay in other activities.

The ecosan-approach is also in accord with the Bellagio Principles and the Household Centered Environmental Sanitation Approach (HCES), which has been developed by the environmental sanitation working group of the Water Supply and Sanitation Collaborative Council (WSSCC), and recommends that waste be considered as a resource that should be diluted as little as possible, and that sanitation problems should be solved on the minimum practicable size (household, community, town, catchment etc.).

## Conclusion

To realistically have a chance of meeting the Millennium Development Goals, we need a revolution in our way of thinking in order to see human excreta and domestic used water not as a waste but as an important natural resource.

The focus of the efforts for the next years should concentrate on developing and implementing new approaches on sustainable wastewater treatment and sanitation for a variety of suitable closed-loop systems in urban areas including the efficient agricultural reuse of organics, nutrients and water.

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# Current technical options for ecological sanitation

**Ralf Otterpohl**

Technical University Hamburg-Harburg
Institute for Wastewater Management
Eissendorfer Str. 42, 21073 Hamburg, Germany
Internet: www.tuhh.de/aww
e-mail: otterpohl@tuhh.de

Ladies and gentlemen,

let me welcome you on behalf of the International Water Assiciation, IWA. It is new that the IWA is on board with ecological sanitation, and especially since the 3rd World Water Forum 2003 in Kyoto, ecosan has really become part of the key strategic issues of the organisation. We had our own IWA session on ecosan in Kyoto, even having the president of the IWA, Prof. Tambo with us. The director Paul Reiter and deputy director Marc Pascoe are supporting ecosan strongly. This is really good news that the major international organization of the water professionals is taking notice of this key issue. However, active promotion of ecosan it is certainly not done by all members yet.

To start with some of the current ecosan-options available I want to go briefly into the background of why we are doing this. For many conventional engineers this is very weird, so the first presentations I gave about ten years ago people were just incredulous of what I was talking about. And then a few years later they would first laugh and then discuss, but now it has become a key issue even internationally.

The basic thing is that we have to look at wastewater in a different way. I've put up a chart showing all the wastewater flows that are typically produced in houses. On one side, greywater being the largest amount but with a relatively small load of nutrients. It can be re-used in simple ways after appropriate treatment, including recharge of aquifers where appropriate. But this can only be done with affordable technology if it is not mixed with faecal matter. The mixing of faeces with the big amount of wastewater is the crime that has so often been committed and has and does result in the death of so many million people. It is done simply because we are used to it, having learnt it at home and at school so we think it's normal. But now is the time to re-learn, because faecal matter has got nothing to do with the water loop but it belongs to the nutrient loop. On the other side of the slide I show you that large amounts of water can be saved if we do not flush it down the toilet. It also shows that the amounts of urine and faecal matter are very small compared to the massive amounts of wastewater. The faecal matter is the smallest part and if kept separate and treated in the appropriate way, it is a simple material to handle and can even provide renewable energy and restore soil fertility. Throwing this into water creates a hazard, making it very difficult to treat the water at the other end of the pipe. The urine is the major nutrient resource, a natural fertilizer, in principle easy to collect and to use. Subsidies for commercial fertiliser are reduced around the world, many farmers now find it essential to be able to have cheap local fetiliser, and urine is the answer. We should get away from our understanding of what we still call wastewater to maybe blackwater, brownwater, greywater, yellowwater, etc, the new colours of sanitation.

Now I want to go briefly through some technological applications, starting with some high-tech solutions. These include necessarily low-diluting toilets. The main thing is that we have toilets that minimize dilution in such a way that we can produce fertilizer and ensure sanitization.

I start with the vacuum toilets, which many of you know from aeroplanes, which have a high-tech appeal about them. Then there are the sorting toilets which have been re-invented in modern times. They were used is several places around about 100 years ago but did not get the attention at they deserve at that time. Finally there are the desiccation- and composting toilets.

Source control in urban and rural water management is first of all about finding ways of dealing with human excreta in a different way, and there are many ways. Ecosan specialists are working in different areas, from densely populated urban areas to sparsely populated rural areas. Of course we need very different approaches for these different situations. Ecosan is available for the rural and less densely populated peri-urban areas. We do have many choices and can make appropriate designs, at very low prices in many cases. Operation and interacted implementation in co-operation with users and operators are essential for success. There are many people living in metropolitan areas for who we need a lot more ecosan development. There are some promising approaches for those situations, but little experience so far. Some high-tech and some low-tech approaches, as demonstrated by the model of EcoSanRes from Sweden, showing how we can deal with black and brownwater in urban areas in relatively simple way.

Now I show you what the consultancy Otterwasser has built here in Lübeck, one of the reasons why we are holding the symposium here in this beautiful historic UNESCO world heritage city. It is a vacuum toilet system for urban areas that can be adapted even for high-rise buildings with its vacuum collection system, with urban production units for energy and fertilizer. The greywater is available for reuse, infiltration or discharge after appropriate treatment. This system can be used from around five hundred to maybe twenty thousand inhabitants in densely populated settlements, suitable for areas where a certain technological complexity can be handled. It is not, of course, a solution for all areas but a good model to illustrate the wide range of solutions that follow the ecosan principles. There are examples of similar developments in Berlin, Norway, Holland and China.

The same type of technology can be implemented in a more low-tech way with simple digesters especially in warm climate countries. It is far easier to install ecosan in new housing developments rather than retrofitting existing ones. There is a lot of construction done around the world, especially in south-east and east Asia. This type of technology can be incorporated into new construction projects to offer more cost effective solutions that have a number of advantages.

There are more toilet types based on the same principle where, even in urban areas, urine can be collected in tanks for agricultural purposes. But the amount collected in urban areas would be too much to be consumed in the neigbourhood. In my Institute at Technical University of Hamburg we are working on ways to make it more concentrated. This is mainly for transportation reasons and also because the agricultural industry would rather use it in dry form. The problems around micro-pollutants have to be addressed specially for pharma residues in urine, however this is also a major problem in conventional systems with their shortcut to the drinking water taps.

Composting toilets are probably the oldest form of ecological sanitation toilets in modern times. They are mainly found in central and northern Europe. I have to say that they still have too many failures and more developmental is needed, one of the major changes will be to divert the urine and install moisture control.

And then we have the composting tank system which is still in research and development phase. It is based on the principle of flushing with very little water and having a composting tank outside the house. The is a promising idea adopted from Australia to introduce some special type of worms in such a tank to help with the decomposition and sanitization process, preliminary experiments in Hamburg where very promising (see www.ecosan.org). The greywater can be treated in different ways for re-use, especially for recharging aquifers with the additional treatment in soil passage. Membrane-biology systems can be used for densely populated city areas with very little space. The technology is available at reasonable prices now and the membrane prices are still dropping. If we want to turn the greywater into tap water (not drinking water) then we need one more step, preferably reverse osmosis. The combination of the two systems can be installed de-centrally, saving money by avoiding the often excessive costs of big central systems of supply and wastewater transport. This money can then be used for more intelligent technologies that are potentially cheaper and adaptable to local situations and water

scarcity.

We must not forget the rainwater, especially in urban areas. It is one of the tasks of the engineers to get rid of the stormwater run-off. But once again we need to get it to infiltrate and refill the aquifers so that decentral water supply systems can make use of this water. Of course we must make sure that we use enough of the infiltrated water in the region, otherwise we may flood these areas. Careful survey of the geological situation and the expected waterflows is of course necessary.

To say it once more: For most of the ecosan applications the key is to keep the faecal matter apart from the greywater. I also want to repeat that more than five million people, mostly babies and small children, a year are dying from polluted water, the main reason being that our profession is still mixing faecal matter into the waters.

There are many good ecological solutions of low-tech decentral ecosan which are working very well. The interesting thing is that on the one hand there can be local economic benefits generated from the manufacturing of these units by local companies while the money can circulate within the community and then not be drawn out. On the other hand there are low operation costs of the system, and the high-tech systems do not necessarily perform better than the simple ones. In fact all ecosan systems, if implemented correctly, perform better than the large-scale central wastewater treatment plants. They may look very shiny but they do not perform a very thorough recovery and cleaning job, compared to ecosan systems.

Finally I want to show the valuable resource of sunshine in warm climate areas. This unused resource can perform dehydration in sanitation systems very well if implemented correctly: Built above ground to avoid contact of water and faeces, two chambers alternating yearly, diverting the urine and making use of it. One sad thing I have seen with some ecosan projects is that often urine is simply infiltrated into the ground, and that will contribute to problems of nitrates in the groundwater. The re-use of urine in agriculture is the key to making the loop complete, one person produces fertiliser for around 100 to 400 m².

So ecosan can be a dry or flush (little dilution) system. It can even be the conventional flush system upgraded by urine diversion and from an ecological point of view it is not a bad system at all. In the city of Hamburg the Hamburger Stadtentwässerung is looking at the possibility of converting the city, over 50 years, into a urine diversion system in partnership with the fertilizer industry. This would be a major step indeed.

Thank you very much for your attention. I am sure we will have a most interesting conference and hope you will discuss many creative solutions following the principles of ecosan.

# The role of ecosan in achieving sustainable nutrient cycles

**Håkan Jönsson**

Associate Professor
Swedish University of Agricultural Sciences
P.O. Box 7032, SE-750 07 Uppsala, Sweden
e-mail: Hakan.Jonsson@lt.slu.se

## Keywords

Plant nutrient flow, fertilising effects, environmental effects, hormones, pharmaceutical residues

## Abstract

The present flush-and-discharge sewage system introduces a large one-way flow of excreta, containing organic matter, plant nutrients, hormones etc. from terrestrial to aquatic environments. This flow has proven to be a serious impediment to the development of a sustainable society.

End of pipe solutions (sewage treatment works) have so far not been able to make up for this impediment and will probably not be able to do so in the future either. This is shown by the continuously increasing number of problems observed due to this flow of excreta; eutrophication and algae blooms, depletion of arable fields, fish affected by endocrinal disruptions and water polluted by pharmaceutical residues.

EcoSan systems direct the excreta flow in the correct direction, closing the nutrient loop and diverting the hormones to arable land, just as previously during evolution. Furthermore, practical and resource efficient sanitation methods can be employed, since the excreta are collected in a small volume. Therefore, the hygiene standard of EcoSan systems can be higher than that of the present flush-and-discharge system. Furthermore, EcoSan systems also increase the possibility of developing practicable treatments for inactivation of pharmaceutical residues, should this be prioritised by society.

## Introduction

We have not inherited this globe from our ancestors, but borrowed it from our children. It is therefore our obligation to strive towards sustainable development. This implies that the use of our two most important sources of food, water and arable soil, must be sustainable. The plant nutrients of the food must be recycled to arable fields, from where they originate. The plant nutrients must flow in closed loops, in the way they have always flowed. With closed nutrient loops, plant production can be sustainable over a very long time perspective. This is illustrated by the African savannah, where plant production has been sustainable for such a long time that the giraffe has had time to evolve its long neck to graze from the trees (Figure 1). This is real sustainability!

This is far from the situation of the present society, where nutrient flows are linear and one-way. Plants take up nutrients from arable soil. We then consume the plant nutrients in the form of food and excrete them in the form of urine and faeces. However, the excreta nutrients are currently not recycled to the fields. If a flush-and-discharge sewage system is used, they are instead flushed away. In some places of the world, the phosphorous and nitrogen in sewage are efficiently reduced before the sewage is emitted to recipient waters. In such cases, most of the phosphorous usually ends up on a landfill (Figure 2). However, in most places, sewage receives

no, or very little, treatment before being emitted. The excreta nutrients fertilise algae instead crops. It is quite unavoidable that worldwide eutrophication is increasing.

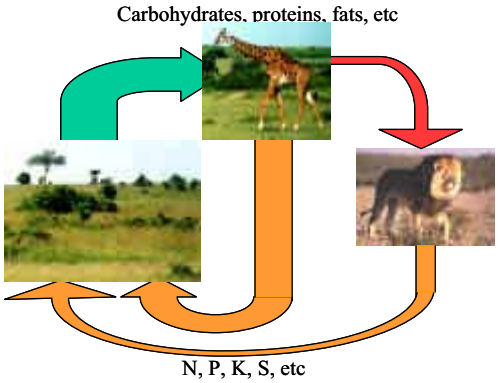


**Figure 1:** The nutrient loops on a savannah.

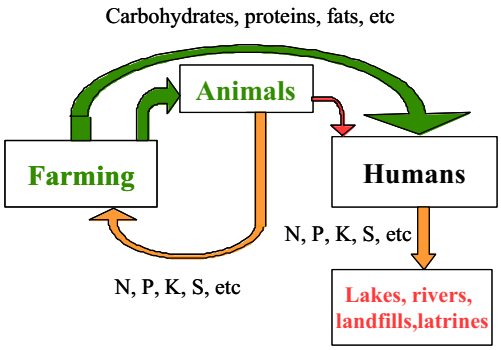


**Figure 2:** The linear one-way nutrient flow from fields to lakes, rivers and landfills of current human society.

At the other end of the flow, arable fields are being depleted of their nutrients, with decreasing productivity as a result. To remedy this, the fields are supplemented with chemical fertilisers when these can be afforded. Chemical fertilisers are produced by the use of fossil resources, e.g. phosphates and potassium from mines and oil and natural gas to produce plant available nitrogen. In many countries agricultural fields are supplied with doses of plant nutrients that are far larger than any that plants have been exposed to before during their evolution. Naturally, this increases the leakage of nutrients from the fields.

The ample supply of chemical fertilisers also decreases the motivation to recycle excreta nutrients to arable land. This is one factor behind the rapid spread of the conventional water-borne flush-and-discharge sewage system, introduced in Western Europe during the late 19th Century. For city populations, the introduction of the water-borne system led to improvements in health, because it rapidly removed infectious wastes from densely populated areas and because it improved the drainage of the cities. However, excreta may contain pathogens in large concentrations and the flush-and-discharge sewage system normally does not destroy these. Instead the pathogens are partly accumulated in sludge or sediment and partly flushed out with the effluent.

Excreta contain not only plant nutrients and pathogens, but also organic macro and micro substances, e.g. hormones. The flush-and-discharge sewage system drastically increases the flow of excreta, and thus of a large number of different substances, from terrestrial to aquatic environments. This has led to serious eutrophication and oxygen deficiency in the recipient waters. To remedy these negative effects, advanced sewage treatment plants were developed, includ-

ing processes to remove biodegradable organic substances, nitrogen and phosphorous. However, new negative effects are continually being discovered. One example is the negative effect on aquatic wildlife caused by the female hormone oestrogen in the sewage effluent. Another example is pollution by pharmaceutical residues, which are being discovered in more and more places, even in groundwater resources used for production of drinking water.

The linear flow of excreta substances thus causes eutrophication, depletion of fields and problems with endocrine disruptors in the marine environment. Therefore, it becomes ever more evident that the linear substance flows introduced by the water-borne flush-and-discharge sewage system are major violations of ecology. The sustainable solution to this is not to improve the present end of pipe sewage treatment. It is instead to introduce a sanitation system that supports, instead of violates, the natural cyclic substance flows of nature. It is to introduce EcoSan.

## EcoSan - substance flows and hygiene

Ecological Sanitation, EcoSan, is designed to support the natural cycles of plant nutrients and other natural components of excreta, e.g. hormones. When fully implemented, all excreta are returned to arable land in a hygienically and chemically safe way. Thus, the cycles of the plant nutrients contained in food are closed and the other natural constituents of excreta, e.g. natural hormones, also flow to soil, just as previously during evolution.

There is a mass balance in the human body. Excreta contain approximately the same amount of heavy metals as food and therefore there is no risk of heavy metal accumulation in soil due to these fertilisers. They are chemically safe. Of course, this assumes that infrastructure systems are well designed and do not themselves contaminate the excreta.

Pharmaceutical residues are often cited as a new and additional risk when using excreta fertilisers, i.e. in EcoSan systems. This risk has not yet been verified, as far as I know, but risk assessments are underway. Meanwhile, before these studies are reported, my guess is that it actually is the other way around. The risks associated with pharmaceutical residues in EcoSan systems are probably smaller than in the conventional flush-and-discharge system. Downstream from the sewage effluent outlet of big cities, the concentration of many pharmaceutical substances is large enough to be detectable. In some places medical residues have even been detected in the groundwater. These findings are worrying as ground and surface waters are the sources of our drinking water.

Studies have also shown that pharmaceutical compounds degrade to varying degrees in sewage treatment plants and that this degradation increases with the retention time. Since arable soil contains the same types of microorganisms as treatment plants, it is reasonable to assume that the degradation will be high, or essentially total, since the retention time in the soil is very long. However, EcoSan also offers another unique possibility of eliminating the risk of pharmaceutical residues. This possibility is due to the small volumes of excreta collected, which increases the possibility of finding practicable and resource efficient treatments that eliminate or inactivate these substances. For example, incineration of dry faeces will not only sanitise them, but also eliminate pharmaceutical residues.

In EcoSan systems the excreta are source separated, i.e. they are collected and treated in a separate system from the greywater. Since the excreta are collected, stored, treated and transported before being reused as fertilisers, it is very important for practical reasons that they are collected in a minimal volume. The volumes of the excreta themselves are quite small, that of urine being only 1-1.5 litres per person and day and that of faeces only 0.1-0.3 litre. To keep the total volume down, no or very small amounts of flushwater are used in EcoSan systems for collection of excreta.

EcoSan strives towards a sustainable society. The recycling of excreta nutrients for sustainable production of food is a requirement for this society. However, this is not enough. To be sustain-

able the food produced must also be safe and of high quality. This implies that, while the plant nutrients should be recycled, pathogens should not. This is a very important requirement and at least two barriers against spreading pathogens should be implemented. Several barriers are possible. One is to sanitise the excreta well, another is to handle the excreta in such a way that they do not contaminate food consumed raw. Still another is not to harvest until a long time after fertilising with excreta.

Urine diversion is a component of many EcoSan systems, mainly because urine diversion simplifies the construction of hygienic, no odour, no fly and no water toilets. Therefore, urine diversion toilets with dry collection of faeces can be built inside the house.

Urine diversion also has the additional advantages of simplifying the sanitation of the excreta and of providing two fertilisers with different properties, instead of one, which makes it possible to address the specific nutrient requirements of different crops.

Urine diversion simplifies the sanitation of excreta. This is because the faeces accounts for only a small fraction of the volume but essentially the whole hygiene risk. The small volume of the dry faeces, i.e. without urine or flushwater, makes it easier to contain them and to sanitise them. They can be sanitised already in the toilet, for example by a combination of regular addition of ash or lime and dehydration, which also decreases the risk of flies and odour. The faeces can also be sanitised upon removal from the toilet by a secondary treatment, for example digestion, composting, incineration or by addition of urea or other chemicals. Further studies and developments are needed on these sanitation methods to minimise their need of resources for meeting a specified hygiene standard. Until such studies have been carried out and hygiene guidelines developed, it is important to apply the faeces before planting/sowing, to incorporate them well and not to use them for vegetables eaten raw.

The hygiene risk associated with urine is very small compared to that with faeces. Therefore, provided that the diversion of the urine functions well, the diversion itself can be seen as a hygiene barrier. Urine should also be incorporated well into the soil, to maximise its fertilising effect. In addition, as a hygiene safety measure, until hygiene guidelines have been developed, it is recommended that crops consumed raw are not fertilised with urine closer to harvest than one month (Schönning, 2003). This also ensures that the plant nutrients have time to be taken up and utilised by the crop.

The hygiene risk associated with latrine or blackwater (urine mixed with faeces and in the case of blackwater also with flushwater) is the same as that of faeces. It is therefore important that several hygiene barriers are enforced.

## Fertilising effects

Urine is a complete fertiliser that is rich in nitrogen. It can be used in the same way as a nitrogen rich liquid chemical fertiliser. For biological fertilisers, the plant availability of the urine nutrients is uniquely high. In experiments, the phosphorous effect has been as good as that of chemical fertiliser (Kirchmann & Pettersson, 1995) and the nitrogen effect has varied from around 70% to more than 100%, compared to chemical fertiliser. On average the nitrogen effect has been around 90%, after deduction of the nitrogen lost as ammonia (Figure 3; Johansson et al., 2001). In Swedish experiments, the nitrogen loss in the form of ammonia has varied from less than 1% to more than 10%. On average it has been around 5%. To keep the ammonia loss low, it is important to mix the urine into the soil as quickly as possible. The best method is probably to apply it in furrows or holes, which are then covered over immediately after application.

Faecal matter is an organic fertiliser that is rich in phosphorous, potassium and organic matter. Faeces improve soil fertility and increase the buffering capacity of the soil, especially if they have also been mixed with ash or lime. The availability of the nutrients in faeces is slower than

of those in urine.

Thus, urine and faeces supplement each other well. Urine is well suited as a fertiliser for nitrogen demanding crops, like maize and spinach, while faeces are well suited as a fertiliser for crops without any large nitrogen demand, like legumes. So far, documented experiments are lacking concerning blackwater. However, since it is a mixture of urine and faeces, and urine contributes most of the nutrients, its fertilising effect should be fairly similar to that of diverted urine.

If plant nutrients are wisely used, introduction of EcoSan will lead to improved production of food. In deprived circumstances and, especially in subsistence farming, this factor can improve both health and economy. EcoSan fertilisers are well balanced complete fertilisers, as they contain the elements in the same ratios as the crops removed them from the fields. Therefore, the risk of unbalanced fertilisation is far less with EcoSan fertilisers than with chemical, which simplifies soil management and decreases the need for chemical soil analyses.

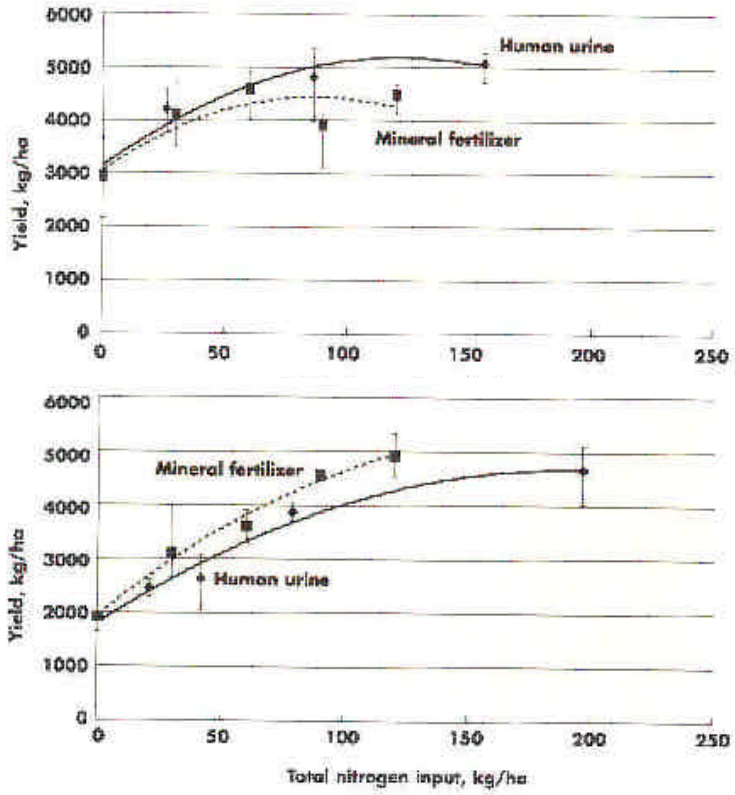


**Figure 3:** The effect of urine and mineral fertiliser on the yield of barley in an experiment in Sweden 1998 (upper diagram) and 1999 (lower diagram) (Johansson et al., 2001).

## Environmental assessments

It is obvious that EcoSan recycles far more nutrients to arable land and emits far less nutrients to water than a conventional flush-and-discharge system, even if the conventional system contains a very effective treatment. For blackwater systems this has also been shown in a number of environmental systems analyses (Bengtsson et al., 1997; Kärrman et. al, 1999; Balmer et al., 2002). These studies also confirmed the low concentrations of heavy metals in excreta, and thus that it is a very pure and unpolluted fertiliser.

However, they also showed that the energy usage of existing blackwater systems is very high. This is due to the large energy usage both by the vacuum system used for collection and by the sanitation process, liquid composting or thermophilic digestion. One conclusion from these studies is that the development of resource efficient sanitation processes should be given the highest priority. Another conclusion is that further development of collection systems is needed, to increase their resource efficiency and decrease their use of water.

## Conclusions

The present flush-and-discharge sewage system introduces a large one-way flow of excreta, containing organic matter, plant nutrients, hormones etc., from terrestrial to aquatic environments. This flow is an obstacle to a sustainable environment. End of pipe solutions (sewage treatment plants) can probably never be a sustainable remedy to this imbalance. This is indicated by the continuously increasing number of problems observed, eutrophication, depletion of arable fields, fish affected by endocrinal disruptions, water polluted by pharmaceutical residues.

EcoSan systems make the excreta flow in the natural direction, closing the nutrient loop and directing the hormones to arable land, just as previously during evolution. Since the excreta are collected in a small volume, practicable and resource efficient sanitation methods can be developed. The hygiene standard of these systems can therefore be higher than that of the present flush-and-discharge system. Furthermore, these systems also increase the possibility of developing practicable treatments for the inactivation of pharmaceutical residues, should this be prioritised by society.

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# Addressing the environmental dimensions of sanitation

**Cees van de Guchte**

Senior Programme Officer
Coordination Office UNEP/GPA
P.O. Box 16227
2500 BE The Hague , The Netherlands
Internet: www.gpa.unep.org
e-mail: c.vandeguchte@unep.nl

Firstly, I would like to offer my compliments to the organisers of this symposium, especially to the GTZ, as well as to the governments of Sweden and Germany for their active involvement in this field and for making this symposium possible.

My first slide, a picture of a child standing inside a large wastewater discharge pipe, addresses the environmental dimensions of sanitation. It clearly shows that there is something wrong with both human and environmental health. The agreed target of Johannesburg, as mentioned earlier today, challenges the mandates of organisations, groups and professionals to put more energy into halving the proportion of people without access to sanitation by 2015, which is often seen as only being limited to household sanitation services but should be regarded in a holistic view to provide benefits for both humans and the environment.

Fortunately we do not have to act alone in this world, and many partnerships exist between different organisations. There are numerous groups operating in their own niches. Ecosan however is not simply a GTZ niche but represents more a collaboration with other partners to jointly address specific issues. I think it is the strengths of such partnerships that will make it possible to achieve the 2015 targets.

Although east and south Asia currently have the biggest problems of poor sanitation coverage we are aware that these problems are not only in Asia, but also on other continents such as Africa, South-Pacific, and South America including the Caribbean, which over the last decade were unable to keep up with their population growth. Here the numbers of the unserved population have increased over the last decade and we must pay attention to these regions. In addition to this, and often forgotten, are the problems that will be faced by the other half of the unserved population that do not receive the adequate sanitation aimed for in the Johannesburg targets. What will happen to them? And who is addressing the needs of the poorest of the poor? The poorest of the poor are quite often living in slums in poor countries with unstable economies. Poor countries where the international financing institutions tend to withdraw their support. It is one of the concerns of the United Nations Environmental Health Programme to address those issues of traditional financing mechanisms which lead to strained relations.

The rather traditional approach to sanitation; sewage treatment and discharge of wastewater requires that we look for innovative approaches to sanitation. Ecological sanitation is part of the toolbox containing these innovations. We therefore need to get the message across to the professionals and the financing institutions, and we need to strategise and professionalise the message for those we wish to reach.

It will be a time consuming process to shift from a use and discharge, to a use and re-use mindset. It will be a time consuming process to not only have household sanitation at the centre of achieving the targets of Johannesburg but also to include efforts considering the environmental dimensions of treatment and discharge of wastewater, and the re-use of nutrients as fertiliser rather than treating them as waste.

At UNEP we address issues of environmental protection, develop guidelines, key principles and knowledge bases in partnerships with other international organisations, and have a strong mandate concerning the environmental conventions currently being implemented. And I think that

within the framework of these environmental conventions UNEP strategies can help to implement ecosan as one of the solutions where governments have committed themselves to address environmental issues.

It is through setting targets, and outlining the necessary measures to implement them, that environmental conventions can assist parties involved, including NGO's, communities, governments and the financial sector. It is these types of statements that are being used at a political level to address environmental dimensions in step-wise approaches. For sanitation programmes these targets should be feasible and should encourage the joint development, in a professional way, of the guidelines to implement them.

I would like to use this opportunity to mention one of the ways in which we can further our debates, as ecosan is one of the tools in addressing the environmental dimensions of sanitation, and to promote the e-mail based conference due to take place at the end of April 2003. It addresses sanitation for the health of the environment. Another conference, planned for November, on sustainable environmental technologies, is being co-organised through our offices in Japan and the International Technology Centre of Japan.

Finally, to end my presentation I would like to repeat this statement „we need to professionalise the ecosan movement". At this conference we have gathered as friends and colleagues sharing a vision, but I believe it is time to include those who do not share this vision in our discussions and work. I hope this symposium will succeed in producing such sound messages.

I wish you all a productive symposium over the coming days.

Thank you.

# The UNDP's approach and activities in ecological sanitation

**Ingvar Andersson**

Senior Water Policy Advisor
UNDP / ESDG
304E 45th Street, FF-994, New York, NY 10017, USA
e-mail: ingvar.andersson@undp.org

**Keywords**

Ecological sanitation, UNDP, Millennium Development Goals

**Abstract**

United Nations Development Programme is the United Nation's development agency. It works with global and national counterparts on solutions to achieve the overarching goal of cutting poverty in half by 2015, one of the Millennium Development Goals (MDGs) pledged to by world leaders. UNDP activities, covering 166 countries, help countries strengthen their capacity to achieve sustainable development, seeking out and sharing best practices and providing policy advice that help the poor build sustainable livelihoods. Access to safe water and sanitation services is essential to reach the targets of the MDGs, to reduce poverty and achieve sustainable development.

**Global UNDP concerns:**

- Currently more than 1 billion people living in developing countries lack access to safe water supply and about 2.5 billion lack adequate sanitation.
- Modern waste management practices, such as water-based sewage where safe drinking water is used to flush away human excreta, are abusive to human well-being, economically unaffordable and environmentally unsustainable.
- Shallow ground water, which is the main source of accessible water for poor people, is increasingly becoming polluted and depleted.
- In the next two decades it is estimated that water use by humans will increase by 40% and that 17% more water will be needed to grow food for growing populations in developing countries.

**UNDP priorities:**

- Improve national and local capacities to manage water recourses, sanitation and water services including civil society, public and private sector,
- Support communities/households with small grants to improve water and sanitation - emphasis on ecological sanitation.
- Promote ecosystem based solutions to the management of excreta to prevent disease and protect the environment,
- Supporting and enhancing women's involvement in sanitation, water supply and water resources management.

UNDP's ecological sanitation activities are to a large extent funded by the Swedish Government and UNDP's projects are carried out in close collaboration with Sida. The basic strategy is to complement and add value to what is implemented under Swedish bilateral assistance which includes to introduce ecological sanitation to countries where Sida has no presence as well as to support the conceptual development e.g. for application in peri-urban areas.

In addition **UNDP's focus** is to:

- develop the concept and promote its application in activities of other agencies / sectors.
- explore linkages between ecological sanitation, urban agriculture, community composting etc.
- identify and address gaps in research and development (e.g. gender).
- identify opportunities, give advice, build capacity and provide funding for pilot studies and demonstration projects.
- disseminate information and knowledge - case studies, networking (Red Seco, Indian Lecture tour).

The geographic focus of UNDP's work on ecological sanitation is Latin America and Asia / Pacific. Countries benefiting from UNDP support include India, Sri Lanka, The Philippines, Vanuatu, Kyrgyzstan, Mexico, Peru, and Mozambique.

Focal point and consultant for Latin America is Ron Sawyer (http://www.laneta.apc.org/sarar),

Asia/Pacific Paul Calvert: (http://www.eco-solutions.org/).

Main UNDP publication: Closing the Loop – Ecological Sanitation and Food security, UNDP/Sida, 2001, available in English and Spanish on web site: http://www.laneta.apc.org/sarar/

More information about UNDP's work in sanitation and water: http://www.undp.org/water/

# Putting ecosan on the global agenda - results from the 3rd World Water Forum, Kyoto, March 16-23, 2003

**Arno Rosemarin**

Stockholm Environment Institute
Box 2142, 103 14 Stockholm, Sweden
Internet: http://www.ecosanres.org/
e-mail: arno.rosemarin@sei.se

## Keywords

Ecosan, ecological sanitation, global, Millenium Development Goals, Kyoto

## Abstract

The Third World Water Forum provided a major opportunity to put ecological sanitation onto the global agenda. A series of key workshop and lecture sessions were organised in collaboration with the IWA, City of Kyoto, Japan Toilets Association and the EcoSanRes Programme. A resolution on ecosan was written and agreed to by a number of organisations including multi-lateral, bi-lateral, finance institutions, national governments, etc. This represents a paradigm shift in the making where sanitation is no longer a practice of disposing human excreta in deep pits and water courses but one centred around the all-so-important relationship between humans and soil systems The 3rd WWF Ministerial Declaration and Commitments from UN agencies also referred to new opportunities where positioning of ecological sanitation will be possible. The linkage to the Millennium Development Goals was also made and details describing the roadmap ahead for the Water and Sanitation goals are described.

## Ecosan at the Third World Water Forum

The Third World Water Forum was a large meeting involving many parallel sessions, plenaries and a Ministerial meeting covering virtually all aspects of water concerns from all over the planet. This is not meant as a summary or review of the 3rd WWF but merely a bridging introduction to help kick off the 2nd International Symposium on Ecological Sanitation held in Lübeck no April 7 to11, 2003. The 3rd WWF contained some 351 sessions covering 33 themes and 5 regions of the world. One of the main themes of the Forum was sanitation and ecological sanitation was given a large opportunity to show its presence. This is the main message of this paper – that ecosan was put on the global agenda at the 3rd WWF.

In collaboration with IWA, Japan Toilet Association, City of Kyoto and the EcoSanRes Programme, the following sessions dealing with ecosan were organized:

- Ecological Sanitation – Progress Being Made Around the World: What is Ecosan and what is Being Done Generally? (Uganda Ministry present)
- Ecological Sanitation – Closing the Nutrient Loop Through Ecosan in Rural and Urban Areas (Swedish Minister present)
- Affordable & Ecologically Sound Community Sanitation – New Solutions to Old Problems (IWA Head present)
- Proper Toilets for Everyone All Over the World

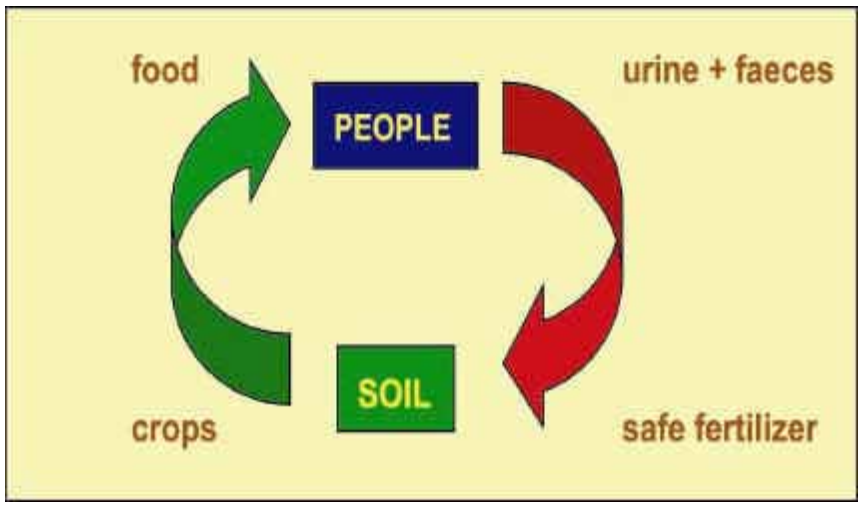
These were well-attended attracting practitioners and policy-makers and provided new insights into latest developments and the progress made thus far within the field of ecological sanitation.

## The Kyoto Resolution on Ecosan

A resolution was generated and consensus achieved along the following lines:

- Ecological sanitation (ecosan) is an environment-friendly and safe approach to sanitation.
- Ecosan is holistic in that it saves water, prevents water pollution, sanitizes and recycles the nutrients and organics to restore soil and soil fertility.
- Ecosan includes low- as well as high-cost solutions for rural and urban settings. Ecosan can be more cost-effective than conventional sanitation and thereby offering a greater chance of meeting the Millennium Development Goals and the Johannesburg Commitments on Sanitation.
- Ecosan is applicable to a wide array of local physical, cultural and economic conditions providing permanent installations.
- Ecosan concepts and techniques can also be used to upgrade conventional pit latrines and flush systems.
- Ecosan is being applied successfully in many locations in Africa, Asia, Europe, the Americas, and Oceania.
- At the Kyoto 3rd WWF, ecosan emerged as a significant option in meeting the Millennium Development Goals and the Johannesburg Commitments on Sanitation and is supported *inter alia* by UNDP, UNEP, UNICEF, Water and Sanitation Programme (World Bank), EU, Government of Uganda, GTZ (Germany), Sida (Sweden), Austrian Aid, SDC (Switzerland), IWA, CREPA (West Africa), Mvula Trust (South Africa), the City of Kyoto and the Japan Toilets Association.

A new paradigm is thus in the making, whereby sanitation should be based on the relationship and dependency that people have on soil systems and should not continue the common practice of disposing of human excreta in deep pits (ground water) or water courses. This shift in thinking is depicted by the following diagram:




## Ministerial Declaration

The Ministerial Declaration arising from the 3rd WWF included several statements referring to topics related to ecosan. Under the heading Safe Drinking Water and Sanitation the following was resolved:

- §16. Achieving the target established in the MDGs to halve the proportion of people without access to safe drinking water by 2015 and that established in the Plan of Implementation of the WSSD to halve the proportion of people without access to basic sanitation by 2015 requires an enormous amount of investment in water supply and sanitation. We call on each country to develop strategies to achieve these objectives. We will redouble our collective efforts to mobilize financial and technical resources, both public and private.
- §17. We will address water supply and sanitation in urban and rural areas in ways suitable for the respective local conditions and management capacities, with a view to achieving short-term improvement of water and sanitation services as well as cost-effective infrastructure investments and sound management and maintenance over time. In so doing, we will enhance poor people's access to safe drinking water and sanitation.
- §18. While basic hygiene practices starting from hand washing at the household level should be encouraged, intensified efforts should also be launched to promote technical breakthroughs, especially the development and practical applications of efficient and low-cost technologies tailored to daily life for the provision of safe drinking water and basic sanitation. We encourage studies for innovative technologies to be locally owned.

## Kyoto Commitments

Several organizations announced new commitments at the 3rd WWF. The following four samples are relevant to ecosan and should be seen as opportunities:

- The **Water and Sanitation Program** (World Bank) commits itself to funding national capacity building projects for MDG monitoring. Candidate countries are welcomed to apply.
- The **WSSCC** is committed to publishing every three years a 'People's Report' that will present progress towards hygiene, sanitation and water for all. The first one is due in December 2003, and thereafter at each WASH Global Forum.
- The **United Nations Development Programme (UNDP)** commits to a Community Water Initiative, aimed at building on the power of the local community to solve water and sanitation challenges. Its aim is to provide innovative communities with small grants to expand and improve their solutions to the water and sanitation crisis. The Community Water Initiative has an estimated target budget of $50 million for 2003-2008.
- **UN-HABITAT** signed a memorandum of understanding with the Asian Development Bank (ADB) to create a programme to build the capacity of Asian cities to secure and manage pro-poor investments and to help the region meet the Millennium Development Goals (MDG) of halving, by 2015, the proportion of people without safe drinking water and basic sanitation. The programme will cover a pipeline of US$10 million in grants from ADB and UN-HABITAT for the first two phases and US$500 million in ADB loans for water and sanitation projects in cities across Asia over the next five years. Additional funding for Water for Asian Cities has also been made available to UN-HABITAT by the Government of Netherlands.

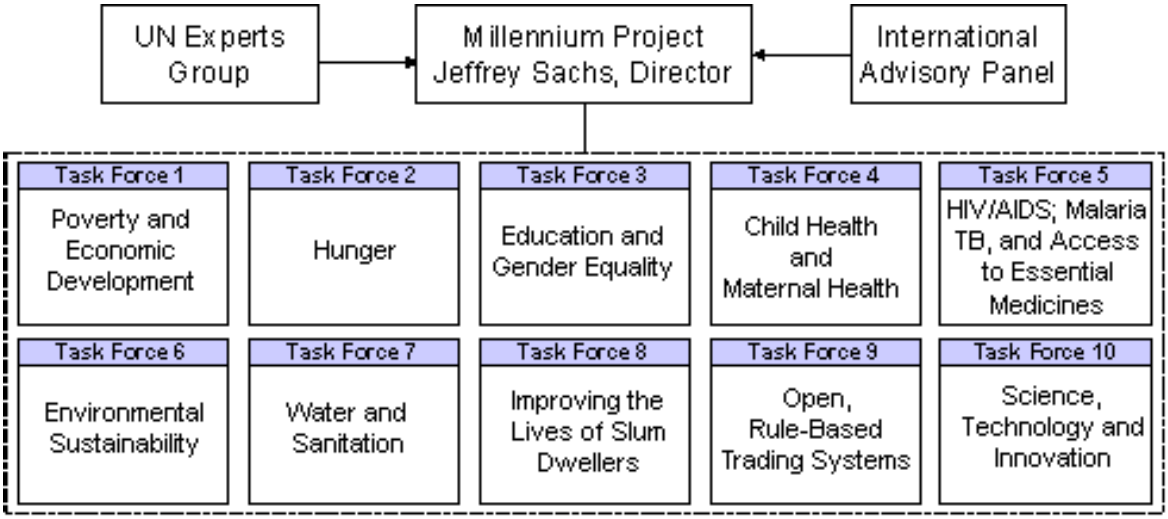
## The UN Strategy for the Millennium Development Goals

The UN MDG strategy is also relevant in providing opportunities for ecosan development. The following are the four main features of the MDG process:

- The Millennium Project, which analyses policy options and will develop a plan of implementation for achieving the Millennium Development Goals. Headed by Jeffrey Sachs, Columbia University.

- The Millennium Campaign, which mobilizes political support for the Millennium Declaration among developed and developing countries. This is led by Evelyn Herfkens, the Secretary-General's Executive Coordinator for the MDG Campaign.
- Country-level monitoring of progress towards achieving the Millennium Development Goals, led by the UN Development Group.
- Operational country-level activities, coordinated across agencies through the UN Development Group, which help individual countries implement policies necessary for achieving the Millennium Development Goals.

A battery of Task Forces have been set up one of which deals with the issues of water and sanitation:




The MDG timeline is as follows:

- **Late-2002.** Completion of background papers, which map out the planned research work of each Task Force.
- **Mid-2003.** Publication of the Human Development Report 2003, which will focus on the Millennium Development Goals and draw upon research contributed by the Millennium Project Task Forces.
- **Mid-2004.** Presentation of the Millennium Project Interim Report to the UN Secretary-General and the UNDP Administrator.
- **June 30, 2005.** Presentation of final recommendations by the Millennium Project to the UN Secretary-General.

The Water and Sanitation Task Force includes the following representatives:

- *Coordinators*: Roberto Lenton (Columbia University and GWP) and Albert Wright (Africa Water Task Force, GWP, World Bank)
- Ingvar Andersson Senior Water Advisor, (UNDP)
- Michel Camdessus, Chair, Panel on Water Infrastructure Financing
- Margaret Catley-Carlson, Chair, Iobal Water Partnership
- Ivan Cheret, Suez Lyonnaise des Eaux

- Kamla Chowdry, Vikram Sarabhai Foundation (VSF), India
- William Cosgrove, Vice President, World Water Council
- Manuel Dengo, Chief, Natural Resources, United Nations Department of Economic and Social Affairs (DESA)
- Halifa Drammeh, Deputy Director, Division for Policy Development and Law, United Nations Environment Programme (UNEP)
- Gourisankar Ghosh, Executive Director, WSSCC
- Richard Jolly, Emeritus Fellow, Institute of Development Studies, University of Sussex
- Torkil Jonch-Clausen, Chairman, GWP-TAC
- Mike Muller, Director General, South Africa Department of Water Affairs
- Kalyan Ray, Chief, Water, Sanitation and Infrastructure Branch, United Nations Human Settlements Programme (UN-Habitat)
- Frank Rijsberman, Director General, International Water Management Institute
- Jamal Saghir, Director, Energy and Water, The World Bank
- David Seckler, Former Director General, International Irrigation Management Institute
- Andras Sollosi-Nagy, Deputy, Assistant Director-General, Science Sector Director, Division of Water Sciences, (UNESCO)
- Vanessa Tobin, Chief, Water, Environment and Sanitation, United Nations Children's Fund (UNICEF)
- Gordon Young, Coordinator, World Water Assessment Program

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Esrey, S., Gough, J., Rapaport, D., Sawyer, R., Simpson-Hebert, M., Vargas, J. and Winblad, U. (1998). *Ecological Sanitation.* Stockholm: Sida.

Millenium Project (2003). Background Paper of the Task Force on Water and Sanitation. April 18, 2003. 78p

Website for the EcoSanRes Programme: http://www.ecosanres.org/

# Session A

## Progress, policies and legislation

### Chairpersons

*Ingvar Andersson* (UNDP, USA)

*Xiangjun Yao* (Ministry of Agriculture, China)

### Lectures

**The EU water initiative, its research component and ecosan**
*Zissimos Vergos* (European Commission, Belgium)

**The BMBF programme "decentralised (alternative) water systems" - international projects**
*Rüdiger Furrer* (Research Center Karlsruhe, Project Agency for Water Technology and Waste Management, Germany)

**Demand on and difficulties for implementation of ecosan concepts in China**
*Jiang Zhang* (Institute for Sustainable Technology, Zhejiang University, China), *Jun Chen*

**New legislation for on-site sanitation in Finland***
*Harri Mattila* (Häme Polytechnic, Environmental Engineering, Finland)

**Key-activities, services and current pilot projects of the international ecosan programme of GTZ***
*Christine Werner, Heinz-Peter Mang, Ve Kessen* (GTZ, Germany)

**EcoSanRes - a Swedish international ecosan-programme**
*Arno Rosemarin* (Stockholm Environment Institute, Sweden)

**Guidelines for the implementation of the Bellagio Principles and the household centred environmental sanitation approach (HCES) ***
*Roland Schertenleib, Antoine Morel,* (EAWAG/ SANDEC, Switzerland), *John Kalbermatten, Darren Saywell*.

**Tentative guidelines for agricultural use of urine and faeces***
*Björn Vinnerås, Håkan Jönsson* (Swedish University of Agricultural Sciences, Sweden)*, Eva Salomon, Anna Richert-Stinzting*

### Oral poster presentations

**Ecosan - clean production mechanism under the Kyoto-protocol**
*Gert de Bruijne, Nadine Dulac* (WASTE, Netherlands)

**Rainwater harvesting, water re-utilisation and ecological sanitation - further developments**
*Dietmar Sperfeld, Erwin Nolde* (Fachvereinigung Betriebs- und Regenwassernutzung e.V., Germany)

*This paper has been peer reviewed by the symposium scientific committee*

# The EU water initiative, its research component and ecosan

**Zissimos Vergos**

European Commission
Directorate General for Research
Directorate Environment
e-mail: zissimos.vergos@cec.eu.int

## EU water initiative - A quick overview

**World Summit for Sustainable Development**

**Geographical Components**

- Africa (sub-Saharan)
- EECCA
- Mediterranean
- (North Africa and Middle East)
- Latin America

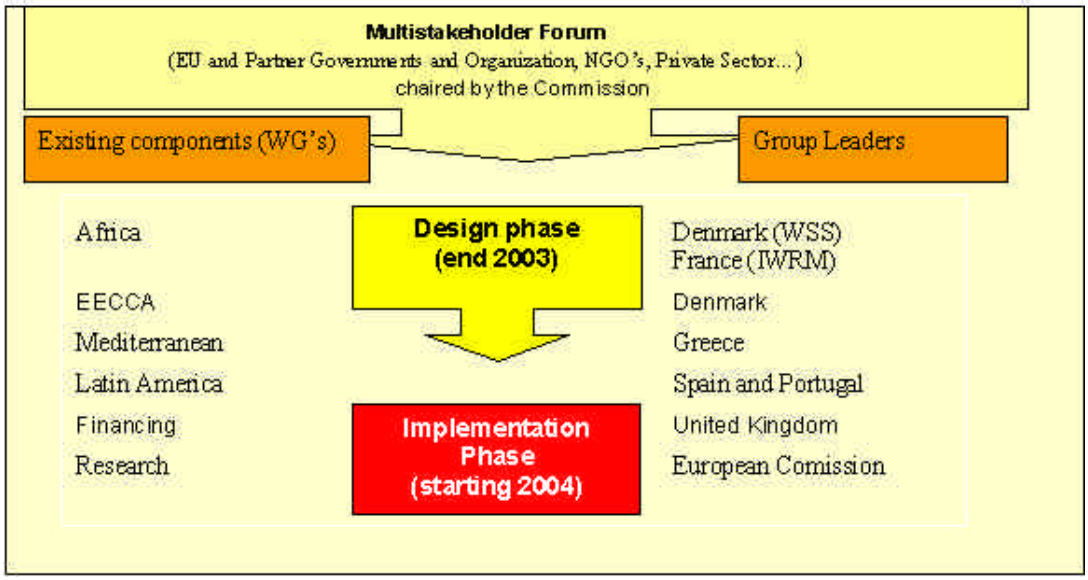
**Thematic Components**

- Water Supply and Sanitation (WSS)
- Integrated Water Resources Management (WRM…including transboundary resources)

**Horizontal Components**

**Financing**
**Research**

## EU water initiative – organization



**EU water initiative - research component: aims and expected contribution to the water initiative**

- Co-ordination, coherence and complementarities of European efforts
- Higher impact, critical mass and strategic partnerships
- Support and Feedback for policy formulation and integrated water research approaches
- Awareness, proactive participation, human resources and better knowledge and innovation management in developing countries
- Integration and operational feedback between development co-operation and research

**EU water initiative - research component: the mapping of European efforts**

- Policy frameworks
- Major Organisations and Institutions
- Strategic Approaches
- Problems and best practices
- Targeted Water Research areas
- Beneficiary regions/countries

**EU water initiative - research component**
**Preliminary conclusions from mapping exercise**

- High profile of international water research at EU Member States and Community level
- Significant efforts taking place = systematic analysis is needed for capitalising on lessons and best practices
- Added-value, critical mass and higher impact can be derived from better co-ordination
- Diversity of strategic approaches of international co-operation in water research
- More integrated approaches are needed to tackle existing problems
- Planning should be demand orientated, based on stakeholders analysis and public participation
- Additional efforts shall be put into better streamlining and integration of water research in development co-operation efforts

**EU water initiative - research component**
**The way forward**

- Finalise mapping, assessment and dissemination of results and feed back from concerned stakeholders
- Operational links with the other Working Groups, promotion of strategic partnerships and integration with development co-operation programmes
- Identify target regions and thematic areas (pilot integrated water research activities)

- Intensify dissemination of Public Information and Awareness to institutions and stakeholders in European and Partner countries

## International research co-operation
## 6th research framework programme (2002-2006)


## Potential interfaces for ecological sanitation
## Specific measures in support of international co-operation (INCO)

**Developing Countries** - Rational Use of Natural Resources

- Humid and semi-humid ecosystems (call 2003)
  - Ecosystem dynamics and use of renewable natural resources.
  - Integrated approach to natural and agro-resource use systems.
- Multiple Demands on Coastal Zones (call 2003)
- Food Security (future call)
- Arid and Semi-Arid Ecosystems (future call)

**Mediterranean** - Integrated Management of Limited Water Resources

- Policy for Integrated Water Planning (call 2003)
- Improving Water Consumption (call 2003)
  - Non-conventional water resources.

- Fertilisation and Plant Nutrition.

- Advanced Water Treatment, re-use and energy implications (call 2003)
  - Efficient use of treated water and multiple uses of water resources for a variety of uses.
  - Institutional and legal mechanisms for water purification and reuse

**Potential interfaces for ecological sanitation**
**Specific measures in support of international co-operation (INCO)**

**Western Balkans** - Environment (calls 2003)

- Development of waste water treatment and reuse technologies (including agricultural water use)
- Innovative cost-effective techniques for the efficient treatment of industrial and municipal waste and the use of recycled materials through bio-depuration and composting.

**Russia and other NIS (EECCA)** - Environment and Health Protection

- Stabilisation of research and development potential, changes in the industrial production system, environment and health protection and related safety aspects.

**Potential interfaces for ecological sanitation**

**Thematic priority 6:** Sustainable Development, Global Change and Ecosystems

**Sub-priority**: Global Change and Ecosystems

- Integrated water management at river basin level, African and EECCA countries
  - Twinning European/Third Countries river basins (call 2003)
  - Methodologies of IWRM and Transboundary Issues (IP or NoE - call 2004)
- Integrated urban water management, problems of African, Asian and South American mega-cities and peri-urban areas
  - Wastewater reuse (call 2004)
  - Integrated Urban Water Management (IP or NoE - future calls)
  - Strategies, technologies and Management Practices for Drinking Water supply (future calls)

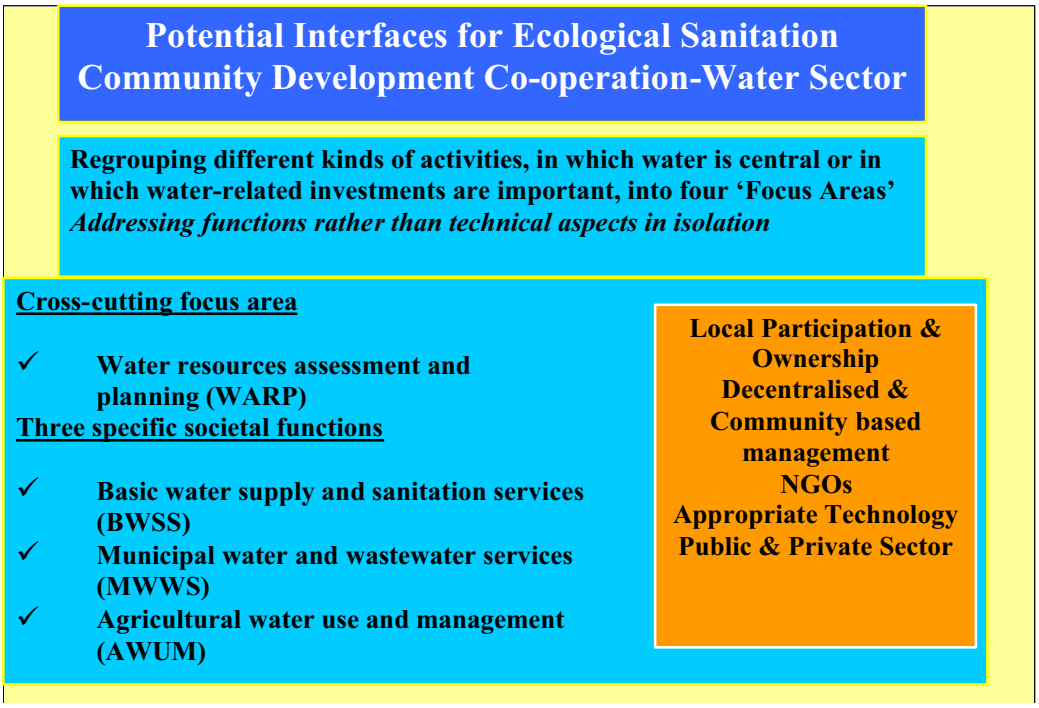
**Potential interfaces for ecological sanitation**

**Thematic priority 6**: Sustainable Development, Global Change and Ecosystems

**Sub-priority**: Global Change and Ecosystems

- Management of water under scarcity, focussed on South Mediterranean countries
  - Technologies for monitoring and mitigating the impact of water scarcity (call 2003)
  - New approaches to water stress (IP or NoE - call 2004)
- Development of scenarios of water demand and availability at 25-50 years, with focus on South and East Mediterranean and EECCA countries
  - Water Scenarios for Europe and neighbouring countries (IP or NoE - call 2004)

## Potential interfaces for ecological sanitation




## Research work related to ecological sanitation
## 5th research framework programme

In Europe and Third Countries

- Water Conservation and Water Saving
- Wastewater treatment, recycling and re-use in agriculture
- Economic, social and environmental sustainability
- Water Contamination and Pollution Control
- Cost-Effective Reclamation Technologies for domestic wastewater
- Groundwater and Soil Interactions
- Public Health, Sanitation and Hygiene
- Cost-effective rehabilitation of water supply and sewer networks
- Private sector involvement in water supply and sanitation

## Member states - international research - focal points

**Austria:** Federal Ministry of Finance and BOKU - University of Natural Resources and Applied Life Sciences, Vienna - Austrian Development Co-operation.

**Belgium**: Directorate General for International Co-operation in the Ministry of Foreign Affairs

**Denmark**: Development Research Department in the Danish International Development Agency (DANIDA)

**Finland:** Department for International Development Co-operation in the Ministry for Foreign Affairs

**France:** Ministry for Foreign Affairs and the Commission pour la Recherché Agronomique Internationale (CRAI).

**Germany:** Federal Ministry for Economic Cooperation and Development (BMZ) and Federal Ministry of Education and Research (BMBF)

**Greece**: Ministry and Mediterranean Information Office for Environment, Culture and Sustainable Development (GWP-MED)

**Ireland**: Development Co-operation Division (Ireland Aid) in the Department of Foreign Affairs.

**Italy**: Directorate General for Development Co-operation in the Ministry of Foreign Affairs and guided by the Instituto Agronomico per l'Oltremare

**Luxembourg:** Ministry of Finance

**The Netherlands:** Directorate General for International Co-operation in the Ministry of Foreign Affairs

**Portugal:** Office for International Relations in Science and Higher Education

**Spain:** Ministry of Science and Technology and Spanish International Co-operation

**Sweden**: Department for Research Co-operation (SAREC) in the Swedish International Development Agency (SIDA)

**The United Kingdom**: Department for International Development

## Some concluding remarks

- Ecological Sanitation is a **concept perfectly in line with the sustainable development perspective and major orientations of the Community Research Framework Programmes** in the water and sanitation sector.
- The **EU Water Initiative** includes sanitation as one of its focal areas providing a fertile ground for extending **environmental sanitation into ecological sanitation** in developing countries.
- Existing **strategic partnerships and field work in ecosan are of particular relevance to the EU Water Initiative**, and vice versa, and **effective linkages shall be established.**

# The BMBF programme “decentralized (alternative) water systems” - international projects

**Rüdiger Furrer**

Forschungszentrum Karlsruhe
Project Agency for Water Technology and Waste Management acting on behalf of the BMBF (German Federal Ministry of Education and Research) and BMWA (German Federal Ministry of Economics and Labour)
Mailbox 36 40, 76 021 Karlsruhe, Germany
internet: http://www.fzk.de/ptwte/
e-mail: ruediger.furrer@ptwte.fzk.de

## Introduction

The projects funded by the BMBF/PTWT+E concerning decentralized (alternative) water systems are based on an announcement in the “Bundesgesetzblatt” (Federal Law Gazette) of June 27, 2001.

All the drafts (112 in total) were surveyed on behalf of the BMBF by an external committee consisting of experts in water management, associations, universities, and members of industry. The announcement itself was made in accordance with the BMZ/GTZ project “ecosan”. The levels of international development, technical feasibility, and administrative requirements were compiled from two studies carried out by the University of Witten-Herdecke and the University of Munich.

Especially with the international projects, we wish to contribute to a more conscious and sustainable use of water, a resource that cannot be replaced. Accordingly, these projects contribute to the ambitious aims of the Sustainability Summit of Johannesburg, which was to halve, by the year 2015, the proportion of people who are unable to reach or afford safe drinking water and do not have access to basic sanitation.

The BMBF research program is mainly designed to combine and to improve existing components. Apart from the reduction of the drinking water consumption key aspects are to decouple materials and water flows such that recovery of nutrients and energy will be possible and economically efficient.

Subjects of investigation are: Anaerobic waste water treatment, membrane filtration, processes close to nature, reuse of gray water and rainwater, separation vacuum and compost toilets, winning of biogas and decentralized power stations, production of compost and fertilizers, economic, sociocultural, and legal aspects.

Concerning the implementation and dissemination of the research results an adequate contribution from German private companies as well as from the foreign partners is required. (The system of project funding does not allow a direct funding of foreign partners.)

## Current projects: Vietnam - (Dr. Clemens - University of Bonn)

**Topic:**

Closing of agricultural nutrient cycles via hygienically harmless substrates from decentralized water systems in the Mekong delta

**University of Bonn:**

working group materials flows Dr. J. Clemens

| | |
|---|---|
| working group hygiene | Dr. Th. Kistemann |
| working group sociology | Prof. Dr. Th. Kutsch |
| working group agricultural ecology | Prof. Dr. M. Becker |
| working group agricultural water management | Prof. Dr. A. Rieser |
| **University of Bochum:** | |
| working group drinking water | Prof. Dr. H. Stolpe |
| University of Can Tho | Prof. Le Quang Minh |

**Level of knowledge:**

About 17 million people are living in the Mekong delta (40,000 km²). The population density is twice as high as in Germany. The delta is mainly used for the growing of rice, vegetables, and fish farming. Less than 50 % of the total population has access to fresh water, in rural areas less than 10 %. Instead of drinking water, people use collected rainwater (pathogenic germs) or water from uncontrolled wells (chemicals for use in agriculture, seawater intrusion)

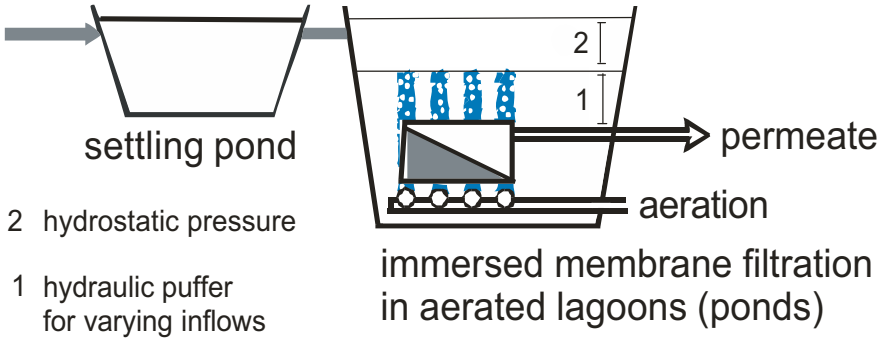



**Figure 1:** Sketch of the pilot plant

**Main activities:**

In the first part of this project the soils, groundwater, water and materials flows, and the agricultural use of two different areas in the Mekong delta will be studied in detail.

The varying demands of soils for fertilizer/sludge or humus/compost will form the basis on which the most suitable waste water concept will be worked out.

Concerning drinking water, the disinfection with soil filtration, solar energy and the sustainable abstraction of groundwater will be examined.

**Comment on project funding:**

The Mekong delta is considered typical for many territories of South Asia:

- alternation between flood and demand for irrigation
- pollution of the raw waters (groundwater, surface water)
- rural areas which are intensively used for agriculture

Construction and maintenance of drinking water treatment and waste water treatment plants are expensive, especially in areas with low average income. The idea of this project is to adapt the waste water treatment system directly to the demands of agriculture. This will increase the consumer acceptance and decrease the costs of the maintenance.

## Egypt (Prof. Hegemann - Technical University of Berlin)

**Topic:**

Improvement of the effluent quality of aerated lagoons (ponds) by membrane filtration

Institute for Technical Pollution Control — Prof. W. Hegemann

National Research Center — Prof. Abdel Shafy

**Level of knowledge:**

Lagoons are widely spread because of the simple and cost-saving construction and maintenance. However, the rate of degradation and the retention of bacteria and germs are limited compared to activated sludge plants. Strictly speaking, direct use of the effluents for irrigation purposes is not possible.

**Main activities:**

A pilot plant will be constructed and transferred to an existing waste water treatment plant in a village near Cairo. The pilot plant will serve for about 500 population equivalents.

The device will be optimized to reduce water evaporation, to increase retention of pathogenic germs, the operation safety, and to reduce the costs of maintenance.

After membrane filtration, the treated waste water is intended to be reused for irrigation or as industrial process water.

For applications in Germany or Eastern Europe, where lagoons are frequently met, operation conditions for N- and P-removal will be studied. The treated waste waters should then be discharged into receiving water bodies or infiltrated into the ground.

**Comment on project funding:**

In the case of success, this project will contribute to the improvement of existing simple waste water treatment plants. It is designed to save rare drinking water resources and reduce the costs for fertilizers. Egypt was chosen as location as it is considered typical for all semi-arid climates.

The operation conditions with N- und P-removal will allow to optimize existing lagoons (ponds) in Germany and Eastern Europe, respectively.

## Turkey (Dr. Theilen - AT-Association)

**Topic:**

MODULAARE - Integrated modules for high-efficient waste water treatment, waste treatment and recovery of energy in tourism resorts

partners:

AT association — Dr. U. Theilen

University of Stuttgart

Department of Waste Water Technology — D. Steinbach

Department of Municipal Solid Waste Management — Mrs. A. Schultheis

Iberotel Sarigerme Park (TUI) — Heinz H. Fugger

**Level of knowledge:**

The materials flows in (tourist) hotels are extremely high:

| | |
|---|---|
| waste/hotel | up to 2.5 kg/guest day |
| average/Germany: | about 0.5 kg/inhabitant day |
| drinking water consumption/Hotel | up to 1.200 L/guest day |
| average/Germany: | < 130 l/inhabitant day |

Proper recycling management is generally not applied in hotels or tourist resorts.

Sarigerme Park Hotel situated on the Turkish Aegean coast about 372 beds and was selected for the following reasons:

- there is sufficient place for pilot plants
- the hotel provides the necessary technical equipment to support the research program.
- the hotel is connected to a municipal waste water treatment plant. In the case of operation troubles or reconstruction measures there will not occur any problems.
- the hotel has been granted different environmental awards and was certified according to DIN EN ISO 14001. This shows the commitment of the hotel management to a sustainable tourism.

**Main activities:**

A large closed-loop recycling waste water and solid waste is intended to be achieved by the activated membrane reactor the fermentation module.

The membrane module will produce industrial process water. Its suitability for irrigation, fertilization, and the hotel laundry will be investigated.

Cut grass, kitchen garbage and the surplus sludge will be treated in the fermentation reactor. This module will be optimized in terms of amount of produced biogas, quality of compost, and pre-treatment of the input materials.

A concept to make use of the biogas (i.e. decentralized power station) will not be realized at the moment.

**Comment on project funding:**

Since the tourism industry is an important economic factor in Germany, we are particularly responsible for supporting sustainable tourism. In a lot of touristic areas the situation is quite similar.

Due to the modular concept, an adaptation to various places and climatic zones seems to be easily realizable.

**Brazil (Dr. Sternad - Fraunhofer Gesellschaft, Institute for Interfacial Engineering and Biotechnology)**

**Topic:**

Decentralized water supply and waste water treatment combined with recovery of nutrients and energy under consideration of hygienic aspects for Piracicaba

Partner

Universidade Metodista de Piracicaba A. Nascimento

**Level of knowledge:**

Only 9.6 % of all South American bigger cities (> 50,000 inhabitants) treat their waste waters. In the city of Piracicaba (320,000 inhabitants) about 35 % of the waste waters are treated in 45

usually smaller treatment plants. The waste water is frequently treated in open ponds, so that the dengue fever and other tropical diseases have spread.

Solid waste is deposited on unsuitable dumps, no recycling has been applied up to now.

**Main activities:**

Waste Water:
Improvement of waste water treatment in Piracicaba.
- A study will be carried out regarding the optimization of existing treatment plants. They will be evaluated concerning the production of biogas, production of N-, P-fertilizers, disinfection of the effluents.

Most of the existing waste water treatment plants start with an anaerobic stage. (target: optimization of the anaerobic reactor.)
Most of the plants apply an aerobic reactor as second step. At the biggest waste water treatment plant (Piracicamirim) it is intended to install a closed pilot reactor developed in Germany.
Waste:
- A concept for the separation, recycling of waste, and production of biogas will be worked out. A pilot plant for the production of biogas will be constructed on the campus.

**Comment on project funding:**

The city of Piracicaba is considered a promising location in Latin America. The region has a good reputation regarding its commitment to environmental protection. The first environmental associations were founded in Piracicaba. So we are looking forward to finding highly motivated local authorities.

The concept developed by FhG strongly considers the local infrastructure which is characterized by a lot of small (decentralized!) plants, no space for enlargement, and frequently the above mentioned two-stage construction.

With the help of two pilot plants it is intended to show an economically efficient way to improve existing plants.

## Ghana (Dr. Geller - Ingenieurökologische Vereinigung e.V.)

**Topic:**

Ecological recycling management at the Valley View University in Accra

Partners:

| | |
|---|---|
| Bauhaus University of Weimar/ecological engineering | Prof. Dr. D. Glücklich |
| University of Hohenheim/Tropics center | Prof. Dr. J. Sauerborn |
| Valley View University | Dr. S. Laryea |

**Level of knowledge:**

- biggest private university of Ghana (about 710 students, 50 lecturers/administration)
- water supply is mainly managed by trucks because of the inefficient public supply
- no utilization of rainwater or water-saving technologies
- old-fashioned waste water treatment
- the university will be enlarged (2005: about 1300 students)

**Main activities:**

- The present concept for the enlargement of the university will be extended to an ecological master plan (subjects: urban development, transport; energy, water, and waste; social and cultural activities).
- Reconstruction of a building with water saving toilets, construction of a new building with water saving toilets, compost toilets, and utilization of gray water.
- Storage of rainwater in a cistern for irrigation
- Recycling of biowaste, compost, urine, in agriculture, production of biogas.

**Comment on project funding:**

This project addresses to a target group that is highly interested in new technologies. We expect this to be of great advantage to the implementation of the joint research results, because the graduates of the university will spread their acquired knowledge to their home countries.

It will be interesting to study the social acceptance and the technical advantages or disadvantages of different techniques (water-saving toilets, compost toilets etc.) applied at the same place.

The results of this cooperation will be incorporated into a new study course called “Community and International Development Studies” at the Valley View University.

## Projects in preparation

Four more projects are in preparation, which are briefly introduced in the following:

**China:**

This project is designed for rapidly growing urban areas. The most effective size of waste and waste water treatment plants will be determined regarding the recovery of energy and raw materials.

**Algeria:**

Waste water without or with little pretreatment will be reused to irrigate municipal areas to improve the air quality of the city of Algiers (i.e. along the main roads). The waste water will be taken directly from the sewer system. (GTZ cooperation).

**China/Tanzania:**

A new concept to obtain drinking water from the humidity of the air will be studied. The problem of the energy need will be solved by the exchange of radiation with the atmosphere.

**South Africa:**

Construction of a so-called “water house” designed for all water-related activities to improve the hygienic conditions in villages of developing countries.

# Demand on and difficulties for implementation of ecosan concepts in China

**Jian Zhang** Institute for Sustainable Technology, Zheda-Water - Zhejiang University Water Technology Co., Ltd.
e-mail: j.zhang@t-online.de

**Jun Chen** Zheda - Zhejiang University Enterprise Group

## Urbanisation and water pollution in China

The delayed family planning policy has resulted in a continuous population increase over one hundred years, and the social and economic development results in urbanisation. China is undergoing a precedent-less quick urbanisation process.

Summarizing various data sources the urbanisation in China can be reflected in the following figures.

| Year | 1980 | 1995 | 2010 |
|---|---|---|---|
| Urbanisation grade | 19.39% | 28.85% | Ca. 40 % |
| Urbanised population | 191 mio. | 352 mio. | Ca. 520 mio. |
| Cities | 223 cities | 640 cities | ? |

**Table 1:** Urbanisation in China

Uncontrolled exaction of groundwater resulted in significant decline of groundwater level. Municipal and industrial wastewater as well as runoff from farmland pollute the insufficiently available water resource. The shortage of clean water has become to an essential limiting factor for the social and economical development.

Currently in more than 70 % of the Chinese cities the clean water resource is scare. Most Chinese lakes in and near cities are overloaded by nutrients phosphor and nitrogen.

According to the official source the treatment rate of the wastewater in China nowadays is only 7 %. At the same time the urbanisation speed is 8.3 % with an increasing trend.

## Analysis of the countermeasures currently being implemented in China

In order to solve the problems China is undertaking the following measures in the field of urban construction:

1. Increasing the wastewater treatment rate with conventional European sanitation concept and centralised wastewater plants
2. Increasing reuse rate of effluents from the centralised wastewater treatment plants
3. South-water to northern projects

These measures are analysed and evaluated based on concrete examples. The results reveal the following problems:

1. According to both Chinese and European experiences the water pollution problem, particularly eutrophication problems in Chinese lakes cannot be sufficiently solved by the central-

ised wastewater plants, because of the very limited dilution possibilities and the huge difference between the nutrients concentration in effluents of wastewater plants and the requirement for surface water bodies.

2. Case studies showed that the possibility of reutilisation of effluents of wastewater plants is very limited in the praxis.
3. "South-Water to northern" can improve the water quantity situation in the northern cities but not the water quality situation. On another side, comparing the precipitation in northern Chinese cities with some European cities, for example with Berlin, it can be concluded that many northern cities are not absolutely water-"poor". A comprehensive water management including rainwater harvesting is much more necessary.
4. Ecological sanitation and source control of wastewater (Otterpohl, 2000 etc.) can be regarded as very sustainable solutions for Chinese urban areas, particularly for construction of the new settlement areas and sanitation of old downtowns.

## Comparison of south control measures with traditional sanitation concepts with preliminary model analysis

One of the typical pattern of urbanisation in China is the development of suburban area to urban area. A preliminary model analysis has been made for a new settlement with a total area of 10 km² and a projected population of 100,000.

The water consumption is divided into: drinking water, kitchen and shower water, washing water, toilette flushing water, water use in summer for green areas/facilities, road and street cleansing, water demand for scenery water bodies for compensation of evaporation loss, water used for construction, car washing etc.

Alternatives for water supply and treatment are compared with each other with cost estimates. The result shows the advantage of the source control concepts in ecological and economic terms.

## Implementation conditions

The acceptance in Chinese circles, particularly politicians for such as source control measures in urban construction is still very low. Reasons are many. One of the typical questions is that "we are learning European well proved experiences and concepts, these are centralised plants with thick pipelines".

Current regulations and financing systems in China for urban construction are analysed, suggestions for research and development works as well as possibilities for application of ecosan concepts are made.

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# New legislation for on-site sanitation in Finland*

**Harri Mattila**

Häme Polytechnic
Environmental Engineering
Visamäentie 35 B, FIN-13100 Hämeenlinna, Finland
e-mail: harri.mattila@hamk.fi

## Keywords

Legislation, on-site sanitation, wastewater management

## Abstract

Decentralised sanitation is very prominent in Finland at the moment. New legislation has caused and will cause further, number of changes in existing practices. These changes will cost billions of euros over the coming years.

The magnitude and speed of the development in the sector of decentralised sanitation is causing much confusion among authorities, manufacturers and other entrepreneurs and house owners.

Municipal authorities should now take a firm hold of the new tools (laws, decrees, municipal ordinances, etc.) and start requiring an improved standard of wastewater treatment also in rural areas. If they are not strict enough, they might lose the power of the new tools. It is easier to loosen one's grip in the future (if necessary) than to tighten it.

Workable solutions will require totally new thinking as regards services. There will be new types of companies, co-operatives and entrepreneurs producing wastewater services.

Composting toilets should be promoted more forcefully as an alternative in the process of selecting proper sanitation management. But the reputation of dry toilets must first be improved. We all have mental pictures of old earth toilets that were cold, dark, smelly and had flies. That is why dry toilets are not very much appreciated in Finland today.

## The need for on-site sanitation in Finland

The Finns have loaded their watercourses relatively heavily with different pollutants during the past decades. From about 1950 onwards, industrial development began, and the pulp and paper industry polluted badly certain rivers and lakes. At the same time, cities grew and the expansion of water distribution networks resulted in an extra load of wastewater on the same receiving waters. The use of artificial fertilisers in agriculture and forestry and subsequent leaching and runoffs into receiving waters has also increased. All these causes of pollution are now controlled to some extent. (Mattila, 2001)

Successive governments have supported rural areas in constructing drinking water supplies up to now, but wastewater treatment has been largely neglected. Now developers are working to keep the countryside alive, by trying to slow down migration from rural areas to cities. That is why farmers are supported in their efforts to process their products locally. And that is why there are projects aiming to improve the standard of the summer cottages to make them suitable for year-round living. The downside of these activities is that they increase the wastewater load on the watercourses[LHL1].

*This paper has been peer reviewed by the symposium scientific committee*

Wastewater treatment by industry, cities, and even villages, developed rapidly from the late 1960s to the early 1980s (see Figure 1). Today, diffuse pollution is the major concern in water protection. Watercourses downstream of big cities and industries are improving, but other waters are in danger of becoming contaminated, because they are receiving more nutrients, solids and even bacteria, than they can tolerate.

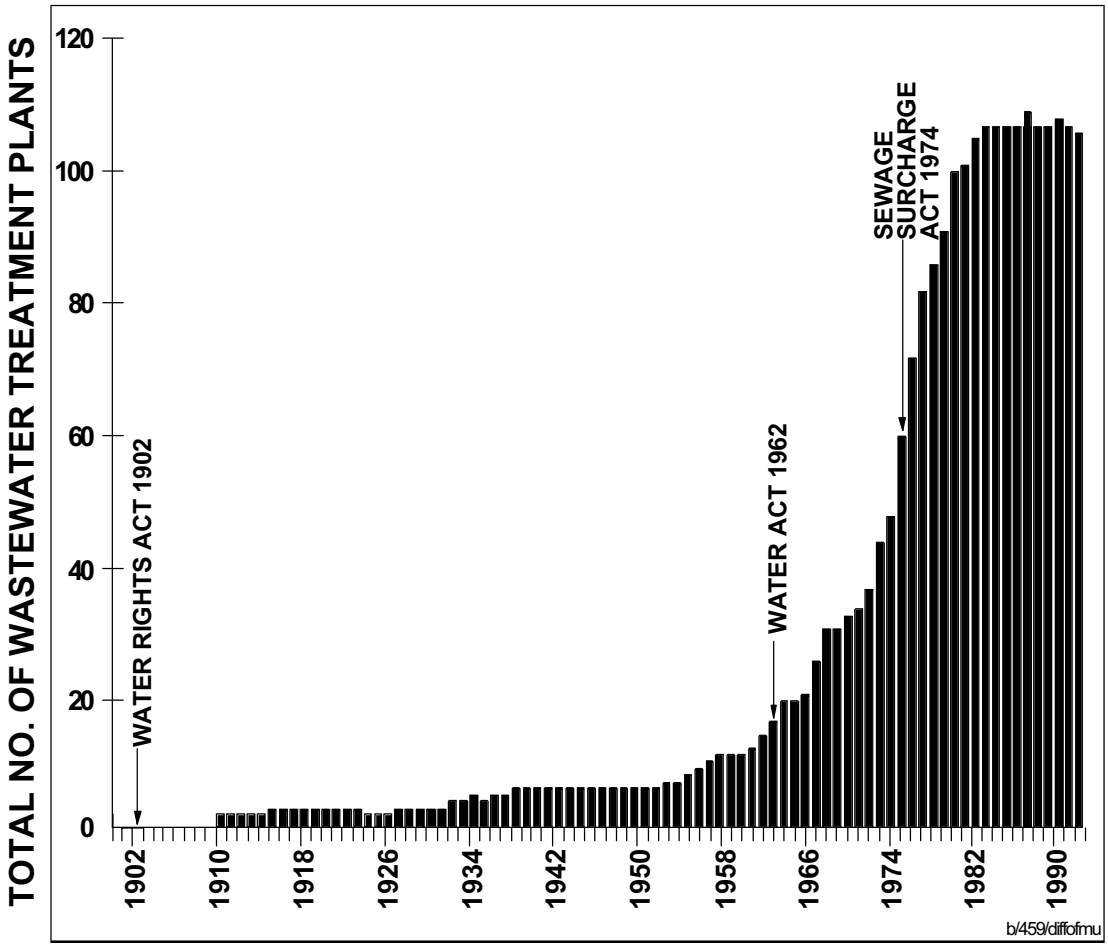


**Figure 1:** Number of wastewater treatment plants in cities in Finland (1900–1993) (Katko and Lehtonen 1999).

Because of the major sources of pollution mentioned above, the wastewater load from individual households outside of sewer networks has so far been neglected. Even the Finnish Water Act has become outdated in this regard. Until February 2000, it was only acceptable to treat wastewater in septic tanks. Yet, it is known that even properly working septic tanks can only remove a maximum of 70% of the solid matter in wastewater (Mäkinen 1983; Santala 1990). Dissolved impurities flow freely into the environment, often directly into a ditch or a river.

National targets for water protection in Finland until 2005 were set in 1998. The targets for scattered settlements are ambitious. The BOD load should be reduced by 60% and the phosphorus load by 30% (Ministry of the Environment 1999).

There is also a real need of on-site sanitation in Finland for technical and economical reasons. With a population density of about 17.3 /km$^2$ for the whole country and only about 11.7 /km$^2$ outside of the capital area, it is clear that the centralised systems would be either too complicated, too expensive, or both in many areas.

## The changed on-site sanitation legislation

The **Environmental Protection Act** was amended on 1 March 2000 to meet the targets for 2005. The new act states that wastewater in rural areas must be treated to the extent that it cannot have a negative impact on the environment. The treatment technology, or even the methodology, is not specified in the law, but municipalities are given the right to issue local ordinances on these matters based on local circumstances. On the other hand, municipalities are also responsible for controlling the quality of wastewater treatment in their areas.

The Environmental Protection Act also has some other important sections dealing with on-site sanitation.

The general principles of the Environmental Protection Act are:

- environmental damages must be prevented beforehand
- environmental damages must be minimised
- people must exercise caution in their actions
- BAT (Best Available Technology) must be applied
- BEP (Best Environmental Practices) must be applied
- the one causing environmental damages must also pay for the rehabilitation.

The Environmental Protection Act gives the Ministry of the Environment the right to issue a decree on wastewater treatment in rural areas. Such a decree was ratified on the 11th of June 2003 and it will come into force on the 1st of January 2004.

According to the decree (Committee of Ministry of the Environment 2001):

- Wastewater must be treated so that
  - BOD load is diminished by 90 %,
  - total phosphorous content by 85 % and
  - total nitrogen content by 40 %.

  The measured effluent quality will be compared with the so-called house-specific wastewater load. It can be calculated by multiplying the number of occupants of a house by the average wastewater load per person and day which is equivalent to 50 g of $BOD_7$ and 2.2 g of total phosphorous plus 14 g of total nitrogen.
- A municipality can lower the percentages to 80 % (BOD), 70 % (P) and 30 % (N) in an area which is not very sensible as to environmental damages.
- Each and every household without a sewer connection must have a written (and drawn) description of its wastewater treatment system.
- Each wastewater treatment system must be designed according to the guidelines given in the decree.
- Sludges from septic tanks, other treatment units and containers must be collected from the properties like solid wastes. Thus, the municipality must organise centralised collection if the house owner cannot show he has made a contract concerning the collection with a company or an entrepreneur.
- The decree must be followed immediately from the beginning of 2004 with regard to new houses and within ten years with regard to existing houses.

The Environmental Protection Act gives municipalities the right to issue local environmental ordinances according to local circumstances. This means that a municipality can, for example, deny water closets in a certain area where water or groundwater pollution could seriously contaminate water supplies or, for example, nature.

Further, the Environmental Protection Act gives the municipal environmental authority the right to make inspections on site. If there is sufficient reason, the authority can demand improvements, for example, to the wastewater treatment system.

According to the Environmental Protection Act, it is not permissible to spoil the quality of groundwater or the soil. This is a quite important fact to remember when designing soil treatment systems for wastewaters.

The **Water Supply Act** is another new law affecting the sanitary solutions in rural areas. The act states that municipalities must have a Development Plan for Water Supply Services approved by the end of February 2004. This is the most essential section of the act. In the development plan municipalities are to present time schedules for the expansion of water and wastewater supply networks in the near future. This will provide the properties now outside of the networks valuable information the kind of technology and the size of investment reasonable for them.

According to the Water Supply Act, all the properties within the operational area of a water supply company have, on the one hand, the right to be served by the supply and, on the other, the responsibility to connect themselves to the network.

The **Land Use and Building Act** is a new act as well. It has the aim of improved quality of planning and construction. A design of a new house with a design of an on-site sanitation system must be approved by the municipal authority before the construction. Some of the sections of the act deal with the qualifications of persons involved in the construction business.

Quite an interesting and valuable section of the Land Use and Building Act is the one requiring that all new houses must have operation and maintenance guidelines in written form. These would be beneficial in the case of old houses and their equipment as well.

The **Health Care Act** gives the municipal health authority the right to make inspections on site. If some defects that could possibly cause health problems are found, the authority can demand improvements, for example, to the wastewater treatme nt system.

## Will the new legislation be followed?

The mentioned acts as well as some lesser acts will lead to quite an improvement in on-site sanitation in Finland in the near future, especially if the municipal authorities are willing to use the available tools.

Figure 2 shows the changed situation with respect to the legislation concerning of on-site sanitation in Finland. The practical application of the new acts might be difficult in those Finnish rural areas where municipalities have few inhabitants. Thus, it may not always be easy for local politicians to set strict enough requirements: on-site wastewater treatment always means extra costs to households.

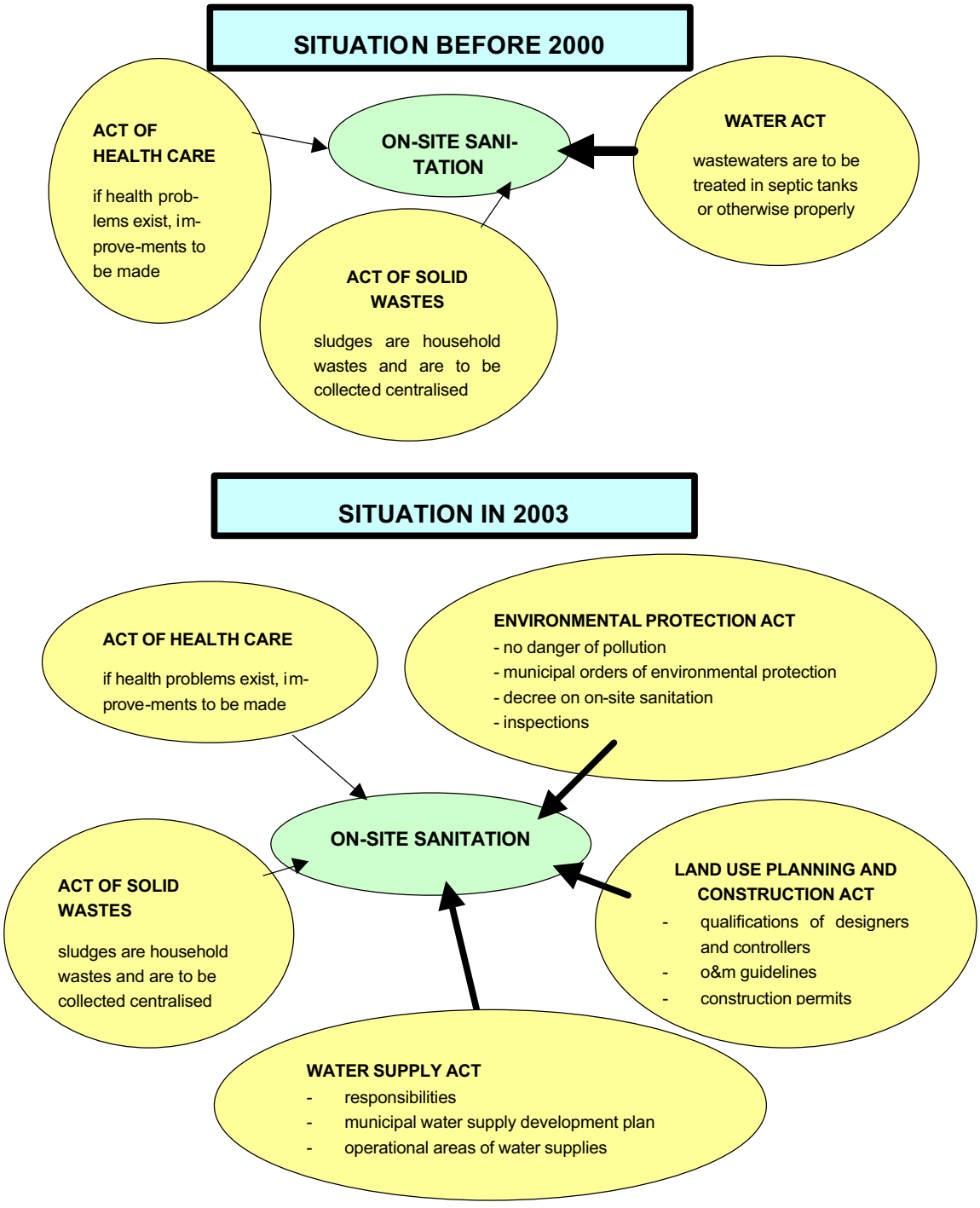


**Figure 2:** The changes in legislation for on-site sanitation in Finland

However difficult it will be to apply the new legal tools to achieve better on-site sanitation in municipalities, the authorities should be quite strict when doing so. If even the weakest tool is broken the stronger ones can also become useless.

## New services are required

As long as on-site sanitation means wastewater (especially black wastewater) treatment on the property, house owners themselves cannot assume responsibility for designing, constructing, operating and maintaining the treatment units. In many cases even the septic tanks have proven too difficult to them to take care of, not to speak of more complicated systems.

Thus, successful on-site sanitation requires new actors to be involved. There are some 350,000 houses and 450,000 summer cottages outside of sewer networks in Finland (Committee of Ministry of the Environment 2001). Even though the sites are many, it is obvious that the big consultancy and construction companies are not very interested in tendering for this type of work where the unit prices are minimal.

Due to the new legislation on wastewater treatment in rural areas, product development work is very intensive in companies manufacturing treatment units. The BAT principle of the Environmental Protection Act requires that a person maintaining on-site sanitation systems must be a professional. Only a person involved in the sector daily knows always what is the newest and best technology for the property in question.

There are so many properties with on-site sanitation systems in municipalities that the municipal environmental protection authority cannot visit all of them to exert control. That is why control of the type in Figure 3 is suggested. The professional performing the maintenance on the on-site system reports major needs for repairs and other bigger undertakings not only to the house owner but also to the municipal authority. The authority can then make a control visit to the properties time allowing.

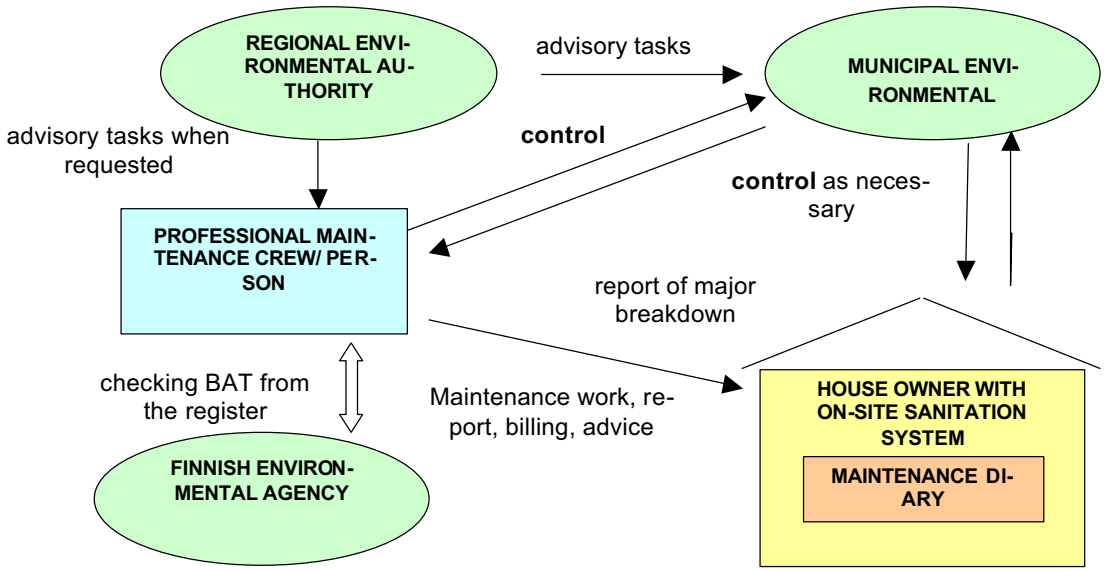


**Figure 3:** Proposed control system for on-site sanitation (proposal by the author)

In future, the Finnish Environmental Authority (FEA) is to keep a register of the on-site sanitation systems which meet the requirements of the decree on wastewater treatment in rural areas (Committee of Ministry of the Environment 2001). That will ensure that BAT is used as far as possible.

The Regional Environmental Authorities (REA) are given an advisory role in the process. They have the latest information on, for example, the legal and financial aspects.

Of course, all the parties can consult FEA when-ever necessary. And the houseowner can contact REA to check, for example, the possibilities of getting financial aid for investments.

## The dry toilet could solve water protection problems

Most of the nutrients, especially in black wastewaters, come from urine and faeces (Table1).

| | BOD | | P | | N | |
|---|---|---|---|---|---|---|
| | g/pd | % | g/pd | % | g/pd | % |
| faeces | 15 | 30 | 0.6 | 30 | 1.5 | 10 |
| urine | 5 | 10 | 1.2 | 50 | 11.5 | 80 |
| grey water | 30 | 60 | 0.4 | 20 | 1.0 | 10 |
| total | 50 | 100 | 2.2 | 100 | 14 | 100 |

**Table 1:** Content of black wastewater (Committee of Ministry of the Environment 2001)

Considering the requirements of the decree on wastewater treatment in rural areas (page 3), it becomes obvious that the utilisation of dry toilet technology could help meeting the targets of water protection.

Treatment of grey wastewater is much easier than that of black wastewater. In most cases grey water infiltration would be successful, and if not, there are several rather simple treatment units for sale purifying them.

There is dire need to promote the use of dry toilets in Finland. In this country of tens of thousands of lakes the recreational use of water courses is quite popular during the summer. The problem is the very low discharge of smaller streams and rivers in midsummer which is the season for their recreational usage. When there is little natural flow, the bigger portion of the flow consists of wastewaters. This means that the bacteriological quality of waters is not satisfactory. If black wastewater is not led into ditches and rivers the situation improves significantly.

Yet, it is not too easy to promote the use of dry toilets in Finland. The time people still used traditional earth toilets is not too far behind. Their use in the cold climate with the associated smell and flies do not bring back fond memories. Thus, we should develop the existing composting toilets to bring them up to a level where they can truly compete with the comfort of water toilets. But even this is not enough: powerful marketing efforts are also required to make the new toilet technology popular.

## Conclusions

The existing acts and other legal tools are sufficient for solving the wastewater problems of Finnish rural areas. It is more a question of common will and appropriate management solutions than inadequate tools. Municipal authorities should now take a firm hold of these new tools and start insisting on an improved standard of wastewater treatment in their areas.

The design, construction, operation and maintenance of on-site sanitation systems cannot be made the sole duty of homeowners. The appropriate solutions will require totally new thinking as regards services. There will be new types of companies, co-operatives and entrepreneurs producing wastewater services for consumers.

Until now, the sanitation of rural areas has not been controlled carefully enough. The new tools also make control of the work possible, if so desired.

We should promote composting toilets more forcefully as an alternative in proper wastewater management. There is no sense in mixing pure tap water with faeces and trying to separate them some 10 meters away on the other side of the wall. But the reputation of dry toilets must

first be improved. We all have mental pictures of old earth toilets that were cold, dark, smelly and had flies. That is why dry toilets are not very much appreciated in Finland today.

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# Key-activities, services and current pilot projects of the international ecosan programme of GTZ*

**Christine Werner, Heinz-Peter Mang, Ve Kessen**

GTZ ecosan project
Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH
Dag-Hammarskjöld-Weg 1-5, 65726 Eschborn, Germany
internet: http://www.gtz.de/ecosan
e-mail: christine.werner@gtz.de

## Keywords

Ecological sanitation programme activities, knowledge management, advocacy and networking, ecological sanitation pilot projects

## Abstract

The GTZ started its international ecosan research and development project in May 2001 and is financed by the German Federal Ministry for Economic Cooperation and Development (BMZ). The aim of this project lies in promoting the development and pilot application of integral ecologically, economically and socially sustainable recycling-based wastewater and sanitation concepts in developing countries. Furthermore it aims at contributing to the global dissemination and application of ecosan approaches and establishing these internationally as state-of-the-art techniques – in both developing and in industrial nations.

## Introduction

German development co-operation considers ecosan, including rainwater harvesting, as a new approach representing a series of technologies that are important in order to resolve the increasingly urgent problems related to the global water crisis. These approaches should serve as a key element in finding the necessary solutions if we are realistically to have any hope of achieving the Millennium Development Goals (MDG) in water supply and sanitation of halving the proportion of poor people without access to safe water and sanitation by 2015, and to contribute tremendously to environmental protection, sustainable natural resources management and safeguarding our future food security on earth.

The GTZ started its international ecosan research and development project in May 2001, with the project being financed by the German Federal Ministry for Economic Cooperation and Development (BMZ). The aim of the project is to promote the development and pilot application of integrated ecologically, economically and socially sustainable recycling-based wastewater and sanitation concepts in developing countries. Furthermore it aims at contributing to the global dissemination and application of ecosan approaches and establish these internationally as state-of-the-art techniques, in both developing and industrial nations, and at mainstreaming ecosan-approaches into technical and financial German development co-operation.

Ideally, ecosan systems enable an almost complete recovery of all organic nutrients and trace elements contained in domestic wastewater. Appropriately treated, such raw materials can be returned to agricultural processes, where they help maintain soil fertility and ensure long-term food security. At the same time, ecosan systems contribute to the conservation of our water resources and to reducing water-related environmental pollution and health risks.

*This paper has been peer reviewed by the symposium scientific committee

## Key activities of the GTZ ecosan project

### Know how management and networking

In co-operation with international and local partners, the ecosan project collates existing know-how so that existing experience on ecological sanitation can be used and further developed. This knowledge may include publications and practical know-how from users and experts on established as well as new ecosan specific developments, the problems encountered, news of successful projects, research findings and much more.

The ecosan project promotes the systematic development of a global sector-specific network of people, institutions and projects. It addresses experts, potential users and decision-makers who are looking for information, seeking concrete answers to specific questions, in need of decision-making tools or looking for contacts.

The GTZ ecosan project supports this network in several ways:

- e-newsletter

  Since June 2001, the ecosan project has been producing a multilingual electronic newsletter (in English, German, Spanish and French); it contains news of interesting new developments in ecological sanitation, information on, and downloading options for, current publications, details of upcoming events, contacts and interesting links, plus a sector forum for communicating with a readership of several thousand. The electronic GTZ ecosan newsletter appears quarterly. You can subscribe to the newsletter by sending an e-mail containing the words “subscribe ecosan” to majordomo@mailserv.gtz.de

- ecosan website

  Current information on closed-loop wastewater management and sanitation is available in German and English at: www.gtz.de/ecosan.

- ecosan project data sheets

  in cooperation with the SIDA (Swedish International Development Cooperation Agency) funded EcoSanRes-Programme of the SEI (Stockholm Environment Institute) and other partners, the GTZ-ecosan-project is compiling and constantly extending an overview list of existing pilot and research projects. Additionally, information concerning interesting and exemplary projects will be realised in the form of project data sheets.

- ecosan technologies data sheets

  with the support of the technical working group, the gtz-ecosan-project is elaborating technology data sheets on various ecosan-components.

- other publications on ecosan

  ecosan-experiences and know-how are published by the ecosan-project along with brochures, posters, magazines, technical publications, films and other media

- conferences and workshops

  Organization of, and participation in, international events and workshops.

  (The 1st and 2nd international symposia on ecological sanitation Bonn 2000 and Lübeck 2003, 1st international conference on ecological sanitation, Nanning, China 2001, and many others.)

- co-operation in the field

  to advance ecosan ideas and to ensure that practical applications of ecosan result in good practise, a close co-operation between the experts working in the new field of ecosan and a

constant exchange of views and experiences between them is needed. The GTZ supports this co-operation through the exchange of experts between projects, through common evaluations, local workshops, and through the joint development and implementation of pilot projects.

- national and international working groups

  This involves the initiation and coordination of expert working groups as project think-tanks, to establish basic materials and develop model ecosan concepts. So far a German-speaking technology working group has been established to compile, discuss and further develop various ecosan suitable technologies. Another international working-group for the subject of participation, awareness raising and education in the field of ecosan-promotion is in preparation in order to develop strategies, guidelines and tools for application in ecosan-projects.

## Design and implementation of pilot projects

The design and implementation of research and demonstration projects with a focus on urban areas is the second main focus of the GTZ's ecosan project. The aim of such pilot projects is to arrive at cost-effective, user-needs-oriented, practical ecosan solutions, which benefit users. In addition to addressing sanitation technology issues, another essential component of ecosan pilot projects are the concepts needed for the safe agricultural and horticultural application of the recovered products. Market analyses and suitable marketing strategies for the recovered recyclates are also necessary. Cost comparisons with conventional systems are just as important as the development of training modules for users, service enterprises and farmers, and health education measures.

At present, pilot demonstration projects are being prepared or implemented with the support of the GTZ- ecosan project in more than 20 countries. As the overall budget of the international GTZ ecosan project is limited, the main activities lie in laying the foundations for projects by researching, preparing and elaborating a financing concept as well as supporting the elaboration of baseline-studies, feasibility studies and project proposals which may be submitted to financing agencies or investors. Also ecosan-consultancy and knowledge management during the project implementation phase is offered.

Implementation on a larger scale and particularly in urban areas demands larger investments, as well as additional financing for the planning and development of innovative solutions, awareness raising and community participation. More funds are necessary if scientific research also forms a part of the project along with the promotion of agricultural use. Therefore, a commitment and budget is needed from local communities, bilateral German technical or financial cooperation, research programmes, other donor agencies or private investors.

## Ecosan pilot projects supported by German Development Cooperation

### Botswana - ecological sanitation as an element of sustainable natural resources management

In many African countries, including Botswana, conventional forms of wastewater disposal have drawbacks for the general population. Most households located outside the major urban centres are not connected to any existing waste management and sanitation system. Droughts and inadequate water resources make an already unsatisfactory situation even worse.

Over the next five years, a project devoted to sustainable regional resource management will be co-operating with local authorities, the International Union for the Conservation of Nature (IUCN) and the German Development Service (DED) to develop, test and demonstrate sustainable, decentralized wastewater management and sanitation systems and methods. Initially, private households in the districts of Ghanzi, Gaborone and Serowe are to be tied into the research activities. Later, the approach will be extended to the municipal level. One of the aims of this GTZ-project is to recover nutrients and trace elements from domestic wastewater, faeces and urine for use in agriculture. This not only contributes toward long-term food security, but also provides the people with an opportunity to earn extra money.

**Figure 1:** Workshop on village level

## Egypt – Soilization of sewage sludge

In many countries, the use of sewage sludge in agriculture is thwarted either by the complexity of the processing technology or by the poor quality of the sludge, which arouses very little interest among farmers for its use as a soul conditioner. In Egypt, the GTZ has therefore supported a large scale field test, carried out by IPP Consult, of a process of sewage and faecal sludge upgrading, or soilization, by means of sewing sludge polders with grass or common reed. The results are promising and the process will be introduced in other ongoing ecosan pilot projects of GTZ in Kafr el Sheikh in Egypt and in Mali:

- process technology is easy to manage and economical
- structural, aesthetic and hygienic attributes of the soilised sludge are superior to those of dried sludge
- soilised products find more acceptance and the market potential is improved

**Figure 2:** Large scale test on soilisation of sewage sludge with plants

## Mali - On-plot ecosan systems for the treatment of faeces, urine and greywater

Koulikoro has a central potable water supply system dating from the 1970s, but as yet no sewage system. In an arid sub-Saharan country like Mali, where financial and water resources are scarce, a water-carried sewage system resembling those used in Europe would be inappropriate and too expensive. Mali is also faced with the steadily worsening problem of soil degradation, including desertification, chiefly as a result of agricultural overuse and an insufficient return of nutrients.

**Figure 3:** Greywater garden and experimental sanitation module

An affordable means of proper wastewater disposal is needed. The GTZ has therefore developed an on-plot household ecosan system in which faeces, urine and greywater are separately collected and treated. This offers major advantages over conventional latrine-based systems, as it enables the hygienic recovery of soil amending substances from faeces and of nutrients from urine and purified greywater. The ecosan system is also in harmony with local traditions. In 2002, the National sewage and Solid Waste Department at the Malian Ministry of the Environment incorporated the grey-water gardens and separating toilets developed by the ecosan initiative into its program. Together with the GTZ, the department is now examining their suitability for a widespread introduction. Ultimately, however, the success of grey-water gardens depends solely on the degree to which they are accepted by women for growing vegetables, bananas and papayas. At present, preparations are being made within a GTZ-supported decentralisation programme in a 2nd region, for a further development of this ecosan concept and its dissemination in 19 densely populated urban areas with between 2.000 to 130.00 inhabitants.

## China - Municipal ecosan concepts in a Beijing suburb

Located in one of Beijing's three river basins, Yang Song covers a little more than three square kilometres and is home to some 21,000 people. With its intensive livestock farming and grain and vegetable production, the region is a major source of food for the city of Beijing. The community currently produces roughly 15 tonnes of solid waste each day. Less than 10 % of the town's wastewater is treated prior to being discharged into the rivers or groundwater. Within the scope of a local ecosan project, the community is to be provided with a modern, material-separating disposal and recycling concept for wastewater and organic wastes that is in line with the

**Figure 4:** Model of Yangsong Development Plan

principles of closed-loop wastewater management and sanitation. The GTZ, Chinese and German scientists and companies are working together to analyse and compare different sanitation, wastewater treatment and recycling options in various harmonized systems. The cost-effective recovery of useful materials and energy is the main objective

There are also plans to use water-saving vacuum technology and urine separation systems. Organic waste from kitchens and markets will be collected, shredded and, finally, fermented in a bioreactor system. The resultant fertilizer and hygienized urine will be suitable for use in growing flowers and vegetables. Greywater will be used for watering public parks and gardens.

**Figure 5:** New housing area in Yang Song

## Cuba – ecosan research into non centralized applications

Throughout Cuba, and particularly in urban areas, the wastewater management and sanitation systems lack capacity and are in urgent need of rehabilitation. Most notably in peri-urban areas with considerable agricultural activity, the soil, groundwater and watercourses are heavily polluted. As a result, health conditions and odour-nuisance levels are critical in many places.

Moreover, many households do not have access to electricity. This forces many people to use ecologically questionable forms of fuel for there everyday needs.

To address the situation, a GTZ-supported ecosan research project is conducting field tests on various household sanitation systems and looking for appropriate-technology solutions that may generate cooking energy. For example, on several city farms in two different project regions, the utilization of household sewage and organic waste is being integrated into the in-house production of fertilizer and cooking energy. In a third region, pre-fabricated components are being designed and developed for diverse decentralized disposal systems, and in a fourth region, different ecosan systems are being implemented in urban centres. The four regions in question are located in different parts of the island to ensure the study of the representative of the island's diverse climatic, structural and social conditions.

**Figure 6:** A common type of agricultural biogas plant in Cuba consisting of a long plastic tunnel with an in- and outlet made of concrete tubes:

## Ecological sanitation concept in Lesotho, water borne closed loop

Lesotho is selling drinking water to South Africa, but in their capital Maseru, high quality drinking water is scarce. Groundwater and lake water pollution in the city area was measured and pit latrines and septic tank overflows have been identified as contaminating source. The rocky underground is impermeable. At the other side, the large urban housing plots could be more efficiently used for urban agriculture and gardening, a need in a land where the arable space is under pressure. The central sewage treatment system is under loaded, because only a small part of Maseru city is connected and even half this sewer-connected area does not reach the treatment plant, as the pumping station has not been functioning for several years due tom high operation costs and technical difficulties, which has resulted in a shortcut of the used untreated water to the border river.

Supported by the German Embassy, the German Development Service (DED) is realising some training and demonstration measures for household centred and community based closed loop on plot reuse of all wastewater and nutrients, driven by a market oriented sanitation approach.

**Figure 7:** Construction work in Lesotho

The first system consists of a small bore sewer grid for eight houses (40 persons), a biogas-septic tank unit, an upflow filter based on recycled plastic bottles, a wetland, 800m² vegetable and fruit garden, and two household connections for the biogas as a full cooking energy source (for two families), has been installed and has been in service for one year. Moreover, the organic waste of the whole neighbourhood is composted in the garden area. The demonstration has shown, that year round gardening is possible, with higher yields and quality than only rainwater dependent agriculture and much cheaper than the use of piped fresh water for irrigation with additional fertilizer use. Driven by private demand and investment, an extension of similar systems for individual households and neighbourhoods (3-10 houses) is ongoing. Due to the German support, each site is actually used for training of private constructors and engineers, even from South Africa.

As the non-separation of streams results in a potential over-fertilisation of the garden area, and as first results of the pilot unit show that the biogas-septic tank unit could be smaller with the same energy efficiency if the hydraulic charge is lowered, the next steps planned are the stream separation of grey water and black water and the subsequent introduction of urine diversion. However, this last step will only be taken, when the gardening and urban agricultural demand is established and the liquid fertiliser demand is stabilised.

## Further projects in preparation

Other projects are presently being prepared with the support of GTZ-ecosan in several other countries, where advocacy workshops, baseline and feasibility-studies are currently running or being organised:


**Figure 8:** Further projects in preparation

## Conclusion

The joint development and implementation of, mainly urban, pilot projects with other international and local partners in developing countries are a major pillar of the GTZ ecosan project. Pilot projects are indispensable, firstly because a great deal of research and development is still necessary to develop economical, workable and replicable ecosan solutions geared to user needs in urban areas and, secondly, because successful demonstration projects are the best publicity for recycling-based strategies.

Public relations, also via functioning demonstration projects, are enormously important for the successful and sustainable application of new eco-sanitation systems and their acceptance by the actors concerned. These actors include, on the one hand, the users, whose awareness, habits, convenience standards, finances and technical ability must be catered for in developing and implementing ecosan strategies, but also the private sector, public institutions and political decision-makers. The basic idea is to alter perception and concepts: Solid waste and wastewater should be seen primarily as resources containing nutrients rather than waste loads or pollutants.

In addition to addressing technological issues in wastewater disposal, the development work still needs to underpin new integral wastewater and sanitation strategies tailored to various framework conditions by way of pilot projects, including a range of investigations into the hygienic application of recyclates in agriculture and horticulture. There is also a need to prepare market analyses and develop suitable marketing strategies for the recovered recyclates. It is equally necessary to make economic comparisons with conventional systems, as it is to develop training modules for users, service enterprises and farmers as well as measures in health and hygiene education.

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GTZ-ecosan project (August 2002) recycling beats disposal –flyer

Internal information of GTZ

# EcoSanRes – a Swedish international ecosan programme

**Arno Rosemarin**

Stockholm Environment Institute
Box 2142, 103 14 Stockholm, Sweden
internet: http://www.sei.se/
internet: www.ecosanres.org
e-mail: arno.rosemarin@sei.se

## Keywords

Ecosan, ecological sanitation, EcoSanRes, Sweden, global, pilot projects

## Abstract

Now that sanitation has made it to the global agenda and that it is one of the Millenium Development Goals, sustainable alternatives to conventional practice need to be brought forward. Up to now the sector has not benefited from the 15-year learning curve on sustainable development. Ecological sanitation provides a battery of choices to communities both rich and poor and features source-separation and containment of human excreta, sanitization and recycling, all of which conventional approaches fail to do. Most of the world practices unsafe, and unsustainable sanitation and only an elite group of countries can afford to build and maintain sewage collection and treatment systems. The EcoSanRes programme has been set up by Sida in Sweden to develop ecological sanitation methods and promote these through full-scale pilot projects in selected developing countries. The outcome of this work will help meet the global needs for improved sanitation using safe, environment-friendly approaches that everyone can afford.

## The sanitation crisis and the ecosan challenge

There are at least 2.4 billion people in the world without improved sanitation (defined by the World Health Organization as connection to a public sewer, connection to a septic system, a pour-flush latrine, a simple pit latrine or a ventilated improved pit latrine), primarily residing in rural Asia and Africa. But technically, even access to “improved” sanitation does not solve the problem because conventional pit latrines usually fail to sanitize and they contribute to groundwater pollution. Also, septic systems and sewage treatment plants often discharge into the environment with little or no sanitization or nutrient removal. So in actuality, far more than 2.4 billion people need to gain access to effective and sustainable sanitation.

Taking a somewhat radical view and considering that conventional solutions like pit latrines serving some 2.8 billion people, are often both health and environmental hazards, and that 70% of the sewage systems in the world, serving about 1 billion people, are often dysfunctional, the global sanitation crisis involves most of humanity (Matsui, 2002). Sanitation has somehow escaped entirely the debate on sustainable development. Thus the ecosan challenge is really of global proportion.

## Reaching the WSSD target

The UN World Summit on Sustainable Development (WSSD) in Johannesburg, South Africa in autumn 2002, articulated several targets for the coming decade. Among them, “halve, by the year 2015, the proportion of people that do not have access to basic sanitation”. This has been built into the UN Millennium Development Goals project within the Task Force on Water and

Sanitation. An initial background document has been released (Millenium Project, 2003). An action plan will be produced in 2005.

The World Summit for Children in 1990 called for universal sanitation by 2000. With significant effort, the 1990s saw a ten percent increase in global sanitation coverage, rising from 51%-61%, meaning an additional one billion people gained access to improved sanitation. However, the discrepancy between rural and urban sanitation improvement is high, with urban sanitation coverage consistently eclipsing rural sanitation coverage, where 80% of the people without sanitation live. Realizing that population growth is increasing, and that in addition to ensuring the 1.2 billion people in need of sanitation gain access, we must also secure sanitation for the expanding population – projected growth is about 20% by 2015 – the WSSD targets are less idealistic than the World Summit for Children goals, calling for universal sanitation coverage by the year 2025. Still, the consistent delay in reaching international sanitation goals should not be overlooked. The present timeline has already been pushed back 25 years since the status of sanitation in the world reached a crisis level almost 15 years ago. More than 4 billion people will need to gain access to basic sanitation to meet the 2025 target for universal coverage, according to the Global Water Supply and Sanitation Assessment 2000 Report (WHO, UNICEF, WSSCC, 2000).

## No sanitation is dangerous

The health risks of a lack of, or inadequate, sanitation are mortal. The Framework for Action on Water and Sanitation, produced in conjunction with the WSSD, indicates close to 6,000 children die each day from diseases related to inadequate sanitation and hygiene, and a lack of access to safe drinking water. “In China, India and Indonesia, twice as many people are dying from diarrhoeal diseases as from HIV/AIDS” (WEHAB, 2002).

“Approximately 4 billion cases of diarrhoea each year cause 2.2 million deaths, mostly among children under the age of five. This is equivalent to one child dying every 15 seconds, or 20 jumbo jets crashing every day”, states the Global Assessment on Water and Sanitation 2000 Report. Other indicators of health risks associated with poor sanitation are the frequency of related parasites that have human faecal origin – about 1 billion people are infected with roundworm and 700 million with hookworm.

Uncontained and untreated human excreta pollute groundwater, streams, lakes and coastal zones, helping to perpetuate the cycle of human disease and upsetting fragile aquatic ecosystems by nutrient overloading and eutrophication. Just the need to “close the loop” on nutrients dictates the necessary paradigm shift toward sustainable sanitation. The health risks of conventional approaches are calling for immediate global action.

## Inadequate sewage treatment creates problems downstream

The United States operates close to 100 million flush toilets, averaging 15-19 litres of freshwater per flush as a means to transport human excreta. Conventional sewerage is not a sustainable sanitation system, even for wealthy countries. Sweden, with a population of less than 9 million, produces about 1 million tons of wet sludge each year, most of which cannot be recycled to forests or agriculture due to heavy metal contamination. Of 540 major European Union cities, only 79 have advanced sewage treatment and 45% have either no treatment or incomplete primary or secondary treatment (EU, 2001). In February 2002, the European Commission took legal action against France, Greece, Germany, Ireland, Luxembourg, Belgium, Spain and the United Kingdom for alleged failure to implement various environmental laws for water quality protection. Of the 1 billion people that have flush toilets in the world, only 30% receive advanced sewage treatment (Matsui, 2002).

For developing countries attempting to use conventional flush sewerage systems, the situation is worsened by the resulting surface and groundwater pollution, resulting in an estimated 1 billion people left without access to clean drinking water.

## Socio-economic impact

According to the Water Supply and Sanitation Collaborative Council's Vision 21, "recognition of water and sanitation as basic human rights, and of hygiene as a prerequisite…form a major component in poverty reduction".

Hygiene, safe water and sanitation are fundamental human rights. Ecological sanitation can improve social and economic conditions for all, especially for impoverished communities. Ecosan offers empowerment and safety, particularly to women and girls in urban and peri-urban areas that are often without sanitation, by providing a private and dignified environment for urinating and defecating. The use of sanitized human excreta as a fertilizer stimulates crop growth and, as a result, increases nutrition for those who depend on subsistence farming, or helps to generate or supplement income for those who sell the products they grow.

## The challenges

Because 80% of the people without adequate sanitation (2 billion) live in rural areas – 1.3 billion of those in China and India – the barriers to communication present a significant impediment to informing these people about ecological sanitation. Television advertising, newspapers or printed material do not reach most of these people. Government services make infrequent calls to remote areas and NGOs serve a small segment of this population. Instead, most information is exchanged through face-to-face communication. How can we spread the message about sanitation alternatives and improved hygiene behaviour to such a large number of people living outside the reach of familiar communication channels?

## Need for alternatives

Even if the sanitation crisis can be communicated to and understood by more people, the need to find sustainable alternatives to conventional approaches for both developed and developing countries remains. Sustainable and ecological sanitation requires a holistic approach, building on the intimate relationship between ***people and soil***. Sanitation cannot be a linear process where excreta is hidden in deep pits or flushed untreated downstream to other communities and ecosystems.

## Ecological sanitation

Ecological sanitation provides alternative solutions with or without water, while providing ***containment, treatment and recycling*** of excreta. It can involve soil-based composting toilets in shallow reinforced pits, dry urine-diverting toilets with storage vaults, urine-diverting mini-flush toilets and even high-tech vacuum systems. Cost-effective ecosan can be adapted for developing and developed countries. In arid zones, water resources can be saved for more important needs like personal hygiene and growing food. In humid areas with high water tables, above-ground and shallow ecosan systems can remain functional during seasonal floods. Ecosan provides human health and environmental protection using affordable and appropriate technologies to match the needs of the entire world. Figure 1 illustrates the ideal ecosan model.

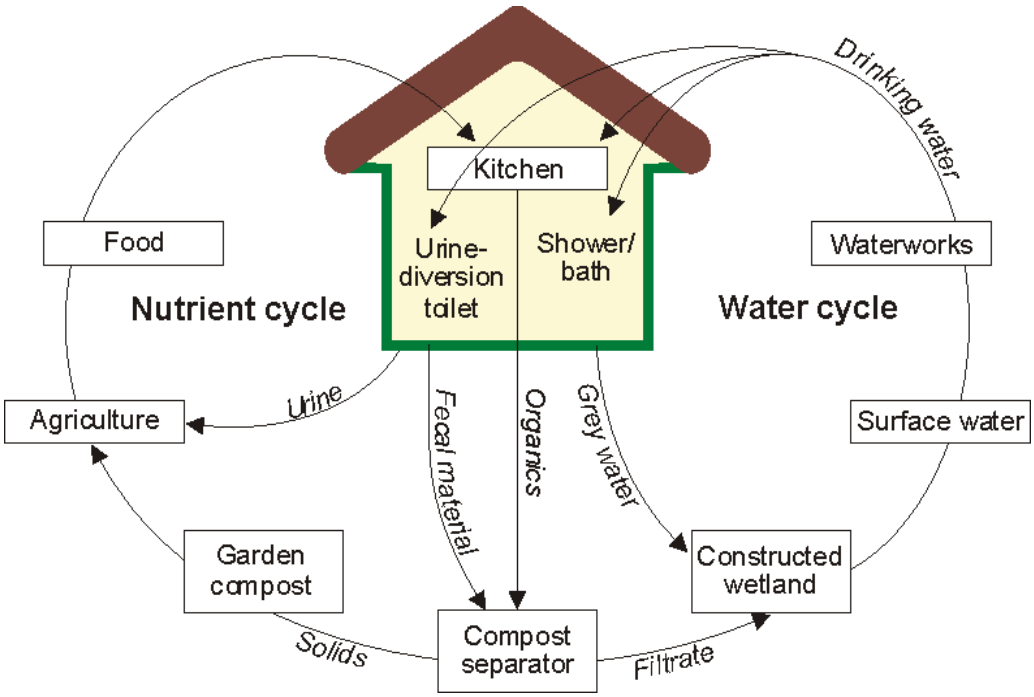


**Figure 1:** Ecosan model with closed nutrient and water cycles (based on Oldenburg et al., 2003)

## The need for safe sanitation

Pathogens and parasites found in human excreta, if ingested, can result in a variety of illnesses, including diarrhea leading to malnutrition. If left untreated these illnesses can result in poor growth, iron deficiency (anemia), vitamin A deficiency, and leave the body's immune system weakened and susceptible to more serious infections. Not all pathogens and parasites result in death, but the resulting malnutrition creates poor health and a predisposition to continual disease and death from other causes.

## The limitations of present day sanitation

Conventional sanitation is currently offered by two models: pitsan (pit toilets) or flushsan (flush toilets). Although conventional sewage systems transport excreta away from the toilet user, they fail to contain and sanitize, instead releasing pathogens and nutrients into the downstream environment. This is considered the "linear pathogen flow" (Esrey *et al.*, 1998). These systems mix faeces, urine, flush water and toilet paper with grey water, storm water and industrial effluents, usually overtaxing the design capacity of the treatment plants, if such a facility exists, as very few communities in the world are able to afford fully functional sewage systems. Simply put, flushsan has a dismal track record because all sewage systems contaminate the environment. Far more common than flush sanitation is the pit toilet, primarily because it is inexpensive and requires no infrastructure. This method fails to contain and sanitize excreta since pathogens and nutrients seep into the groundwater. Deep pit latrines also fail to recycle since the excreta is too deep for plants to make use of the nutrients. Pits are prone to periodic flooding, causing them to spill their contents. In general, pits are smelly, are often infested with flies, and in most parts of the world, are poorly maintained and continue to be a source of disease and pollution.

## Ecosan is a real option

An essential step in the process of sanitation is the containment of that can cause disease. Human faeces contain bacteria, viruses and parasites, which, if not properly treated, can result in spreading of disease. Ecological sanitation systems are designed around true containment and provide two ways to render human excreta innocuous: dehydration and decomposition. The preferred method will depend on climate, groundwater tables, amount of space and intended purpose for the sanitized excreta. Dehydration is the chemical process of destroying pathogens by eliminating moisture from the immediate (containing) environment. Some drying materials, like wood ash, lime and soil are added to cover the fresh deposit. Ash and lime increase pH which acts as an additional toxic factor to pathogens if the pH can be raised to over 9.5. The less moisture the better, and in most climates it is better to divert the urine and treat it separately.

**Figure 2:** Dry, double-vault urine diversion toilet from Mexico.

Figure 2 shows a dry, double-vault urine diversion toilet, a model being used in China, India, Vietnam and Mexico. It takes an average family 6 months to fill one of the vaults. Then the second vault is used. The first vault is emptied following an additional 6 months of sanitization and the material is taken to a soil compost. Urine is never mixed in this toilet but continuously diverted into a separate container and later used in diluted form as plant fertilizer. The dry ecotoilet meets all necessary health and environmental protection criteria and goes well beyond what conventional approaches can offer (Stenström 2002), saving water and preventing water pollution. It produces no smell, does not attract flies and is an affordable solution inside and outside of dwellings throughout the world.

**Figure 3:** *Fossa alterna*, a shallow reinforced pit, soil-composting toilet in use in Mozambique (Source: Water Aid)

Soil-composting toilets make use of the process of decomposition, a biological process carried out by bacteria, worms and other organisms to break down organic substances. In a composting environment, the competition between organisms for available carbon and nutrients continues until the pathogens are defeated by the dominant soil bacteria. Soil-composting toilets are constructed using shallow, reinforced pits where soil and ash are added after each use. Toilets such as the *Fossa Alterna* (Figure 3) and *Arbour Loo* (Morgan 2001) have been successfully tested in Mozambique and Zimbabwe. The Fossa Alterna uses two alternating pits with a similar frequency of alternation as the double-vault dry toilet. Once sanitized and composted, the contents are removed and used in agriculture. The Arbour Loo is a single shallow pit which receives soil additions after each use and a tree is planted in the pit when it is full.

## Recycling

The recycling of nutrients in urine and faeces is one of the key benefits of ecological sanitation. The nitrogen and phosphorus found in urine is a valuable fertilizer and the high organic content of faeces makes the composted product – humus – an excellent soil conditioner. In addition, it is important to recover and reuse these nutrients toward sustainable ecosystems to reduce the drain on natural reserves and lessen the dependence on artificial chemical fertilizers. Some countries and cultures have been recycling human excreta for agricultural purposes for thousands of years, especially in China and Southeast Asia, but often excreta have not been properly sanitized therefore perpetuating disease. By implementing ecosan, we can safely recycle nutrients without risking people's health and polluting the environment.

Urine contains 75-80% of the nutrients leaving the human body and 80% of the volume of excreta as well (Table 1). By using urine diversion we can reduce the nutrient load in sewage systems – thus eliminating the need for tertiary treatment. By using low-water or dry toilet systems we can reduce further the size of the sewage problem. Containment of dry faecal material and secondary treatment in eco-stations ensures that enteric pathogens are not released into the environment as is the case today with conventional sewage and pit systems.

| | Urine | Faeces |
|---|---|---|
| volume (L/p/d) | 1.2 litres | 0.15 |
| Nitrogen (g/p/d) | 11 | 2 |
| Phosphorus (g/p/d) | 1 | 0.6 |
| Potassium (g/p/d) | 2.5 | 0.6 |

Source: Del Porto & Steinfeld (1999).

**Table 1:** Average production of urine and faeces and nutrient content

By year ca 2100, economical sources of mined phosphorus will be nearing depletion (Steen 1998). A global program for phosphorus recycling from agriculture and humans must be in place within a few decades. The geopolitics of phosphorus are more delicate than oil due to skewed distribution (60% of the resource is in one location, Morocco). World fertilizer consumption (ref. IFA) is about 85 million tons of nitrogen and 14 million tons of phosphorus per year. Recycling of urine and faeces applied globally could answer for at least a third of the nitrogen and a quarter of the phosphorus we use in agriculture.

## Ecosan for grey water treatment and composting of household organics

The ecological sanitation approach can be broadened to cover all organic material generated in households (kitchen and food wastes). If these organic materials are sorted within the home, rather than mixed with solid waste and dumped, they become valuable recyclable materials once composted. Grey water can be treated using biological systems, such as evapotranspiration beds and constructed wetlands, and rainwater harvesting can be implemented to harness water for personal hygiene and irrigation (Figure 1).

## The EcoSanRes programme

In 1993, the Swedish International Development Cooperation Agency (Sida) launched a sanitation research programme called SanRes, under the direction of Uno Winblad. The objectives of the programme were to:

- promote affordable and reproducible ecological sanitation systems

- establish pilot projects in various countries (China, Vietnam, Mexico, Bolivia, Chile, El Salvador and Guatemala)
- help build local capacity for research and development
- and to facilitate collaboration between developing nations in the field of applied sanitation research.

The eight-year mandate for the SanRes programme was fulfilled in 2001 and proved so successful it has evolved into a full-scale initiative sponsored by Sida and managed by the Stockholm Environment Institute, Akkadia Environment and SwedEnviro – the **EcoSanRes Programme**. The EcoSanRes Programme consists of three components: *outreach, capacity* and *implementation*.

## Guidelines development

The EcoSanRes Programme is researching and testing methods of sanitation, primarily focusing on the safe removal of pathogens from human excreta and its subsequent optimal uses in agriculture as a fertilizer and soil conditioner. The end results of these investigations are guidelines to aid professionals, people and communities in implementing ecological sanitation systems. Guidelines are being written for safe handling of urine and faeces, agricultural reuse of human excreta, grey water treatment and management, and implementation and planning of ecosan projects.

## Studies

Sanitation is usually heavily regulated at all levels of government, due to its impact on public health and safety, and it is also a subject traditionally approached with discomfort and inhibition. But, the need for sanitation is so basic it affects humans indiscriminately. Realizing the sensitivity of this issue and the reluctance of governments to embrace change, the EcoSanRes Programme has undertaken studies to explore the more elusive and social aspects of sanitation, such as regulatory frameworks, a review of alternative sanitation systems and legislation and norms and attitudes.

## Implementation

The EcoSanRes Programme has established itself, and the concept of ecological sanitation, as legitimate by promoting local input to and adaptation of sanitation systems. Sida is implementing pilot projects in West Africa (eight countries), East and Southern Africa (Uganda, Mozambique and Zimbabwe), South Africa, China, India, Latin America (Bolivia, Guatemala and Mexico) and the Middle East (Palestine).

Efforts are in progress to provide new methods to help meet the Millennium Development Goals. Since the SanRes Programme was introduced in southern China in 1997, more than 100,000 urine diversion double vault toilets have been built in the Guangxi Region (Wei Bo, 2002), and ecological sanitation activities are increasing in half of the Chinese provinces.

## Eco-Town projects

The full-scale ecological sanitation projects being initiated by EcoSanRes are efforts to generate the necessary data, technology and policies required to affect a major change in the way human settlements relate to the environment. The objective of one such project is to build a small eco-town in Inner Mongolia, China, with about 1,000 households, with an emphasis on testing, research and development and social marketing, as well as cultural, financial, legal and institu-

tional issues. This pilot project represents an evolutionary advancement in the implementation of ecological sanitation. It includes the management of grey water and solid waste, and the agricultural reuse of household residues. The incorporation of secondary treatment for faeces and solid waste in eco-stations differentiates this project from others because it is extending the concept of ecosan into a comprehensive sanitation system. It marks a shift from concentrating on small-scale household implementation to embracing a holistic approach to sanitation on a larger, urban scale. The goal is to provide the world with an example of a sustainable eco-town. Similar projects are being set up in Mexico and South Africa during the period 2003 to 2007.

## Capacity building and training

One of the keys to successful implementation of ecosan is education. By funding training programs the supporters of ecological sanitation, including Sida and the EcoSanRes Programme, help to create a knowledgeable base of people who can promote the concept and act as a resource pool for others interested in ecological alternatives to conventional sanitation. Training courses gather experts from a variety of disciplines to strengthen capacity for planning, managing and implementing ecological sanitation systems. In particular, the focus of the courses is on how ecological alternatives to sanitation can be affordable and contribute to health and personal security, improve nutrition and protect drinking water and the surrounding ecosystems from pollution. Training courses were held in Uganda and South Africa in 2002, and courses are planned for India, China and Tanzania.

**Organisations involved with EcoSanRes (www.ecosanres.org)**

- Stockholm Environment Institute
- Akkadia Environment Management Consultants
- SwedEnviro Consulting Group
- Linköping University
- WKAB Consulting
- Swedish Institute for Infectious Disease Control
- Swedish University of Agricultural Sciences
- Aquamor – Zimbabwe
- Eco-Solutions – India
- Espacio de Salud – Mexico
- REDSECO – Latin America
- City of Kampala – Uganda
- CSIR – South Africa
- Mvula Trust – South Africa
- WaterAid – Mozambique
- Palestinian Hydrology Group – Palestine
- CREPA – Burkina Faso and West Africa
- Municipality of Erdos, Dong Sheng District, Inner Mongolia, China
- Ministry of Health – China
- Government of Bolivia
- Government of Guatemala
- Unicef
- UNDP
- World Bank (WSP)

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# Guidelines for the implementation of the Bellagio-Principles and the household centred environmental sanitation approach (HCES)*

**Roland Schertenleib, Antoine Morel**
EAWAG, Swiss Federal Institute for Environmental Science and Technology; Dept. Water and Sanitation in Developing Countries (SANDEC)
Ueberlandstrasse 133, P.O.Box 611, 8600 Duebendorf, Switzerland
e-mail: schertenleib@eawag.ch
e-mail: antoine.morel@eawag.ch

**John Kalbermatten**
3630 Garfield St. N.W.: Washington D.C. 20007. USA
e-mail: jmkkainc@aol.com

**Darren Saywell**
Water Supply and Sanitation Collaborative Council (WSSCC)
1219 Geneva, Switzerland
e-mail: saywell@who.int

## Keywords

Environmental sanitation, household-centered approach, nutrient recycling, sanitation planning

## Abstract

In response to the fact that almost half of the world population still lack access to adequate sanitation and in recognition that the conventional approaches to Environmental Sanitation are unable to make a significant change in this appalling situation, an Environmental Sanitation Working Group of the Water Supply and Sanitation Collaborative Council (WSSCC) developed in 1999 the Household-Centred Environmental Sanitation (HCES) approach. The HCES approach is a radical departure from past central planning approaches as it places the household at the core of the planning process. The approach responds directly to needs and demands of the user and attempts to avoid the problems resulting from either “top-down” or “bottom-up” approaches. Successful implementation of the HCES approach requires the dissemination of information and assistance to those responsible for improving environmental services, such as municipal officials, urban planners, and policy makers responsible for creating an enabling environment. Based on these considerations, provisional guidelines were prepared. They provide specific guidance for (a) creating an enabling environment for the use of the HCES approach and (b) undertaking a 10-STEP-process for its development and implementation.

## Introduction

Since the earliest urban settlements, it has been recognized that some services have to be provided to ensure that the inhabitants are healthy and able to live in decent conditions. These services are: provision of safe water supply; the sanitary disposal of wastewater and human wastes; the proper management of solid wastes; and effective storm water drainage. In this paper these services are referred to as Urban Environmental Sanitation Services (UESS). Throughout the past few decades, efforts to improve living conditions among those lacking basic amenities have emphasized the provision of potable water. The other, equally vital, UESS

*This paper has been peer reviewed by the symposium scientific committee

components have invariably been considered less important. As a result, 2.4 billion people stilldo not have access to proper sanitation (WHO/ UNICEF/WSSCC, 2000), less than 50% of municipal solid wastes are collected (WRI et al., 1996) and no one knows how many people are flooded out each year.

Although there are several reasons for the neglect of these other components and especially for the failure to achieve satisfactory sanitation coverage (Simpson-Hebert and Wood, 1998), the WSSCC Working Group on Environmental Sanitation came to the conclusion that poor planning lies at the heart of current shortcomings in environmental sanitation interventions (EAWAG/ SANDEC and WSSCC, 1999). Too often only lip-service is given by environmental sanitation professionals to environmental management issues and services are not conceived in an integrated way. For example, provision of a water supply without allowing for the removal of wastewater may create standing water, thereby producing health hazards and poor living conditions. Nor is sufficient attention paid to the fact that the reduction of waste and the more efficient use and reuse of water and materials is the most effective way to reduce demand for waste treatment and disposal.

There has also been a tendency to develop systems that respond to problems of environmental waste management as perceived by policy makers and professionals, rather than to households' and communities' perceptions of their actual needs. Conventional UESS planning usually consists of what became to be known as a "Top-Down" approach. Needs are determined by well-meaning officials at central, regional and even municipal levels, based on their own perceptions. Those to be provided with services are "Target Beneficiaries" without much, if any, say in matters of service level or determination of priorities.

## The Bellagio Principles for sustainable environmental sanitation

A representative group of experts drawn from a wide range of international organisations involved in environmental sanitation accepted the need to challenge conventional thinking and called in the Bellagio Statement for a radical overhaul of conventional policies and practices world-wide based on the following lessons learned from past efforts to improve UESS:

(a) "Business as usual" is not sustainable even in the industrialized countries; (b) the underutilization of organic residues is economically wasteful; (c) the pressure of humanity on a fragile water resource base, and the corresponding need for environmental protection and freshwater savings, require that wastewater and wastes be recycled and considered as resources; (d) sanitation systems designed and implemented without consultation with stakeholders at all levels, and without their participation, are ineffective; (e) there is a lack of integration between the provision of water supply and arrangements for disposal of wastewater, and between excreta and wastewater management, solid waste management, and storm water drainage; (f) without sanitation and hygiene education, the health impacts expected from water supply are greatly diminished; and (g) the export of industrialized-world models of sanitation to environments characterized by water and resource scarcity is inappropriate.

In the light of these compelling arguments for radical re-thinking, the following principles were proposed as the underpinning basis for a new approach in environmental sanitation:

1. Human dignity, quality of life and environmental security at household level should be at the centre of the new approach, which should be responsive and accountable to needs and demands in the local and national setting.
2. In line with good governance principles, decision-making should involve participation of all stakeholders, especially the consumers and providers of services.
3. Waste should be considered a resource, and its management should be holistic and form part of integrated water resources, nutrient flows and waste management processes.

4. The domain in which environmental sanitation problems are resolved should be kept to the minimum practicable size (household, community, town, district, catchment, city) and wastes diluted as little as possible.

The Bellagio Principles were endorsed by the members of the Water Supply and Sanitation Collaborative during its 5th Global Forum in November 2000 in Iguacu (Brasil).

## The Household-Centred Environmental Sanitation Approach (HCES)

The Household-Centred Environmental Sanitation Approach (HCES) developed by the WSSCC Environmental Sanitation Working Group is largely based on the Bellagio Principles (Schertenleib, 2000). There is consensus among the members of the Water Supply and Sanitation Collaborative Council that it offers the promise of overcoming the shortcomings of conventional approaches because its two main components correct existing unsustainable practices of planning and resource management. These components are:

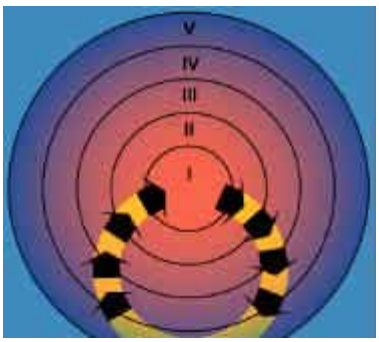
- The HCES approach makes the household the focal point of Environmental Sanitation Planning, reversing the customary order of centralized top-down planning. It is based on the concept that the user of services should have a deciding voice in the design of the service, and that environmental sanitation problems should be solved as close as possible to the site where they occur. Only problems not manageable at the household level should be "exported" to the neighbourhood, town, city and so on up to larger jurisdiction. Making the household the key stakeholder also provides women with a strong voice in the planning process, and changes the government's role from that of provider to that of enabler.
- The *Circular System of Resource Management (CSRM)* that, in contrast to the current linear system, emphasizes conservation, recycling and reuse of resources. The circular system practices what economists preach: waste is a misplaced resource. By applying this concept, the circular system reduces "downstream" pollution.

*Structure of decision making in the Household-centred approach*

The conventional approach to water supply and environmental sanitation is based on a highly-centralized system of decision-making, usually under the control of the national government. In recent years, many governments have attempted to decentralize by delegating their functions to second-and third-tier governments (for example, to provinces and municipalities). However, the results of these efforts have been mixed. Delegation often leaves central policy-makers in charge and does little to encourage initiatives by local office-holders and managers. The problems with devolution generally result from the fact that only the new responsibilities, not the means of implementing them, are transferred to the local authorities.

The HCES Approach is a radical departure from past central planning approaches. As shown in the figure on the following page, it places the stakeholder at the core of the planning process. Therefore, the approach responds directly to the needs and demands of the user, rather than central planner's often ill-informed opinions about them. It is based on the following principles: (a) Stakeholders are members of a "zone", and act as members of that zone ("zones" range from households to the nation). Participation is in accordance with the manner in which those zones are organized; (b) zones may be defined by political boundaries (for example, city wards and towns) or reflect common interests (for example, watersheds or river basins); (c) decisions are reached through consultation with all stakeholders affected by the decision, in accordance with the methods selected by the zone in question (for example, votes at national level in a democratic system, town hall meetings at local level, or informal discussions at neighbourhood level); (d) problems are solved as close to their source as possible. Only if the affected zone is unable to solve the problem should the problem be "exported", that is, referred to the zone at the next level.

The HCES approach attempts to avoid the problems resulting from either "top-down" or "bottom-up" approaches, by employing both within an integrated framework. The needs are determined in a bottom-up approach where decisions flow from the household to the community to the city and finally to the central government based on informed choices at all levels. The top-down part of the HCES approach consists then of fitting the proposed program within the municipality's overall UESS strategy and ensuring support for its implementation.




**I Household**

**II Community/Neighborhood**

**III Local Government**

**IV District Government**

**V National Government**

*Circular System of Resource Management*

An important concept of the HCES approach is to minimise waste transfer across circle boundaries by minimising waste-generating inputs and maximum recycling/reuse activities in each circle. In contrast to the current linear system, the *Circular System of Resource Management (CSRM)* emphasizes conservation (reducing imports) of resources, and the recycling and reuse of resources used (minimizing exports). Resources in the case of environmental sanitation are water, goods used by households, commerce and industry, and rain water. The circular system practices what economists preach: waste is a misplaced resource. By applying this concept, the circular system reduces "downstream" pollution.

*Strength and weakness of HCES*

HCES is a multi-sector, multi-actor approach to delivering integrated urban environmental services. As already mentioned, it is designed to respond to household needs and priorities, since the household is the level at which decisions on investments are made and where behaviour change begins. Its main *strength* is that it offers the possibility of providing an integrated, affordable and sustainable package of services meeting the users' priorities. Its potential *weakness* is that it requires collaboration and coordination between multiple agencies which may have different capabilities and little commitment to working together.

## Guideline for implementing the HCES approach

Successful implementation of the HCES approach requires the dissemination of information and assistance to those responsible for improving environmental services. Therefore, preliminary guidelines were prepared which are mainly targeted at municipal planners (especially those responsible for planning urban environmental services) and civic officials, such as mayors and city managers. These are the people who will initially have to take the decisions on whether and how to apply HCES, who will implement and support the process, and who will be responsible to their citizens for the results. The guideline is intended to assist them to understand the HCES approach, to apply it in their own circumstances, and to be able to explain it to the user communities. Other potential users of the guideline are municipal/state/provincial and central government officials, whose support is essential once local authorities decide to undertake HCES-based programs. The provisional guideline provides specific guidance for:

a) Creating an Enabling Environment for the use of the HCES approach

b) Undertaking a 10-STEP Process for developing and implementing the HCES approach

## Creating an enabling environment for implementing the HCES approach

An "enabling environment" is important for the success of any investment program, but it is especially vital when applying an innovative approach, such as HCES. Most of the critical elements should be identified or become evident during the program development process. Ideally, they should be identified, at least in broad terms, prior to the program launch so that the entire process does not start off with misunderstandings. It is essential that they are recognized before or during the identification and evaluation of options at the latest, since if these critical elements cannot be assured, then some of the options may not be feasible.

*Government Support*

Political support at all levels is essential. HCES involves departures from conventional methods, especially in its institutional approaches, and the program promoters should plan to devote considerable efforts to familiarizing elected officials, senior sector staff and advisers with the concepts. This will involve presentations, seminars, visits to demonstration projects in communities to learn about the possibilities offered by HCES.

*Legal Framework*

The most obvious immediate need for change in order to accommodate HCES is in the matter of standards. Many existing standards (national or municipal) are based on those developed in industrialized countries, under conditions totally different from those applying today in developing countries, and so they are often inappropriate. Even where they are in theory appropriate, they often cannot be applied (because they are too expensive), and enforcement is weak. Nevertheless, it is dangerous for a public sector official to reject the standards explicitly, because then the official may become personally liable for any resulting problems. Part of launching HCES should therefore to be to secure a moratorium on the application of existing standards to the program area, and part of the overall exercise should be to try to identify standards which would be more appropriate.

*Institutional Arrangements*

Stakeholder service demand and delivery capacity will vary from zone to zone, and so will the need for support services. Local (neighbourhood) organizations will therefore require specific support inputs not only from similar organizations (that is, from similar zones), but from organizations in larger zones with greater responsibilities and (hopefully) greater capacities. The most significant change introduced by the HCES approach is the participation of stakeholders that previously have often had little opportunity to participate under the conventional system of project planning and implementation. Most UESS organizations are unfamiliar with the concept of basing their program planning on responding to household demands and arriving at solutions acceptable to the household through a consultative process. Existing organizations will have to change their modus operandi from managing to supporting, requiring a good deal of reorientation and retraining of staff. For now, NGOs often bridge the gap between central organizations and stakeholders at the lower, community levels. This gap should eventually be eliminated, with more permanent arrangements between central organizations and organisms created by the community to satisfy its needs (which might still involve NGOs). Prior to program launch, a preliminary assessment should be conducted to determine the capacities of the various UESS organizations and others who might become involved (including private sector and NGOs), and the existing status of collaborative planning activities. This knowledge will help planners to take quick action to remedy problems identified during the program launch meeting and throughout the HCES implementation.

*Required Skills*

Many groups and organizations will need training and orientation. For example **householders** will need to understand more about the implications of the options open to them, and will also have to be shown how to exert quality control over local builders and contractors, to make sure

that they are not being cheated. **Communities and their organisations (CBOs)** which will undertake construction, O&M and/or management of local UESS will need training on technical matters, accounting and simple financial management, basic contract procedures, and monitoring and reporting. **NGOs** that will become involved in the program need similar training, but at a more advanced level, as they are probably going to have to train the participating communities. They will also need to become familiar with the social factors affecting the selection and proper use of UESS, and with supporting communications strategies. **Municipal staff** will need to be reoriented away from their present perception, that UESS deficiencies are primarily due to lack of technical solutions developed in industrialized countries. Instead, they should be helped towards a better understanding of the social, institutional, financial and other factors that have to be addressed. All of these groups and individuals will need training in "commercializing" waste recycling and urban agriculture/horticulture activities (e.g., marketing) if the full potential that is offered by the application of the circular system is to be achieved. Only then can the simultaneous improvement of both the health and economic productivity of members of the participating households be achieved.

*Credit and other Financial Arrangements*

A major recurring problem encountered by low-income customers and small entrepreneurs is the lack of capital to finance investments or equipment, even when they are capable of paying small amounts for current expenses. Rather than to resort to grants or subsidies, governments and their agencies should consider the establishment of a line of credit, or the provision of equipment and materials against regular payments. The provision of grants and subsidies often has the unintended effect of encouraging users and organizations (at whatever level) to choose systems and technologies they are unable to sustain, which later leads to rapid deterioration of facilities and deficient services.

## 10-STEP-process for developing and implementing the HCES approach

The last section of the guideline describes ten typical STEPs involved in developing and implementing an HCES programme. These STEPs are presented here in sequence, but in practice they will usually overlap, some STEPs may need to be repeated more than once in an iteration to find acceptable solutions, and they will always need to be undertaken bearing in mind the concerns of the municipality as a whole.

*STEP 1: Request for assistance*

The HCES process should start in response to a request for assistance from the people who will benefit from the services: in the model used in the guideline, this request would be made to the mayor (or other professionals serving the mayor), by the users themselves, their political representatives or local community leaders.

*STEP 2: Launch of the planning and consultative process*

Once a request for assistance in developing an HCES-based programme has been received, it is important to check that all the participating stakeholders really understand and accept the implications, for example: intensive user involvement; close collaboration between various agencies; and the possibility that the integrated, balanced, multi-service solution finally adopted may not exactly correspond to what the individual sectoral agencies had envisaged.

*STEP 3: Assessment of current status*

The next Step in the development of the programme is a comprehensive, participatory assessment of the current level of UESS service. This is a more complicated process than that carried out in typical conventional single-sector planning, which is often confined to trying to answer questions such as 'What is needed in order for the water company to provide water through standpipes?' An HCES assessment needs to cover all the services, must be participatory in its

methodology, and understand how services are provided and used within a particular social context.

*STEP 4: Assessment of user priorities*

The results of the status assessment (STEP 3) should be reported to the community through a participatory process (i.e., meeting, focus group discussions) at which representatives of relevant agencies are also present - but as equal participants, not as leaders. The objectives of this part of the process are to (a) present the findings of the assessment, (b) correct possible factual errors, and (c) Establish, in broad terms, the 'ground rules' for the next, most intensive part of the study: deciding which deficiencies should be given priority, what levels of service should be considered, what institutional arrangements would be acceptable, etc. The setting of priorities is ultimately done by the householders, taking into account the Bellagio principles.

*STEP 5: Identification of options*

The identification of the various options for UESS services that are conducted using the HCES approach have to cover the same broad range of topics as those conducted for any feasibility analysis; they must examine the technical, institutional, financial and social feasibility of each option, and assess other factors such as its impact on the environment. The guideline does not discuss these techniques, which are covered by a number of standard texts. However, some special features are discussed which set the HCES analysis apart from conventional analyses.

*STEP 6: Evaluation of feasible service combinations*

Once the costs and implications of various options are known, at least approximately, work can begin on determining which combinations are likely to be feasible. The lowest desirable level of service should have been decided during the consultations in STEP 4. Above this lowest level, the task is primarily matching a particular level of service with the associated on- and off-site facilities (for example, flush toilets are not feasible without a high level of water supply and effective means of wastewater collection, treatment and disposal).

*STEP 7: Consolidated UESS plans for the study area*

The objective of this STEP is to develop a programme that will cover the entire study area (as defined in STEP 2). The various options identified during STEP 6 are likely to be suited to particular neighbourhoods or communities, depending on factor such as income level, housing type, soil conditions and topography. The challenge now is to assemble and integrate these into a broader UESS network.

*STEP 8: Finalising of consolidated UESS plans*

The consultation involves three stages: (a) planners present the options that appear feasible for individual neighbourhoods; (b) planners explain the interactions between neighbourhood choices; and (c) planners assist the community on reaching a consensus on a broader programme. It may be more efficient to conduct the first two stages separately, neighbourhood by neighbourhood, but if this approach is taken, each neighbourhood must clearly understand and accept that the final stage may lead to later adjustments and modifications.

*STEP 9: Monitoring, (internal) evaluation and feedback (MEF)*

MEF must be thought of as one integrated process, even though it consists of three separate elements. There is no point in collecting data (monitoring) unless the data is then analyzed critically (evaluation), and then the conclusions of the evaluation used to improve the process being monitored (feedback). Good MEF is absolutely essential to the success of HCES programmes.

*STEP 10: Implementation*

The final guideline will include a section on matters requiring attention during implementation, because programmes undertaken using the HCES approach are likely to require adjustment and fine-tuning during the implementation process, especially if new communities are added to

the programme as work proceeds. However, this section on implementation can only be prepared after the HCES approach has been applied to actual projects or programmes based on the preliminary guideline.

## Conclusion

A new approach (HCES) has been suggested to overcome the shortcomings of conventional approaches in environmental sanitation planning by placing the household at the core of the planning process and by introducing a circular system of resource management. In order to implement the HCES approach, preliminary guidelines were prepared to give guidance how to create an enabling environment and how to apply the HCES approach. The provisional guideline should be tested on selected projects, which should be subjected to careful monitoring and evaluation. That process should not only test the provisional guideline and reveal areas which need to be improved, it should also bring out the topics which need to be particularly stressed during implementation, and the issues which are likely to arise.

## Acknowledgement

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# Tentative guidelines for agricultural use of urine and faeces*

**Björn Vinnerås, Håkan Jönsson**
Swedish Univ. of Agricultural Sciences, Dep. of Ag. Eng.
Box 7032, SE-750 07 Uppsala, Sweden
e-mail: bjorn.vinneras@lt.slu.se

**Eva Salomon**
JTI Box 7033, 750 07 Uppsala, Sweden

**Anna Richert Stintzing**
Verna Ekologi AB
Malmgårdsvägen 14, 116 38, Stockholm, Sweden

## Keywords

Agriculture, faeces, fertilising, nutrient recycling, urine

## Abstract

Plant nutrients are a necessary input in high-productive and sustainable crop production. The plant nutrients in both urine and faeces emanate from arable fields and thus should be recycled as fertilisers to support sustainability and to retain the fertility of the fields.

This paper presents tentative general guidelines for use of urine and faeces as fertiliser. Urine is a quick acting fertiliser rich in nitrogen, and with a composition of nutrients that well matches the needs of many crops. Urine and faecal matter well supplement each other, since faecal matter is slower acting and rich in phosphorous and potassium. It also contains organic matter and will increase the buffering capacity and the organic matter of the soil. Faecal matter should be sanitised before reuse, since it can contain high concentrations of pathogens.

More research on use of urine and faeces is needed in order to make the recommendations more detailed and to develop new ways to efficiently use human excreta in agriculture. The guidelines are developed by EcoSanRes, a programme supported by Sida.

## Introduction

Many of the nutrients used today are either fossil resources or consume large amounts of fossil resources during their production. During food production, nutrients are removed from the soil and these nutrients have to be replaced by plant-available unpolluted nutrients. The main urban nutrient source is toilet waste and together with organic household waste, these fractions contain more or less the same amounts of nutrients removed from the field during food production.

The major proportion of the nutrients in wastewater originates from urine. Of the amounts consumed in food, about 70-90% of the nitrogen, 45-80% of the phosphorus and 70-95% of the potassium are found in this fraction while the rest is found in the faeces (Lentner et al., 1981; Guyton, 1992; Vinnerås 2002). The urine nutrients are water-soluble and relatively available for plants to take up or easily transformed into plant-available compounds (Kirchmann & Pettersson, 1995).

Plants take up nutrients in ionic form and the nutrients in urine are easily plant-available, since they are in ionic form, or rapidly degrade to this form. Most of the nitrogen in urine is excreted as urea, which is easily degraded to ammonium, often already during collection and storage.

*This paper has been peer reviewed by the symposium scientific committee

Otherwise, degradation takes place within hours of application. In the soil, ammonium is oxidised to nitrate and both ammonium and nitrate are plant-available. The phosphorous in the urine is in ionic form at excretion, but during storage some precipitates as calcium and magnesium phosphates and all of these forms are plant-available. The potassium and the sulphur are in ionic form and easily plant-available. Urine is a nitrogen-rich fertiliser with high plant availability.

Faeces are by weight the smallest of the biodegradable waste fractions. Between 30 and 110 kilograms, wet weight, of faeces are produced per person and year. This corresponds to 10-15 kilograms of dry matter (Lentner et al., 1981; Vinnerås 2002). The volume produced per person depends upon the composition of the food consumed. Meat and other foods low in fibre produce smaller volumes than food high in fibre (Guyton, 1992).

Faecal nitrogen is mainly found as organic nitrogen and has therefore to be mineralised before it becomes available for plants. Phosphorus is mainly found as small grains of calcium phosphates in the faeces (Frausto da Silva & Williams, 1997) and this phosphorous is available to plants. Potassium is mainly found in its water-soluble ionic form (Berger, 1960) and is therefore readily available. Faeces are high in phosphorous and potassium, but also contain slow release nitrogen.

The amount of nutrients found in the urine and the faeces depends on the nutrient content of the food consumed. This varies from person to person and region to region. Vinnerås & Jönsson (2003) present the estimated average composition of urine and faeces for different regions according to the average food consumption as given by the FAO.

## The nutrient requirements of plants

Elements essential for the growth of plants are normally called nutrients. The nutrients used in the largest amounts are the non-mineral elements, i.e. carbon, hydrogen, and oxygen. These substances are mainly derived from carbon dioxide ($CO_2$) and water ($H_2O$). All other nutrients are mainly taken up from the soil by the roots. Increasing the supply of light, $CO_2$, water and mineral nutrients from the deficiency range increases the growth rate and crop yield. The yield response curves for a particular mineral nutrient can be illustrated as in Fig. 1. When the supply of one mineral nutrient or growth factor is increased, other mineral nutrients or growth factors then become important as limiting factors (Fig. 1).

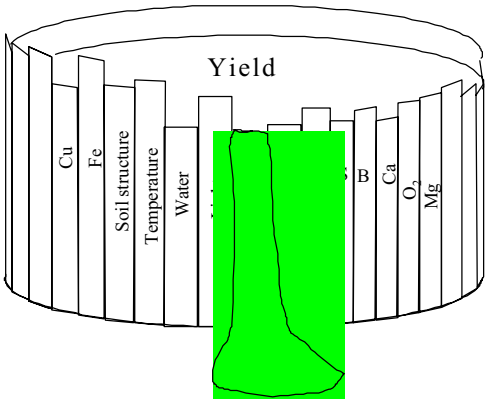


**Figure 1.** The limiting factors regulating the growth of plants. If the most limiting factor is improved, e.g. here by addition of nitrogen, some other factor or element will limit the growth.

Nutrients can be divided into the two categories macronutrients and micronutrients and the total uptake of macronutrients is about 100 times that of micronutrients. The macronutrients are the six elements nitrogen (N), phosphorus (P), potassium (K), sulphur (S), calcium (Ca) and magnesium (Mg). Of these, yearly additions are usually needed of the first four (N, P, K, S), while the soil supply of Ca and Mg is usually sufficient provided that the pH is not too low. All over the world, nitrogen is frequently the most limiting nutrient for plant growth. The main natural sources of plant-available N are degradation of organic matter in the soil and N fixation by microorganisms living in symbiosis with the roots of legumes. The visible fertilising effect of using urine as a fertiliser usually comes from its N content. The natural supply of P comes from mineralisation of phosphates and from degradation of organic matter in the

soil. In acidic soil the availability of P is often low, due to strong bonds between phosphates and metal ions at low pH. The high water solubility of K often results in a good supply of plant-available K. However, many crops such as vegetables need large amounts of potassium and therefore additional fertilisation improves plant growth. S is also highly water-soluble and most crops need it in somewhat smaller amounts than P. Even so, on many soils yearly additions of S are needed.

Micronutrients are also essential for plant growth, but the uptake of these elements is in small (micro) amounts. The elements normally considered to be micronutrients are boron, copper, iron, chloride, manganese, molybdenum and zinc (Frausto da Silva & Williams, 1997). Most micronutrients are needed for formation of different enzymes. These nutrients mainly come from degradation of organic material and erosion of soil particles. Only in special circumstances does scarcity of micronutrients limit plant growth. When human excreta are used as a fertiliser, the risk for such deficiency is minimal as excreta contain all the micronutrients.

## Application strategies for human excreta

Fertilisation only increases crop yield if the plant nutrient supply is one of the most limiting growth factors (Fig. 1). No yield increase is to be expected when fertilising crops that are mainly limited by factors other than nutrient supply, e.g. lack of water, too low or too high pH, etc.

Often when human excreta are used for fertilisation, the available amount is very limited in relation to the amount of plant nutrients needed. Therefore, it is important that the excreta are used in the most efficient way and this differs depending on the amount of available nutrients in relation to the available space.

There is enough space to utilise all of the nutrients to their full potential if the average application of available nitrogen is below dose A in Fig. 2. Dose A is the dose up to which the yield increases linearly with increasing application. Dose A differs between different crops, regions and climate. If its size is not known, then the application of the urine from one person during a full day per square metre (approx 1.5 litres of urine/$m^2$) can be used as a rule of thumb. This corresponds to application of approximately 40-80 kg N/ha.

When space is not a limiting factor, the full fertilising effect can easily be gained from urine, even if the urine is applied at different dosages in different places, as long as the dosage in all places is below dose A (Figure 2).

The best fertilising efficiency when space is so limited that the average dose has to be above A is obtained by keeping the dose even over the whole available space, if all the crops have the same nitrogen demand. The yield increases when the application is increased from dose A to dose B (Fig. 2). However, both the quantity and the quality of the yield are important and high doses of available nitrogen (i.e. urine) can also affect the quality. For example, the quality of wheat is generally improved by a high nitrogen dosage, while the quality of, for example, Irish potatoes may decrease since the tubers can become watery.

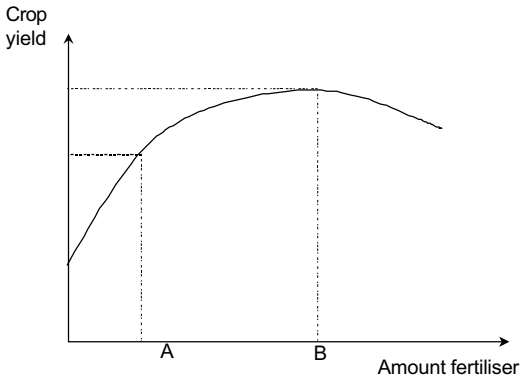


**Figure 2:** The effect on the yield of increasing doses of available nitrogen (urine). Up to dose A, the increase in yield is linear to the addition of urine. Between dose A and dose B, the yield still increases in response to the increased fertiliser application, but at a slower rate. Beyond dose B, additional fertiliser application becomes toxic and the yield decreases if the application is increased.

If no information is available on dose B, then a dose 5 times as high as dose A can be used as a rule of thumb, i.e. applying the urine from one person during one day on an area of 0.2 $m^2$.

If space is even more limited, i.e. so that the average dose would be above dose B, where additional amounts of urine become toxic, then the dose should be limited to dose B. The amount of urine that cannot be utilised as a fertiliser should be disposed of in some other way, i.e. as an accelerating agent when composting.

## Use of urine as a fertiliser

The fertilising effect of urine is similar to that of a nitrogen-rich chemical fertiliser and urine should be used similarly. Therefore, urine is best utilised as a fertiliser to nitrogen-demanding crops and vegetables. If crop- and region-specific recommendations are available for the use of such a chemical fertiliser, a good starting point when using urine is to translate this recommendation to urine. This translation is simplified if the nitrogen concentration of the urine is known. If it is not, then as a rule of thumb, a concentration of 3-7 grams of nitrogen per litre of urine can be expected, or approximately half that concentration if flushed urine-diverting toilets are used (Vinnerås, 2002, Vinnerås & Jönsson, 2003).

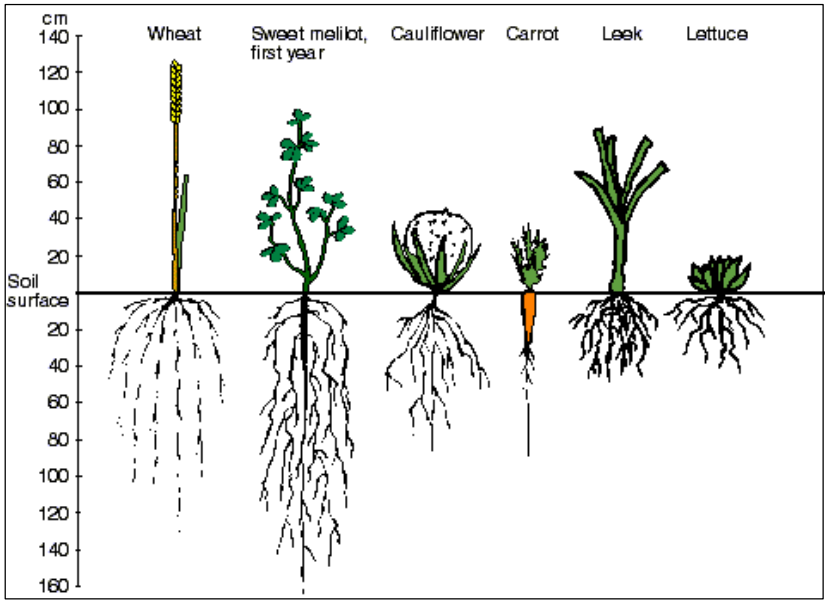


**Figure 3:** Root structures of different crops. (Picture by Kim Gutekunst, JTI.)

Just prior to or during sowing/planting, the soil should normally be fertilised for the first and sometimes only time. The nutrient supply even at this early stage of plant life affects the yield. However, care should be taken to protect the seedlings from high concentrations of nutrients. In the early stages of cultivation, the availability of phosphorus and potassium is the most important factor. In large-scale crop production, the normal fertilisation strategy is application once or twice per growing season. If fertiliser is applied only once, this should be carried out prior to or at the time of sowing/planting. If the crop is fertilised twice, the second fertilisation should be performed after approximately 1/4 of the time between sowing and harvest. The crop can also be continuously fertilised, e.g. if the urine is collected in smaller cans and used more or less directly. However, the nutrients are not well-utilised after the crop enters its reproductive stage. An example is maize; fertiliser applied until the plants are setting ears is well-utilised, but after this stage the uptake of nutrients from the soil is negligible (Marschner, 1997).

Vegetables are normally harvested before they reach their reproductive stage and therefore fertilisation can be continued until some time before the harvest. As a rule of thumb, fertilisation should stop after between 2/3 and 3/4 of the time between sowing and harvest. The amount of nutrients and the intervals depend mainly on nitrogen usage by the plant and root size. Root size varies between different crops (Fig. 3). Plants with inefficient or small root systems, e.g.

carrots or lettuce, could possibly benefit from several applications of nutrients throughout the cultivation time (Thorup-Kristensen, 2001.) In Swedish field trials with leeks fertilised with human urine, only small differences in yield were observed between leeks fertilised twice during the growing period and leeks fertilised every second week, i.e. eight times during the growing period, on clay soil. The total fertiliser dose was the same for both strategies. The yield was only slightly higher in plots fertilised every two weeks on the clay soil while on a sandy soil, there were no significant difference (Båth, 2003). However, as a hygiene safety measure, until hygiene guidelines have been developed, it is recommended that crops consumed raw are not fertilised with urine closer to harvest than one month (Schönning, 2003).

If the storage capacity during the non-cultivation period is insufficient, the urine can be utilised as a fertiliser for trees and bushes or it can be "stored" in the soil by application and incorporation of the urine in the field during the dry season, followed by normal crop cultivation when it is suitable according to rain and irrigation conditions. The main proportion of the nutrients will then remain in the soil and be available for the plants during the growing season, even if some nitrogen is lost. Further investigations are needed to determine the nitrogen loss during such storage.

## Application technique

For best fertilising effect, the urine should be mixed into the soil as soon as possible after the application, instantly if possible. This can be done for example by applying it in small furrows that are covered after application. It can also be done by applying water after the urine, thereby washing the nutrients into the soil. When applying the urine, spraying of leaves with urine should be avoided as this can cause foliar burning due to high concentrations of salts if urine is left to dry on the leaves. Spraying urine in the air should also be avoided as the nitrogen in the urine is then partly lost as gaseous emissions of ammonia (Rodhe et al, 2003).

It is not necessary to dilute the urine before application. However, the whole root of the plants should not be thoroughly soaked with undiluted urine, as this might be toxic and even lethal, especially for small plants. Instead, the urine should be applied either prior to sowing/planting or at such a distance from the plants that the nutrients are within reach of the roots, but that they are not soaked.

## Use of faeces as a fertiliser

The nutrient content in faecal matter is considerably lower than that in urine, especially the amount of plant-available nitrogen. The main contribution from the faecal matter is the content of phosphorus and potassium and the increase in buffering capacity of the soil.

The effect on soil pH and on its buffering capacity is important in areas with such a low soil pH that the growth potential of plants is affected. The importance of this effect, which is increased if ash is added to the faeces, has been shown in field trials in Uganda. The soil pH was low and the fertilising effect of urine and faeces+ash was better than that of urine only (Figure 4).

As faecal matter is one of the major sources of pathogenic microorganisms, this fraction has to be sanitised before usage. The faecal matter should preferably be treated on site at the point of collection to avoid handling of the pathogen-containing material, as one of the major transmission routes is direct contact with raw untreated faecal matter (Faechem et al., 1983). Alternatives for the sanitation of faecal matter are biological treatment, chemical treatment or incineration.

Composting is a traditional biological treatment of organic matter. To be sure that the microorganisms are inactivated, all of the material has to attain a high temperature for a period of time (Vinnerås et al., 2003). This method requires good technological skills to function well. Com-

posting reduces the amount of organic matter and therefore there is less left in the finished compost. Faecal matter to which ash or lime has been added seems to have too low a concentration of organic matter to attain temperatures high enough to sanitise the faecal matter (Vinnerås et al., 2003).

**Figure 4:** The quality of the maize cobs varied between the treatments . Cob no. 1 from the left was fertilised with faeces + urine, Cob no. 2 with urine, while Cob no. 3 received no fertiliser.

Traditionally chemical treatment of faecal matter has been performed by addition of ash and lime. More recent studies have also shown good effects from the addition of urea (Vinnerås et al., 2003). The advantage of chemical sanitation of the faecal matter is that it can be performed at the collection site and it requires less technical skill than composting. It is important to use sufficient ash material to sanitise the faecal matter. An additional effect from chemical treatment with ash and lime is an increased buffering capacity and increased pH in the soil after application.

A third alternative is to incinerate the faecal matter. If the faeces are collected separately in a ventilated chamber, the dry matter content often becomes high enough to be combustable. When all the material is incinerated the risk of pathogens is small, as they are destroyed during the process. However, almost all of the nitrogen and carbon is lost during the process, although the amount of plant-available nitrogen is low in the faecal matter from the start. The other nutrients remain in the ash and become available to the plants when spread on soil. However, the nutrient concentration in this ash is high and therefore it should be carefully dusted out over a larger area.

As a hygiene safety measure until hygiene guidelines have been developed, we recommend that faecal matter, even if it is sanitised, should not be used as a fertiliser to vegetables that are eaten raw.

Faeces are rich in phosphorous and potassium and should therefore preferably be used on crops that have a high demand for potassium and phosphorous. The dose can be based on the recommended dose for use of phosphorous in chemical fertilisers. The risk of over-application is small, but toxic effects can occur at high application rates if the faeces are mixed with large amounts of ash.

## Application technique

To gain the maximal effect from faecal matter it should, just as urine, be applied close to the roots of the plants, but not in such a way that it is the only growing medium available for the root. The easiest way to do this is by application in holes or furrows close to the plant. Faecal material should be cultivated into the ground and covered as soon as possible after application, to prevent unwanted contact with potential remaining pathogens. For best effect, it should be applied before sowing/planting. Care should be taken to prepare a proper seed bed.

## Conclusions

The following tentative recommendations are based on our current knowledge of the use of urine and faeces in small- and large-scale cultivation.

### Urine

- If it has been collected and stored in a correct manner, urine is a quick-acting nitrogen fertiliser. Application of urine can beneficially take place from prior to sowing up to between 2/3 and 3/4 of the period between sowing and the harvest.
- The amount of urine that is used should be based on the amount of nitrogen that is recommended when fertilising with urea-based fertilisers. If no better knowledge exists, an estimate of the nitrogen concentration in urine of 3-7 g per litre can be used.
- If no recommendations can be obtained, a rule of thumb is to apply the urine collected from one person during one day to one square metre of land. The maximum dosage before risking toxic effects is approximately 5 times this dosage.
- Until further knowledge becomes available, the roots of plants should not be soaked with urine, in order to minimise possible risks of root toxic effects. Experience shows that while there is no risk with many crops, some are sensitive, especially as seedlings.
- Fertilisation with urine can be done once in the cultivation period, or repeatedly. Normally the effect on yield of repeatedly applications of urine is small if the total dosage remains the same.

### Faeces

- Faecal matter is a fertiliser rich in phosphorous, potassium and organic matter. Faeces should be applied and mixed into the soil before cultivation starts.
- Faeces contain organic matter that improves soil fertility and increases the buffering capacity of the soil, especially when it has been mixed with ash. These effects are especially important on soils with low pH.
- The faeces should be placed within reach of the roots of plants in order to maximise the utilisation of the nutrients.
- The amount of faeces used should be based on the current recommendation for the use of phosphorous-based fertilisers. There is no risk of toxic effects even at higher dosage except when the faeces are mixed with large amounts of ash.
- For hygienic reasons, the faeces should be sanitised before usage. We also presently recommend that the faecal matter is covered after application and not used as fertiliser to vegetables that are consumed raw.

Lack of documented research in this area makes the development of definite guidelines difficult. Research on the use of urine and faeces as fertiliser is needed, especially in the following areas:

- Nutrient effects of excreta on crops and soil
- Fertilisation strategies when using excreta
- Efficiency of “storage” of urine in soil
- Simple and resource-efficient sanitation techniques for faeces

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# EcoSan – clean production mechanism under the Kyoto-protocol

**Gert de Bruijne, Nadine Dulac**

WASTE Advisers on urban environment and development
Nieuwehaven 201, 2801 CW, Gouda, The Netherlands
e-mail: gdebruijne@waste.nl
e-mail: ndulac@waste.nl

## Introduction

The Kyoto-protocol provides instruments to reduce the greenhouse emissions that can be applicable for the development of EcoSan. The article will give arguments and supporting analysis that EcoSan must be regarded as clean production mechanism (article 12). Through support of EcoSan development in developing countries, industrialised countries must be allowed to claim the emission reduction that is achieved by these measurements. In a similar way joint implementation of EcoSan projects must be accounted for, and therefore become an option for investment.

The authors want to underline that EcoSan is a fundamental aspect of (urban) sustainable agriculture in the light climate change considerations, and should therefore be promoted according to article 2 of the Kyoto-protocol.

This would provide those countries extra means to invest in a sanitation approach that will avoid the introduction of sanitation system that itself also would contribute to global warming through the use of mineral energy for the construction (sewers) and operation (wastewater treatment) of the system. In addition, it will avoid the greenhouse gasses, such as methane ($CH_4$) will be release as a result of anaerobic digestion of wastewater.

## Methods

The article will be a part of the C-N research under the UWEP-Plus programme of WASTE that studies the effects of ISWM on the use of energy and greenhouse emission.

The article will depart from the assumption that all people have the right to improve their standard of living. The economic growth that will be needed to realise this desire can be expressed, among others, in the need for energy and nutrients.

As a substitute for mineral fertiliser, the application of urine and faeces in agriculture will contribute to the reduction of greenhouse emissions ($CO_2$, $CH_4$and $N_2O$). Illustrated with data of the Island on Tingloy in the Philippines, the article will present the argument that when human excreta are use as fertiliser, the standard of living of urban and rural farmers can be raised without an increase in the use of energy and exploitation of arable lands. The research will compare a develop strategy for a community in Tingloy based on the input of mineral fertilisers and of human nutrients. The model will distinguish between and based on the interrelated the C- and N cycle.

## Results

The article wants to present a simple model through which one can start compare the effect of mineral fertiliser and human fertiliser on the global warming.

It is the intention of the authors that this *Tingloy model* can be used as tool by other communi-

ties to make strategic choices concerning the choice of sanitation approach.

With the application of the model one should be able to make a rough estimate of the impact of sanitation choices in specific local context on global warming.

The article will presents links between EcoSan and the Kyoto-protocol in the following sectors/source categories:

Energy; construction; transport; mineral products; agriculture; manure management; waste; wastewater handling.

## Conclusions

The authors aspect to outline an argumentation and a supporting model that EcoSan practice must be certified under article 12 of the Kyoto-protocol, because it results in emission reduction as they are based on:

Voluntary participation

Real, measurable and long-term benefits related to the mitigation of climate change, and

Reduction in emissions that are additional to any that would occur in the absence of the certified project activity.

# Rainwater harvesting, water re-utilisation and ecological sanitation – further developments

**Dietmar Sperfeld,**
**Erwin Nolde**

Fachvereinigung Betriebs- und Regenwassernutzung e.V.
(Association of Rainwater Harvesting)
Havelstr. 7A, D-64295 Darmstadt, Germany
e-mail: info@fbr.de

## Keywords

Greywater, rainwater harvesting, water re-utilisation

## Introduction

Increasing anthropogenic environmental noxious, the change of soil exploitation and the climate change show a risk to the availability of water resources. Also the insufficient water resources in the single countries, various states of sophistication, social aspects and in many areas the low standard or a not even existing water and public sewage systems in different parts of the world are responsible for the mean supply of water. Experiences have shown that the water supply as well as the sewage water systems and clearings can not be treaten separately.

Even Germany with its high level of technology has to face many problems in this point.

The costs of preservation of the physical structures and systems for turning water into drinking water to such a standard which is requested in the German rules are very high. Main reason therefore is the increasing contamination of groundwater and the resulting efforts for the cleaning of “rohwasser”.

The traditional water-carried waste disposal as a kind of transport medium for faeces- becomes a critical look in fact of the sustainability.

Comparing to the European countries which discuss the sanitary risk already at the point of using rainwater for toilet flushing and washing machine, most other countries will be content to dispose water in such a quality as the mentioned drinking water.

Based on these facts different technical innovations for a lasting water resource management and sewage systems have been developed.

Main aspects were the responsible commerce of water, which means a lower consumption and decrease of water contamination as well as a consistent partical flow management.

Whilst Europe focus mainly on technologies for saving water and efficiency of water recycling in all processes - biological, chemical and physical – different parts of the world are still in work for water and public sewage systems in general.

The constitution of new systems also means to renew all kinds of inspections and the modification to the already existing administrative guidelines. In Germany there exist e.g. the “Anschluss- und Benutzungszwang” for properties to the public infrastructure. Therefore many different administrative proceedings will have to be settled for any kind of technical innovations of the water resources management for communities.

So far main points in Germany were to reduce the consumption of drinking water. Technical installations as water saver fittings were a success in the sanitary area. A further important part is the rainwater harvesting and water re-utilisation. Through the substitution of drinking water by

rainwater or different systems of grey water recycling, drinking water can be saved in one single household up to 50 %.

## Rainwater harvesting – state of the technology

Systems of rainwater harvesting were used all around the world with different technical efforts. Reservoirs and transport of water in mainly used in the agricultural area. The utilization of rainwater in the domestic area constantly increases.

While in developing countries the rainwater in general is collected on a low-technical standard for domestic applications and on the regional level also as drinking water and for personal hygiene, in other countries the collection of rainwater, predominantly to the industrial countries, becomes a substitution of drinking water, which then will be used for various ranges of application as toilet flushing, washer and garden irrigation. The technology of the rainwater harvesting offers numerous products for different application cases and installation sizes. A wide range of products are manufactured and are offered in the mean time.

This installation is essentially based on 2 modules. The illustration shows a central rainwater system in a domestic area, combining a pump, a supplemental feed module and the system control unit. It also shows reservoir modul, which integrates the reservoir, quiescent supply, removal line, overflow and filter completely.

The modular construction enables complete, industrially prefabricated arrangements parts finished with connection in different equipment variants and price ranges to produce.

So far the possibility is given to combine different components which are to be started if necessary with alternative sanitary systems meaningfully. Numerous physical-chemical and hygienic examinations/tests prove that the quality of the rainwater from these kinds of installations is suitable according to the state of the technology to use the water for the toilet flushing, washing machine, the garden irrigation and for cleaning purposes.

## Turning rainwater into drinking water

With water treatment systems as e.g. of Aqua Sure, The Netherlands rainwater can be proceeded into drinking water quality. Through the storage of rainwater and subsequent proceeding, these systems offer possibilities to construct public drinking water systems to smaller communities and villages or at least at the domestic area.

These systems are mainly designed for regions, which do not dispose of a drinking water infrastructure. The following pictures show a water treat system, which works with the usual process of drinking water recycling as pre-infiltration, adsorption, ion exchange and disinfection. The tool is build up on a modulare basis an works on a 40 l/h capacity. This is equal to satisfy the daily supply of a family.

Whilst countries with sufficient water resources the supply with drinking water does not show the main problem, regions with less water resources rainwater these becomes an important aspect referring to the daily water supply. By using the new developed, dezentral Wasseraufbereitungsgeräten rainwater can be turned into drinking water.

The use of rainwater in addition /as a supplement to process water, for cool systems and cleaning purposes and other applications in the commercial or industrial areas is already implemented in a lot of cases. Here, first of all, economic reasons were the clincher.

Dependent on the fees for drinking water and the connection on the public sewage water systems these investments amortize themselves in relatively short intervals.

## Grey water-reuse – state of the technology

An increasingly more important role is ascribed to the grey water reuse by the development of a sustainable water resource management. Water recycling in the domestic area is not basically new, but the comfort claims and the lifetime habits concerning water and body hygiene have strongly changed compared to the past times. The water-consumption has risen in this area definitely.

Today water recycling means to grasp and to treat slightly loaded domestic sewage water (grey water) and sewage contaminated with faeces (black water) separately. Typically grey water is such water as the drain of bathes and shower sewage, washing table and the washing machine.

In a water-saving household in Europe approx. 50 to 55 l of grey water are consumpted per day and person.

In fact of the low nutrient content a simple biological cleaning will satisfy the expectations.

Based on the daily personal hygiene grey water continuous comes up not depending on any kind of weather influences.

The arisin grey water can be grabed to quality of process water, which gives the possibility to use this water for toilette flushing, washing machines as well as for watering demands.

Grey water systems can be implemented decentralized as well as centralized.

Decentralized grey water installations are, e.g. installations which process the grey water in the point of origin during central arrangements will bring the water from several housing units together and process them.

The grey water use assumes a functioning drinking water supply system to use the water by cycle guidance repeatedly.

The following image shows a grey water installation in a new built housing area with 120 units at Bejing, China.

## Ecological sanitation

The ecosan concepts is based on a consistent separation of partical flow.

The recycling of nutrients taken from the sewage of domestic areas is most important. Analyses of partial flow show, that the nutrients are from the human excretions urine and faeces. For the further use of these nutrients special technologies are necessary to reduce and avoid the dilution of the partial flow. By the use of special sanitary systems as separation toilets, vacuum toilets and compost toilets the separation of the partial flow can be guaranteed. In an optimal case a complete recovery/retrieval of nutrients in the sewage water taken from the domestic area will happen.

A further combination of systems for solids und also power generation under assistance of biogas reactors is also possible and have successful happened.

## Furter-oriented combinations of rainwater harvesting, grey water utilization and ecosan technologies

Systems of process water and rainwater harvesting and grey water recycling are already in use and proceeded in different countries. Similar systems are already in use for the ecosan technologies. It is recommendebal to avoid any kind of administrative restraints for the implementation and realisation of new and further oriented innovations in the denzentral solutions.

Actual there are multifaceted technologies, which can be accommodated to the individual financial situation of the particular country.

So far systems of rainwater and process water harvesting were successful used in main regions showing an existing drinking water infrastructure and public sewage system.

Possibilities of combinations of the suggested systems have to be proven accordingly to the different contraints. For countries with lower rainfall the question of the quantity of collected and stored rainwater has to be clarified. It will also be important to get further information about the annual spread of rainfall, roof and collecting areas/fields as well as about the possibilities to collect and store this water.

It has to be taken care in general that countries which will investigate ground for further communities or villages, especially the developing world with a low budget of water resources, should not work with any kind of Schwemmkanalistaion.

The combination of ecosan technologies and grey water recycling should be preferred. The grey water can be drained in a dezentral soil filter and be trickled down or can be drained into the Vorfluter.

It other regions with other constraints it has to be proven which kind of combination of the single systems will be the most effective. Additional it should be considered that the installations should only use as less energy as possible so this may guarantee that regions without any infrastructure can use this installtions dezentral by photovoltic or biogas installations.

It is also possible that in the sense of economical aspects and in view of an already existing infrastructure, the combination with rainwater harvesting and grey water recyclingshoul be continued. For the development of the responsible treat with water in municipales in general, the elements of ecosan technologies as well as rainwater harvesting and water re-utilisation systems will become more and more important. The combination of both strategies will be a new task field referring to the planning, installation, operation and maintenance. Therefore further research projects and model test are required.

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# Session B

## Social and economic aspects



### Chairpersons

*Jan Olof Drangert* (Lingköping University, Sweden)

*Katarzyna Kujawa-Roeleveld* (Wageningen University, The Netherlands)

*Richard Holden* (The Mvula Trust, South Africa)

*Judith Lienert* (EAWAG, Switzerland)

### Lectures

**Requirements of sanitation systems - the flush toilet sets the standard for ecosan options***
*Jan-Olof Drangert* (Linköping University, Sweden)

**The development and implementation of ecosan in the Netherlands: social opportunities and risks***
*Bas van Vliet, Nanke Stein* (Wageningen University, Netherlands)

**Lessons learnt on ecosan in Southern Africa - towards closed-loop sanitation?**
*Catherine Wirbelauer* (DED/IUCN , Botswana)

**Experiences with ecosan in Danish allotment gardens and in development projects***
*Henrik Bregnhøj, Ann Marie Eilersen, Martin Krayer von Kraus* (Technical University of Denmark, Denmark)*, Arne Backlund*

**Psychology and sanitation: a personal perspective**
*Isabella Wilke* (South Africa)

**Source separation - new toilets for Indian slums**
*Johannes Heeb* (Seecon GmbH, Switzerland), Ken Gnanakan

**A methodology combination to expose and assess water and sanitation related household behaviour**
*Helena Krantz* (Linköping University, Sweden)

**Factors which have influenced the acceptance of ecosan in South Africa and development of a marketing strategy**
*Richard Holden* (The Mvula Trust, South Africa)*, Riana Terreblanche, Mary Muller, Nawasan*

**Integrated management of water resources in projects of German financial cooperation**
*Uwe Stoll, Bernd Schönewald* (Kreditanstalt für Wiederaufbau, Germany)

**Ecological sanitation in Mozambique: baseline data on acceptability, use and performance***
*Rebecca J. van der Meulen, Christine L. Moe* (Rollins School of Public Health of Emory University, USA)*, Edward D. Breslin*

**Urban household perception of urine-excreta and solid waste source separation in urban areas of Ghana***
*George Danso, Pay Drechsel, Lucy Gyiele* (International Water Management Institute, Ghana)

*This paper has been peer reviewed by the symposium scientific committee

**Assessment of community knowledge attitudes, practice, behaviour and acceptance of ecological sanitation in peri-urban areas of Harare**
*Edward Guzha, Cleophas Musara* (Mvuramanzi Trust, Zimbabwe)

**Environmental alternative to sanitation and food sovereignity**
*Alberto Ysunza-Ogazón, Jaime Leyva S., Enriqueta Martínez M., Silvia Díez-Urdanivia, Laurencio López N.* (Centro de Capacitación Integral para Promotores Comunitarios, Mexico)

**Cost comparison of conventional and modern sanitation solutions** *
*Markus Lechner, Günter Langergraber* (EcoSan Club, Austria)

## Oral poster presentations

**Application of ecosan principles through public private partnership projects -prospects and limitations**
*Hartlieb Euler, Pedro Aibéo* (TBW GmbH, Germany)

**Human urine from city to field - towards a sustainable co-operation?**
*Susanna Degaardt* (Kretsloppskontoret Recycling Office, Sweden)

## Poster presentations

**Complexity of basic needs and the role of ecological sanitation in the rural region of Lake Victoria, Tanzania**
*M. Grottker, D. Grottker, D. Karrasch, V. Kleineidam* (Fachhochschule Lübeck, Germany)

**Preliminary survey based on community need leading to sustainable sanitation – an Indonesian case study**
*Suriptono* (Merdeka University, Indonesia)

**Rural Sanitation in Ghana**
*Michael Tsiagbey* (Council for Scientific and Industrial Research, Ghana)

*This paper has been peer reviewed by the symposium scientific committee

# Requirements on sanitation systems – the flush toilet sets the standard for ecosan options*

**Jan-Olof Drangert**

Department of Water and Environmental Studies
Linköping University
SE-581 83 Linköping, Sweden
e-mail: jandr@tema.liu.se



## Keywords

Sanitation, sustainability, water conservation, urban agriculture, urban growth, systems analysis

## Abstract

The urge for improved sanitation arises from our care about human health as well as the care about nature itself. Pit latrines represented a visible improvement over previous indiscriminate defecation. A variety of dry toilet systems have been and are being replaced by the flush toilet - a process that started almost two centuries ago. Soil and excreta management are inherently inter-linked and they are equal partners in ecological sanitation. The modern urine-diverting toilet is about conservation of resources and protection of nature and humans.

Today there is extensive experience of the various systems from many countries and urban areas. A holistic analysis of sanitation systems comprises aspects pertaining to the toilet in the home or yard and to aspects related to the rest of the community and to nature. In this paper three toilet systems are compared. The urine-diverting toilet compares quite favourably with the WC as for environmental sustainability. If installed indoors, this toilet can match the WC for socio-cultural features. A crucial comparison between the two systems deals with the household choice whether to take on the responsibility for operation or to hire someone to do it for them.

## Introduction

The urge for improved sanitation arises from our care about human health as well as the care about nature itself. People no longer accept high mortality rates and ill health, nor do we want to rid the earth of fresh lakes and green forests. At the same time, most resources in the world are under severe stress due to rapid population growth, rapid urbanisation, and increased consumption levels. Together these trends call for assessing sanitation systems as to their sustainability.

An assessment comprises not only technical function and costs of systems but also management issues to ascertain its proper use and operation. The flush toilet connected to a sewer has been the undisputed technology for a long time. It is probably safe to say that most people in the world view the system as the best. However, the sustainability test of the flush system brings forward question marks that have to be addressed (Urban Water 2002). A variety of dry toilet systems have been and are being replaced by the flush toilet - a process that started almost two centuries ago. Today, therefore, we have extensive experience of the various systems in many countries and urban areas. This in turn allows for a comprehensive comparison and systems analysis.

The discussion about sustainability is appropriate at this time in history. We have lived through

*This paper has been peer reviewed by the symposium scientific committee

a century when the urban population of the world increased from a few hundred millions to 3 billion. In this process water scarcity and squalid conditions in our cities have appeared. By the year 2050 United Nations estimate that some 6 billion people will live in urban areas i.e. twice as many as today. How can we prepare for an urban infrastructure that avoids the drawbacks of water scarcity and low sustainability in the areas that will be converted to urban residential areas in the next 50 years?



## Three sanitation options

Three systems will be reviewed in this presentation, represented by the flush toilet or WC, the pit latrine, and the urine-diverting toilet. These systems are not singular in character, but each of them displays a range of variations.

The flush toilet is attached to a cesspool or a grid of sewers that is managed by a utility. Inside the bathroom the flush toilet shows few variations. The pit latrine is always situated in the yard and managed by the household, but may look very differently. It may be a simple construction and superstructure. The floor may be a slab of cement or just logs put across the pit. The pit may be lined or not, and it may reach the groundwater part of the year.

The third system to be discussed is the *modern* urine-diverting toilet. Its principle is simple: urine and faecal matter are never mixed. The appearance of the toilet itself includes a range of materials and design (Figure 1). The management may involve only a single household, or may comprise several households connected to a communal system.

In Table 1 some principal features are summarised that will be discussed in some detail.

| System | Toilet room | Maintenance | Potential reuse | Management |
|---|---|---|---|---|
| ***WC*** | | | | |
| - sewerage | Porcelain chair or squatting pan | Sewer content to wastewater treatment plant | Sludge contains industrial waste-water compounds | Utility |
| - cesspool | Porcelain chair or squatting pan | Emptying of compartment | Sludge including greywater content | Utility |
| ***Pit latrine*** | | | | |
| - permanent | Structure over pit outdoors | Emptying of pit | Manure | Household or utility |
| - temporary | Shed outdoors | Renewing pit | Plant tree on pit | Household |
| ***Urine-diverting toilet*** | | | | |
| - indoors | Pre-fabricated chair or pan | Collection of urine and faeces | Urine and dried faeces to garden | Household or community org |
| - outdoors | Pre-fabricated chair or pan | Collection of urine and faeces | Urine and dried faeces to garden | Household or community org |

**Table 1:** Principal features of three toilet systems

Pit latrines and WCs are well-known, while the urine-diverting toilet is less known. This toilet may use some water or be waterless. Urine is collected in a bowl or container, and the faecal matter and paper is collected in a net or bucket in a chamber below the floor. It has been installed also in two-storey buildings. Usually the collection chamber is ventilated with a pipe reaching well above the roof.

A major difference from the pit latrine and WC is that the householder or an employee has to empty the urine bowl and dried faeces. A benefit is that the stored urine and faeces constitute a good, hygienic, and relatively little contaminated fertiliser (Stockholm Water Company 2001). Simple storage is enough to sanitise the urine and faecal material (Schönning 2001). Reuse of

sludge from a sewer system, on the other hand, has proven difficult because of its content of heavy metals and other contaminants.

Below is shown a South African urine-diverting pedestal and urinal (a) in plastic. A urine-diverting squatting pan in fibreglass (b) is promoted in China. Both kinds are installed indoors in the bathroom, and the content is being emptied from outside the house. The porcelain toilet chair (c) is marketed in Sweden and can be waterless or uses small amounts of water. In case of using water the collection, treatment, and reuse of nutrients require special arrangements. The wooden box with a bucket for faeces and a porcelain funnel and urine-collection bowl (d) was in use in Swedish towns a hundred years ago.

a) Urine-diverting pedestal from South Africa

b) Urine-diverting squatting pan from China

c) Swedish urine-diverting porcelain chair

d) Old urine-diverting toilet from Sweden

**Figure 1:** Indoor urine-diverting dry toilets from South Africa and China (upper) and Sweden

## Environmental and socio-cultural sustainability and management

In the following we compare the WC and pit latrine with the *modern* urine-diverting toilet which is a technical development of the simpler version from the 1860s (Figure 1 d). A holistic analysis comprises aspects pertaining to the toilet in the home or yard and to aspects related to the rest of the community and to nature. In Tables 2 and 3 a number of important requirements are listed, associated with users, society and nature. The degree of fulfilment of each requirement by the WC, pit latrine, and urine-diverting systems is assessed.

*a) User perceptions and socio-cultural sustainability*

There are numerous reports on user appreciation of the various toilets in the house or yard. The

eight features in Table 2 are a selection, based on the kind of requirements that seem to have crucial impact on users´ appreciation of the facility.

| Features: | WC | Pit latrine | Urine-diverting toilet | |
|---|---|---|---|---|
| | | | Outdoors | Indoors |
| - smell? | No | Yes | No, if well managed | No, if installed correctly |
| - flies and maggots? | No | Yes | No, if well managed | No, if installed correctly |
| - control and security? | Yes | No | No | Yes |
| - easy and safe to clean and maintain? | Yes | No | No, since outdoors | Yes, if properly built |
| - handwashing facility? | Yes | No | No | Yes |
| - hygienic handling of urine & faeces? | Yes | Yes, if covered | Yes, but unpleasant | Yes, if properly designed |
| - affordable to most residents? | Rarely | Yes | Yes | Yes, an alternative for every pocket |
| - space required indoor? | Yes | No | No | Yes |

**Table 2:** Fulfilment of various user and socio-cultural sustainability requirements on a toilet system in the house or homestead

Some of the positive features of the WC include that it is easy to clean, is almost odourless, is indoors, and it benefits health. Odour appears only momentarily from gases and from the falling excreta. These are features that pit latrines do not have, and therefore make the latter substandard in comparison with the flush toilet. A comparison of column one (WC) and two (pit latrine) shows that the two systems are contrasting in every feature but one.

A urine-diverting toilet is odourless in the same sense as the WC and is therefore possible to install in the house. Therefore the household can control its use and who the user is, and keep it as clean as they want. It becomes as easy to clean as the WC and thus does not attract flies and maggots. Children are instructed how to use it and females can visit the toilet in the night with no fear. Handwashing after defecation will increase substantially if indoor, thanks to easy access to water and soap. These benefits will occur **only** where the toilet has its entrance inside the house or flat.

The urine-diverting toilet requires changes of a few practices, however. The handling of urine and faeces can be more or less repulsive depending on the design of the storage. In any case, it is quite different from the dirty work of emptying a latrine pit since the urine is in a container and the faeces are dry. The emptying is done from outside the house and causes no inconvenience for the residents. The frequency of emptying the urine may range from weekly to each year depending on the size of the container, and the same goes for the faeces.

It turns out that a urine-diverting toilet indoors has the same positive features as the WC when it comes to convenience and hygienic safety. A comparison of column one (WC) and four in Table 2 shows that the two systems are similar in all features except for affordability. The main difference is that the urine-diverting toilet is affordable for each pocket. The running cost is nil if the household takes care of the emptying, just like for the pit latrine, while the WC carries a cost both for the flush water and for the utility service for wastewater. Of course, the household with a urine-diverting toilet has to manage the greywater and there are simple ways for doing that.

In case the urine-diverting toilet is in the yard, the toilet has several features similar to those of the pit latrine (column two and three). Since the toilet is away from the house, a certain level of smell may be viewed as acceptable. Each time ash or water for handwashing is missing in the

toilet room, someone has to walk to the house to fetch it. If a child has diarrhoea, the caretaker has to walk it to the toilet outdoors and also to come back afterwards to clean the slab. Female users encounter a security problem when visiting the toilet after dark. Also, if the toilet room is not locked, anyone may use or misuse the toilet, and it is a less inspiring chore to clean after unknown visitors. These examples show that it is likely that (any) toilet in the yard face operational and socio-cultural problems.

*(b) Environmental sustainability*

Any toilet system has an impact on the physical environment through the demand for water and even more so when disposing blackwater or greywater, urine, and faeces. The "foot prints" may be substantial or modest depending on how the system is managed. The assessment of what happens outside the house in an urban setting includes aspects such as the ones listed in Table 3. The urine-diverting system seems more environmentally sustainable than the WC and latrine.



| **Features:** | **WC** | **Pit latrine** | **Urine-diversion toilet** | |
|---|---|---|---|---|
| | | | **Outdoors** | **Indoors** |
| - degradation of the environment? | Yes, sewer leaks to groundwater and may overflow, eutrofication if no treatment plant | Yes, may leak to groundwater and may overflow | No Greywater treated on site | No Greywater treated on site |
| - resource saving? | No, but wasteful use of water | Yes | Yes | Yes |
| - allow for reuse of nutrients? | No, due to accu-mulation of heavy metals in sludge | Yes, if pit is emptied or very shallow | Yes | Yes |
| - flexible system? | No | Yes, can be upgraded | Yes, can be moved | Yes, can be moved |

**Table 3:** Fulfilment of environmental sustainability requirements on toilet systems in the community and in the natural environment

The WC requires water for flushing and treatment of the resulting blackwater. If water supply is intermittent, households are forced to store water for flushing. Two major reasons for questioning the sustainability of the WC system are that it requires water and that it does not conserve the quality of groundwater and surface water. En route from users to the wastewater treatment plant, sewers leak despite low pressure, and in some cases pipes are blocked and the content overflows into residential areas. Such events occur also for pit latrines. If groundwater levels are shallow or the soil is very permeable, leakages result in contamination of the groundwater (Barrett and Howard 2002). If the septic tank is well-built it must be emptied regularly. However, it often happens that the collection is delayed or non-operational and therefore the household has to empty the tank in unhygienic ways.

If sewers and emptying of septic tanks function well, there is still a need to treat the wastewater before discharge into a river or lake. Technically, it is possible to clean any kind of water, but it always carries a cost. The mixing of household water with industrial water and sometimes stormwater has worsened the situation, but in a growing number of treatment plants the industrial effluent is kept separate and treated separately. Still, the demand for extracting nutrients such as phosphorus, nitrogen, potassium, and sulphur from the blackwater requires a substantial investment (SNV 2003).

The modern urine-diverting toilet provides various possibilities to recover and reuse the nutrients in human waste both on site and by a communal organisation. Due to its transparency the urine-diverting toilet encourages, in contrast to the WC and pit latrine, good user behaviour and thus gives a fertiliser of higher quality, ready for reuse in the nutrient cycle. Users will not

knowingly throw alien objects into a urine-diverting toilet, since they know that the content will be used for their own food production or in the vicinity (Drangert and Krantz 2002).

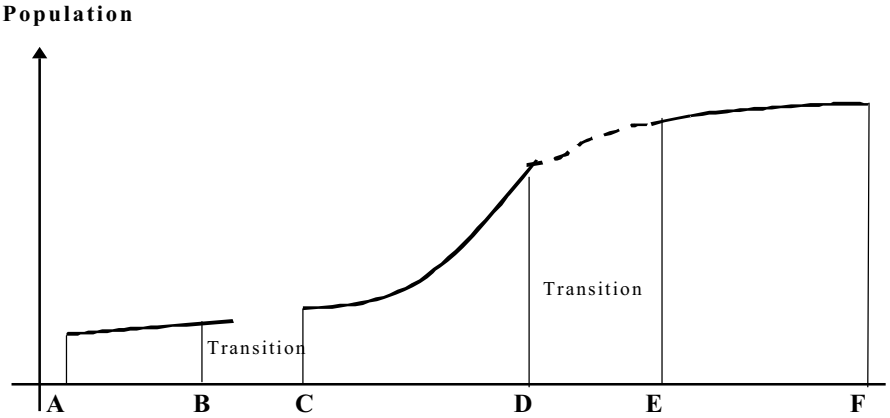
Greywater is produced also by households with a urine-diverting toilet, and it has to be treated. Again, this water can be treated in a simple biological step through sand and soil, where nutrients are taken up by plants instead of reaching the groundwater. The density of houses in the concerned area largely decides what treatment options are feasible.

*c) Management and sustainability*

Poor performance of a sanitation system may be caused by technical deficiencies, but often it boils down to managerial problems. A new framework for division of responsibilities requires new words and concepts. We introduce the term "*own-key*" to indicate activities and arrangements that are managed and controlled by local communities or individual households by employing locally available knowledge, skills and materials. The other end of the continuum consists of *"turn-key*" arrangements that are being utilised by the residents without them being involved in the development or running of the installation. The latter requires the extraction of financial resources from residents to the service provider either as fees or through taxation.

Generally, we note that demographic characteristics and hydrological conditions are factors of fundamental importance in selecting sanitation management solutions. So far we have dealt with sanitation management at household level, and now we analyse the relationship between demographic patterns and administrative capacity at community level. Figure 2 illustrates schematically a model for the link between the rate of population increase in a town or expanding urban area and the associated capacity to organise access to water and disposal of human and household waste. In order to emphasise that there is no simple cause-effect relationship involved, the figure includes transition periods when the population growth changes. The multi-dimensional causes for those changes are not dealt with in this paper.

When the urban population is small and stable or growing slowly (A to B in Fig. 2), a relatively large proportion of the population belongs to the economically active age group. Strong social links among kin and other groups contribute to a cohesive community where societal norms reign fairly uncontested. The hypothesis is that community leaders are fairly uninterested in major changes of the infrastructure. Although financial capability may be present, the leadership is often concentrating its efforts on managing low-budget services to the residents, rather than being entrepreneurs involved in a rapid "modernisation" process (Drangert et al. 2002). Free from external forces such as central government intervention, most of the water needs will normally be satisfied by the urban residents´ *own-key* arrangements.




Source: Drangert et al. 2002

**Figure 2:** Hypothetical relationship between urban population increase and infrastructure

On the other hand, during periods of rapid population growth (C to D in Figure 2), social cohesion tends to be low and public management, including tax collection, is often performed poorly. The hypothesis is that, under such conditions, existing infrastructure functions poorly and that little, if any, expansion of the public infrastructure takes place - a decline is more likely. Residents, especially newcomers to the town, are obliged to take *own-key* actions to solve, for instance, the provision of water and disposal of wastewater and human excreta. The chosen solutions may fall short of what is considered to be desirable by professional criteria. However, since the tax base and/or managerial set-up and other related functions are not adequate in this phase, the option to invest in conventional infrastructure is hardly present. Even if personnel are trained and installations rehabilitated, such measures soon fall into disrepair due to the demographic structural stress. Should this be the case, the search for improvements needs to focus on local solutions that do not require substantial inputs from the public sector. Such *own-key* arrangements are commonplace, but rarely appreciated by the formal sector. Although professionals hardly view these as appropriate, such arrangements are acceptable and, at times, sustainable and they do take into account the existing socio-cultural and economic circumstances.

The rapid urban population increase will sooner or later slow down, however, and as a result, the social cohesion will improve. The hypothesis is that authorities then will have the interest, capacity and financial strength to invest in and manage water and sanitation arrangements (E to F in Figure 2). Such a system may be a combination of turn-key and *own-key* arrangements.

## Concluding discussion

The WC has had a strong impact on the general view of what is a good sanitation system, to the extent that it is perceived as the best. Only recently has the system been challenged on the ground of failing some of the sustainability criteria. However, any alternative has to be at least as good as the WC regarding all other favourable features if it is going to be accepted. Pit latrines, which have been popular in many urban areas over the last 50 years, represented a visible improvement over previous indiscriminate defecation. However, the excreta pits have contaminated local groundwater sources and proved deficient in several, but not all aspects.

Views on toilets have changed from “getting rid of excreta” to “what should we do with excreta?” In the earlier period engineers were requested to find solutions to its discharge, while at present biologists, agriculturists, medical professionals, are involved in reshaping the solution. Urine-diverting toilets is about conservation of resources and protection of nature and humans. Excreta management is inherently inter-linked with soil rather than water, and they are equal partners in ecological sanitation. This toilet system compares quite favourably with the WC as for environmental sustainability. If installed indoors, it can match the WC for socio-cultural features. A crucial comparison between the two systems deals with the affordability of investment and operation. The magnitude of savings of financial resources for the household depends on whether they prefer to handle the reuse of sanitised urine and faecal matter themselves or pay for the collection services.

Rapid urbanisation (Fig. 2) as well as difference in productivity rates between different sectors often push for a management shift from the public sector over to households and use of local resources. The urine-diverting toilet has the important characteristic that it can be managed by the household or by a group of households or even a utility. Therefore it can be adapted to the existing management capacity, unlike the case of the WC or pit latrine systems.
Poor sustainability challenges societies to improve the existing sewerage, but also to look for alternatives. The investment made in sewerage is enormous and there is no reason to abandon or dismantle existing ones. However, the long-term task up to the year 2050 is to house an additional 3 billion urban dwellers, and calls for many alternative solutions. Since conventional sewerage with treatment plants are costly and require efficient management, more affordable

and resource-saving systems need to be developed. The leading idea should be to return nutrients to the soil, and improve and expand food production within the urban boundaries to secure the livelihood for additional urban dwellers.

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# The development and implementation of ecosan in the Netherlands: social opportunities and risks*

**Bas van Vliet, Nanke Stein**

Wageningen University, Environmental Policy Group
Hollandseweg 1, 6706 KN Wageningen, Netherlands
e-mail: bas.vanvliet@wur.nl
e-mail: nanke.stein@wur.nl



## Keywords

Urban water management; eco-sanitation; transition management; consumer participation

## Abstract

The diffusion of eco sanitation systems should be linked to the broader discourse about urban water management that is currently going on in the Netherlands. A shift from central sewer systems to de-central eco-sanitation systems involves a socio-technical transition and should therefore be initiated in socio-technical niches in order to change existing regimes of sewer management. The set-up of an ongoing social-scientific research project is discussed as well as two cases of eco-sanitation development in the Netherlands. For a successful niche development, much more emphasis should be laid upon consumer participation and societal embedding of new sanitation technologies.

## Introduction

Sustainable urban water management is a hot issue these days in circles of water managers, city-planners, municipalities and builders both in the Netherlands and abroad. The implementation of eco-sanitation as one of the options for a more sustainable urban water management is however still lagging behind.

The present paper is reflecting our ongoing work within a project [1] set up by a consortium of environmental engineers, municipalities, utilities and housing developers to develop, study and implement several techniques of on-site anaerobic wastewater treatment in the built environment. The aim of the project is to enhance the diffusion of eco-sanitation within the Netherlands, by setting up niche projects in which researchers, municipalities, consumers and other actors can learn about the new technology. Although it is our objective to broaden the research to a European scope, in this paper we will focus on the situation in the Netherlands, where we have carried out two preliminary case studies.

The social scientific component in the project addresses social problems of implementation and societal acceptance of such eco-sanitation systems. We will first argue in the following section, that implementation of such systems should be connected to the ongoing debate on urban sustainable water management in order to enhance chances of success. Secondly, we will address the development of a special kind of eco-sanitation techniques (Desar systems) as our main study object, followed by a presentation of our metho dology of research and case study selection. In order to address the opportunities and barriers to implement technologies in different spatial contexts, we argue that variables of management and consumer involvement

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should be added to the usually applied technical and environmental variables. In the penultimate section, we present the preliminary findings of some first (pilot) case studies before drawing some more general conclusions in the final section of this paper.

## The societal context: some promising developments in urban water management in the Netherlands



The tradition in Dutch urban planning and building is to deal with water as an exogenous element in urban settings. Where there is an abundance of surface water in urban areas – which is almost everywhere in the Netherlands – one should get rid of it through lowering of water levels, digging canals and building huge storm water sewer systems. Most water infrastructures of the past centuries were designed to lead water away as quickly and efficiently as possible. In fact, the Netherlands, which for the largest part is a delta of 3 major European rivers (Schelde, Maas, Rhine) has become famous for its dealing with (and fighting against) water.

Although large technical systems, and especially the deeply economical, political and cultural rooted Dutch water management system, do not change overnight, there have been a number of developments that at least have made some bursts in the leading water management paradigm.

Since the 1980s the problem of desiccation has emerged on the political agenda. The few remaining natural wetlands in the Netherlands almost ceased to exist due to the severe lowering of ground water levels. On the local level, this may have been caused by ground water extraction for drinking water or industrial water production, but the general and most important threat is the core design of water infrastructure and -management: lowering water levels for agricultural or industrial purposes or to build new housing areas. To tackle this problem, policies have been developed from the 1990s onwards to cease ground water extraction at the most vulnerable sites, and to retain water in rural areas, by financially compensating farmers.

In urban planning, anti desiccation policies have led to some innovative methods to retain water in the area by lowering the percentage of hardened surface, and by substituting asphalt for metalled roads and parking plots. Separated sewer systems for storm water and wastewater have become the new standard. Rainwater from the roofs is increasingly disconnected from sewer systems to infiltrate the soil to fill up ground water levels. The implementation of such measures on ad hoc basis gradually evolved into more generic policies that put forward that water should be the leading principle in urban planning (Ministry of Environment, 2002). This means that existing ground water levels, water currents and flood are a given for new building projects.

While problems of desiccation have mainly been addressed by experts and policy makers, much more in the forefront of public debate is the - at first sight - opposite development of increased and more severe floods. After major the floods of Maas and Rhine in 1995 and 1997, the planning of housing and other building in the flood beds of these rivers have been cancelled or altered to meet the adapted flood risk assessments. Also the paradigm of building increasingly bigger and higher dikes to combat increasing flood-levels is slowly changing into seeking and appointing retention areas where high water volumes can temporarily be stored during floods. The consequence for urban planning and building firstly resulted in the reallocation of projects that were planned in flood beds but it now increasingly implies that housing and building are adapted to the occurrence of floods: floating homes, reservation of public space for watersheds etc.

Parallel to these developments is the increasing (re-) appreciation of surface water in urban public space. Living at the waterside has become very popular among house-owners and most new residential sites now include various smartly designed waters to border as much back-

gardens as possible. Some urban planners sought and found gaps in regulations by which they could convert compulsory percentages of 'green areas' in their plans into 'blue space'. In addition, new residential sites experiment with more sustainable water management techniques such as reed-bed filters for on-site grey water treatment, rain water infiltration and dual water supply systems.

The culmination of these and other new water visions has been assembled in an influential advice to the government on Water Policy in the 21st Century (Commissie Waterbeheer 21e Eeuw, 2000). The Commission recommends a radically different approach to water management, in which water drainage as practiced in traditional water management should only be reverted to if retention and storage capacities have been utilised to their maximum. Space should be created and reserved for water storage and all spatial planning activities should be preceded by a 'water check': all qualitative and quantitative consequences for water systems should be assessed and compensated where needed.

These bursts in long existing water management paradigms seems also promising for the change of a major subject of urban water management: the sewer system. The Dutch sewer system belongs to the most advanced and probably the most dense sewer systems in the world. Increasing numbers of connections (now including rural areas) and increasing scales of treatment plants, together with institutional up-scaling through the merging of Water Boards, have contributed to a further centralisation of management and more sophisticated technologies of transport (pressure pipes), monitoring and treatment. However, these innovations did not alter the disputed design principles of sewer systems: diluting waste (nutrients) with drinking water, transporting it over long distances and treating it with the use of much energy, while generating environmentally problematic sludge. Therefore, we would argue that a thus-far underestimated aspect of sustainable urban water management is the development and implementation of alternatives to large-scale sewer and sewer treatment systems. To gain more public as well as institutional support for alternatives to sewer systems we would suggest that these alternatives should be developed and evaluated within the context of the promising trends in urban water management as have been sketched above.

## From sewer to desar systems

In the afore mentioned EET research project, a specific type of eco-sanitation is considered; DeCentralised SAnitation and Reuse (Desar) systems. Desar systems () encompass a radical shift away from current technological systems of sewers and large-scale wastewater treatment. The main principles of Desar conflict with those of current sewer systems. In Desar systems waste is concentrated instead of diluted and it is treated on-site in compact mostly anaerobe systems. Its products will be reused for soil improvement and/or energy production (Zeeman and Lettinga, 1999). We are dealing here with more than just a next step in a well-defined trajectory of sewer technology development. It is a radical shift away from the basic principles of sewer technology. Such technological shifts, or *transitions,* encompass much more than a change of hardware. The new techniques require a different technological regime as well: the set of rules and regulations and institutional organisation are until now perfectly geared to manage sewer systems, not Desar systems. Equally radical are the changes that users, suppliers and service managers need to make in their daily practices. Collection, storage and discharge of human waste in Desar systems bears more resemblance to domestic waste management than to the current sewer system.

Our social scientific interest in such a transition deals with the changing practices of providers and consumers dealing with sanitation and the changing relations between them (see also Van Vliet, 2002, for similar studies of consumer-provider relations in drinking water and electricity networks). For this reason, we need to explore and compare not only the technical lay-out of Desar and sewer systems, but rather the changes in social practices around the building, use

and management of these sanitation systems.

Social scientific research is rare in 'technological niche' projects like this. In most cases ex-post evaluations can be made: normally only after the development and implementation stages of technology development, one can make judgements about social implications of new technologies. In these cases, sociologists are left with hardly more than the study of acceptation of new technologies by its users. In the current project we are able to study technological development and implementation from *within*. The framework which we will use to do so is that of the management of technological transitions (Rotmans *et al*, 2001). Transitions encompass long term radical system innovations. The magnitude of change in technological transitions differs from only optimised versions of current systems in the following ways:

- In terms of eco-efficiency, a factor 20 improvement is envisaged in stead of factor 5 as in system optimisation
- The pattern of change follows an S-curve with a predevelopment, acceleration and consolidation phase (see figure 1 below)
- Transitions include changes in *regimes*: the rules and institutions shaping and enabling systems to develop

In order to enable regime changes, *technological niches* need to be developed: 'protected' spaces in which actors learn in various ways about new technologies and their uses. Protection is needed as regimes are configured as to support and to develop the technological trajectories that are currently in place, rather than to support or develop alternatives to these systems. Legal exemptions, subsidies or extra manpower may be needed to enable such niche projects to develop within current regimes.

Where technological niches are situated on the micro-level of socio-technical change, and regimes on the meso level, the macro level is that of a socio-technological landscape (see figure 1). The socio-technological landscape provides the broader context for regime and niches. The landscape metaphor refers to the structural character of its influence to technological development: the technological trajectories are guided by the gradients in a landscape of societal or cultural beliefs and practices. Changes in the landscape only occur gradually and slowly. A transition can now be defined as a gradual process of societal change, in which there is a structural change of characteristics of society (or a significant part of it) (Geels, 2002). Whether a regime shift will occur is dependent of a coincidence and coupling over time of successful processes within the niche, reinforced by changes at the regime level and at the level of socio-technical landscapes.

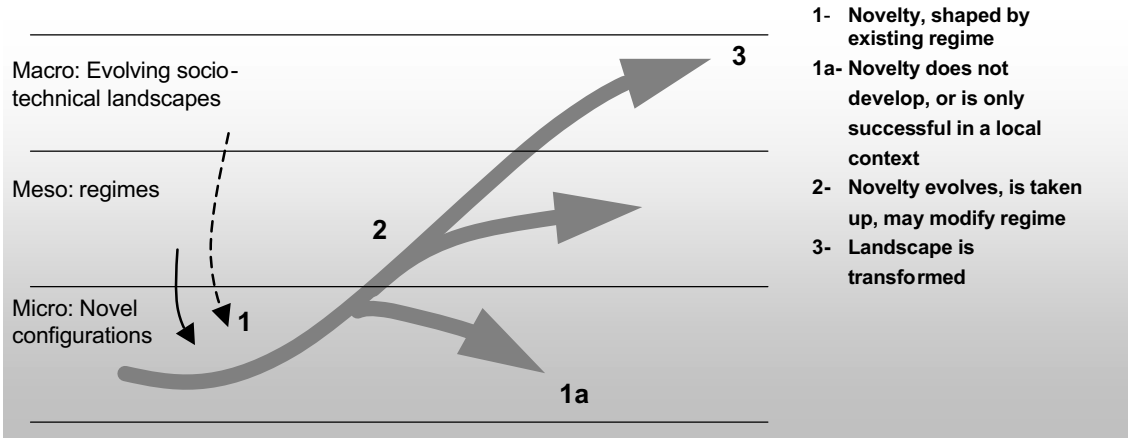


**Figure 1:** A dynamic multi-level view of regime shifts (Rip and Kemp, 1996)

Our study of implementation of eco-sanitation systems, of which Desar technologies are one example, and other alternatives to current urban water management is based on the idea that experimental projects may function as socio-technical niches to further regime and landscape changes in the practices (including technology uses) of urban water management and sanitation. The research includes case-studies of development and implementation of sustainable urban water management projects in different contexts of housing and utility building. . The selection of cases is derived from an initial inventory of environmental innovations in sanitation and urban water management, which is deliberately much broader than Desar technologies only. This inventory reveals a number of relevant variables to proceed our study (see figure 2). Three main clusters of variables can be made to categorise the cases of our study: conventional systems (a), alternative systems (b) and what we have called 'modernised mixtures' (c).

a) Conventional systems can be found in the clustering of values at the top of the diagram: central organisation, large-scaled systems and low user involvement.

b) Alternative systems are to be found at the opposite end of the diagram: small-scale systems, responsible users, de-centralised organisation.

c) Our research aims at combinations of these variable scores (modernised mixtures) in stead of deepening the dichotomy between 'modern' and 'alternative'.

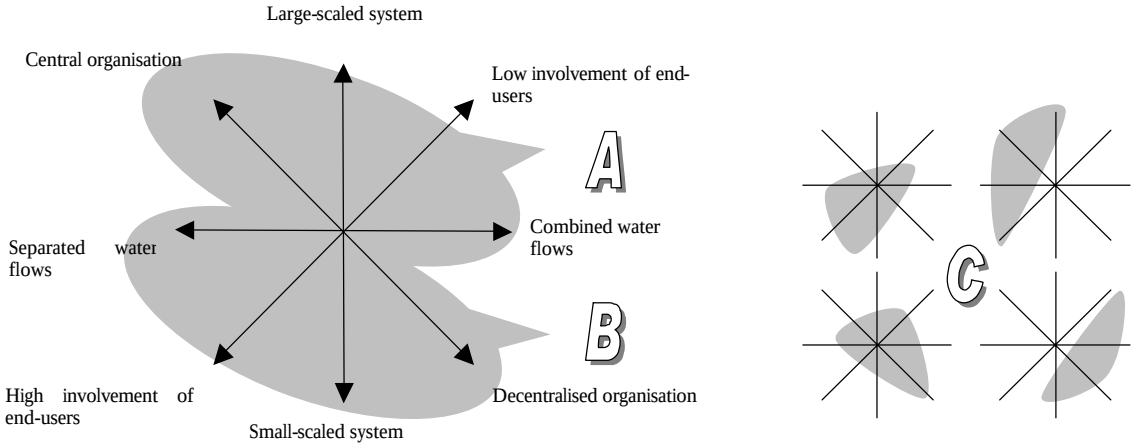


**Figure 2:** Variables for the inventory and selection of eco-sanitation cases

Conventional sanitation systems (a) are centralized systems designed for the treatment of single water flows. Large-scale sewer systems collecting all water flows are the extreme example of this category. The end-user involvement in these systems is low.

The category of alternative systems (b) has since the early seventies been propagated and developed by supporters of Schumacher's 'small is beautiful' thesis, encompassing consumers, technicians, philosophers and environmentalists. The idea is that not only the hard-ware of sanitation systems should be of a small, 'human' size, especially the social organisation around the design, implementation, use and maintenance should be kept as small or local as possible, to secure democratic control by the user of such systems. Besides, it is believed that such small systems are the most environmentally sound. Examples within such an alternative category are 'stand-alone' systems that do not need a connection to larger infrastructures, like composting toilets, rain water recycling systems, and reed-bed filters for waste water.

The category of 'modernised mixtures' (c) encompasses various score-sets on the four variables mentioned. Examples are centrally managed vacuum systems at the scale of a

residential area with a high separation of flows and low consumer involvement; or small-scale but sewer-connected water systems based on the dual water flows and high consumer involvement. As these empirical examples illustrate, we are dealing here not only with a mixture of 'conventional' and 'alternative' technological aspects but with a mixture of social elements as well. The modernised mixtures bring together social and technical elements that used to be strictly separated and organised into ideological debates between the opponents and defenders of conventional, centralised and complex large technical systems.

Our case studies will be done at small and medium scaled systems, in which some waste streams are treated on-site and others transported and treated elsewhere for reasons of environmental efficiency. We will monitor in such cases of modernised mixtures the process of initiation, development and implementation of the new technology. From the side of providers (technology developers, municipalities, utilities, water managers) we assess which regime shifts are needed for a successful transition towards these new systems as well as their views about possible routes of diffusion and the role of end-users. Besides a particular emphasis is laid upon the involvement of end-users in design, diffusion, use and management and the consequences of these changes for current practices and standards of cleanliness, comfort and health.

## Two pilot case studies

As the project is still in its initial phase, we can only present the most eye-catching elements of two pilot case studies, which will be followed through during the project. Although for the purpose of this paper we only look at the Dutch situation, we think that our findings will not only be of value in the Netherlands, but that they will be equally applicable in a wider European setting.

Therefore we will include cases in Germany and Sweden, where experience with eco-sanitation is already further developed. We expect that in these countries too, success or failure of eco-san experiments not only depends on technical adequacy, but just as much on the social environment in which the new technology is introduced. Below our first findings of two Dutch cases are presented.

The *first* case of Desar application we have followed from the start is the planned installation of an anaerobe treatment system of toilet and organic kitchen waste in a new urban residential site in the Netherlands. Although most parts of the system have been successfully applied in other settings (vacuum toilets in trains and aeroplanes, anaerobic treatment at various scales in industry), this would be the first application of Desar technology in domestic urban setting, in this case an apartment block, to be built in a larger residential site. The central idea was that if Desar infrastructures and techniques should be applied at household level, Desar technologists have to be involved in the earliest stages of urban planning.

The municipality, responsible for the planning of the site, had initially committed itself to support the experiment by allocating extra space within the requirements for the architect of the building. Besides, the municipality had to deal with the regional Water Board for all exemptions that are needed in standard procedures concerning sewer connection, and (human) waste management. Lastly the municipality should find a way to collect the remaining sludge from the Desar system and transport it to municipal waste facilities or farmers in the region, at least during the course of the experiment (scheduled for 2 years).

The technology can be characterised as medium to small-scale, based on a separation of waste water flows, a decentralised organisation and a thus far non-existent involvement of the still unknown end-users. The case resembles many aspects of a technological niche-project: the installation of a deviating technology for (human) waste treatment as well as its transport system (vacuum pipes and toilets) needs protection in the form of exemptions of sewer regulations, as well as subsidies to reserve space in the basement of the apartment block and

to install a vacuum system and treatment tanks.

Although these measures of niche protection were more or less secured in advance of the project, it was certainly not enough to get the project started. Apart from technologists, municipality and water board professionals, there are many more actors involved in the planning, design and building of the site. Municipalities do not build houses, they commission private parties, (project developers, architects, building and installation companies, real estate agents) to execute the project from the initial design stages to the selling of the houses to individual consumers. In discussing the project with all these actors, it became apparent that both the municipality as well as project developers, proclaimed to be spokesman of the unknown end-consumers. As project developers and real estate agents are the risk takers in selling the apartments, one should not be surprised when they are the first to object to experiments that may affect either the price or the attractiveness of the apartment to the potential buyer. The municipality, although committed to the execution of the Desar project, also felt responsible for the well-being of its (future) citizens, and for the proper management of the system as well.

Because many crucial aspects of the experiment with vacuum toilets and Desar treatment systems were still unresolved - from seemingly trivial issues like the shape and colour of toilets to more intrusive aspects of management and transfer of technology after the experiments would come to an end - both the municipality and project developers have suspended their collaboration until these issues are clarified. One of the proposed solutions to start the project in time was to transfer the experiment to a block of *rental* houses, owned by the housing corporation in the municipality. This would ease the problem of managing and maintaining the system (the housing corporation would be the main actor here) as well as the issue of limited consumer choice over colour and shape of toilet systems (as consumers of rental houses are used to have no choice). However, this proposal has its shortcomings too and it is by now still unresolved as to whether and where the Desar installations can be built.

The lesson that can be drawn from this example of initiating a niche project is that apart from a commitment of the municipality and a subsidy for the installations, one has to deal with many more conditions under which such anomaly in the current system can be developed. Municipalities and Water Boards are legally responsible for a proper handling of human waste and they wish to have solid guarantees that alternative systems will work as well as, or even better than, the systems they are used to work with. As long as there are as many uncertainties as in the current project, their willingness to co-operate is limited. One of the other outstanding issues seems to be the representation of the end-consumer and his or her expected behaviour. As long as end-consumers are not known, other actors feel legitimised to act as their spokesman with an almost unavoidable caricature as a result. Project developers argued that consumers would renounce buying an apartment if they would find out that they do not have more than 2 models of toilets to choose from, or that they are linked up to a vacuum system in stead of a normal flush system. The problem with such claims is that they cannot be confirmed, nor refuted without consulting the consumer. This is exactly the reason why we have put consumer involvement as one of the factors alongside other characteristics of a water technology to take on board in the evaluation of niche projects.

Consumer involvement should not be caricaturised either. Our idea of consumer involvement stems not – or at least not only - from ideological considerations. We do think that generally speaking consumers are better off when they have a say in all matters that may influence their daily lives. But enabling and organising consumer involvement in technology design and service provision also serves more pragmatic purposes of proper functioning, prevention of misuse, cost reduction and many others. Moreover, in a time of liberalisation of the provision of water, waste and energy services, consumers have already become, willingly or not, much more active players in service provision than in the time that they were captive consumers without having any choice but to use the available networks.

Another project that we have selected as a case study may illustrate what consumer involvement might encompass in sustainable urban water management. In this case, the waste water system formed an integral part of the initial design of a new housing area. The plan to integrate sustainable water management with energy saving, sustainable building principles and participation came from a group of potential inhabitants, who all had different but correlated professional backgrounds in the sustainability field. In the mid-nineties they found a positive response in the municipality of a medium-sized town in the centre of the Netherlands, which at that time was thinking of developing a site that used to be reserved for ground water extraction only. The municipality managed to obtain an additional building quota from the Province, with the condition that it would be spent on this sustainable housing project. In the initial planning phase the project partners included the core group of inhabitants, the municipality, several utility companies (water, gas and electricity), an architect and a representative body of the wider group of potential buyers of the houses. To cut down costs, the municipality decided not to delegate the project to a project developer, but to become the main commissioner itself. In combination with the security offered by the known group of future inhabitants, and the enthusiastic participation of the involved project partners a higher environmental ambition level was obtained than could be realised otherwise.

Another success factor lays in the philosophy behind the project. It encompasses a much broader vision on the outcome of the project then in our first case. It is a vision on sustainable living, that links quality of life with quality of the surrounding environment, in which the use of sustainable technology is just the means to an end, not the centre of the project itself. With this vision, potential inhabitants could be attracted in an early stage of the planning process, so that their wishes could be incorporated in the project before the plan became too definitive.

Not all went according to plan however. It is still not clear whether the biogas installation, that is scheduled to process the black water from the neighbourhood, will come into being. The water system as it exists today (2 years after the first 50 of a total of 200 houses have been built) only consists of the use of rain- and process water as second quality water in the houses. The reed bed filters that are designed to process the grey water of the neighbourhood will become functional when all houses and office buildings will be finalised, and a 'living machine'[2] might be added to process the water of an educational centre for which plans are made at the moment. When the wastewater system is functional, inhabitants will be expected to participate in the management of it. They are also legally responsible, if something goes wrong.

Due to time pressure, the level of inhabitant participation was much lower then envisaged beforehand. Although three workshops were held in which the wider group of inhabitants could ventilate their wishes, they were not able to modify their houses individually, as was planned. The professionals involved in the project were mainly responsible for the choice of sustainable technologies; inhabitants for example had no say in the choice for water saving toilets as opposed to a vacuum system or composting toilets. Inhabitants seem not to be too worried about this lack of participation; they do not mind the professionals to decide on the definite technology, as long as this technology meets their environmental and living standards.

When the system becomes fully operational, it will become clear if the standards of cleanliness, comfort and health of the inhabitants are met, and if these are compatible with a sufficient environmental standard. We will follow the developments closely in the coming years.

We see two major differences between the two cases that might give an explanation for the so far limited results in the first case and the initially successful course of the second case. One difference is that of the scope of the project: the first case is mainly about the implementation of a new technique. The 'hardware' was known, but problems emerged as soon as issues about the 'software' (management and maintenance issues) became apparent. The scope of the

[2] A 'Living machine' consists of a mini-ecosystem in which wastewater is treated naturally.

second case was much broader from the very start of the project: not the technology itself was put to the foreground, but the implementation of a sustainable way of building and living, for which new technologies should be developed and implemented.

The second major difference between the two projects concerns the involvement and representation of (future) inhabitants. They were not known in the first case so only assumptions could be made about their acceptance of new routines. Consumer participation in the design and principles behind the second case seems to have enhanced the willingness to change routines and to accept new responsibilities towards the use and management of new technologies.



## Conclusions

We have argued in this paper that the implementation of decentralised eco-sanitation techniques encompasses nothing less than a socio-technical transition in wastewater management. Although we have witnessed some bursts in traditional water management, thus far a transition from sewer based sanitation towards eco-sanitation is lagging behind. However, the introduction of eco-sanitation would be much more accepted if it were linked to the now ongoing debate on water management rather than if eco-sanitation were only presented as a radical antagonist of sewer systems.

Successful transitions require strategic niches to be developed in order to alter contemporary regimes that are not supportive to eco-sanitation. The development of niches is a matter of careful selection of stakeholders and project preparation, as we have illustrated in our case studies. The involvement of end-consumers seems to be crucial as current conceptions of what consumers might do or need may be only a caricature of what consumers in practice can and are willing to do in eco-sanitation projects. In terms of project initiation it is important not to limit its scope to the hard-ware only. In many cases, the crucial barrier for social acceptance is not merely the technology, but rather its 'software': regulations, management, maintenance and use of technology. With this paper we have shown that when setting up eco-san projects, it is important that besides technical and economical factors, also social and institutional factors which influence the process of social embedding of the technology are considered.

Although the project is still in its initial phase, we already gained some important insights in socio-technical routes of design, diffusion, implementation and use of eco-sanitation technologies in the Netherlands. These insights will hopefully contribute to a better planning and execution of environmental innovation in sanitation technology in the Netherlands and abroad.

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# Lessons learnt on ecosan in Southern Africa – towards closed-loop sanitation? [1]

**Cathrine Wirbelauer**
CBNRM-Missing Link project
IUCN – The World Conservation Union
Private Bag 00300 Gaborone, Botswana
e-mail: cathrine@iucnbot.bw

**Edward D. Breslin**
WaterAid – Mozambique
CP 276, Lichinga, Niassa Province, Mozambique
e-mail: wateraid-mz@teledata.mz

**Edward Guzha**
Mvuramanzi Trust
House n. 2 Manfield Road, Malbrough, Harare Zimbabwe
e-mail: 237612@ecoweb.co.zw



## Keywords

Closed-loop sanitation, lessons learnt, social acceptance, Southern Africa

## Abstract

"Lessons learnt on Eco-San in Southern Africa – towards closed-loop sanitation?" is a short analysis of experiences gained in Ecological Sanitation with an emphasis on closed-loop systems. In Southern African countries the poorer segments amongst a rapidly growing population cannot afford conventional sewage systems and existing approaches to wastewater management and sanitation have become largely non-viable. In response to this, following the example of some Eco-San projects around the world the first compost latrines and Urine Diverting systems were introduced in the Region in the late nineties. Since then households are slowly starting to see the advantages of Eco-San and the systems are becoming more and more accepted despite users having to manipulate urine and faecal matter (often considered a taboo and dirty). However, the response to the different systems available in these countries has not been the same but was depending on household expectations, availability of space, living conditions etc.. Even though Eco-San is still very young in the Region it seems to be a suitable option to address sanitation and environmental concerns, but there is still a long way to go before the loops will be closing in Southern Africa.

## Introduction

"Human excreta are composed of urine and faeces, which are produced in different quantities, have different qualities, and provide different benefits. Urine, faeces and the combination of urine and faeces can be processed in a number of ways. Regardless of how processing occurs, the goal is to return excreta to soils"[2]. The systems representing the approach of returning nutrients to the soil "are based on a systematic implementation of a material-flow-oriented recycling process"[3]: Closed-Loop Sanitation. When we talk about closing the loop we usually don't only think of by-products from the toilets but also combine the cycle with water

[1] With contributions from Aussie Austin (CSIR, South Africa) and Richard Holden (Mvula Trust, South Africa).

[2] SA Esrey, I Andersson, A Hillers, R Sawyer (2001)

[3] Ecosan-closing the loop in wastewater management and sanitation, Proceedings of the International Symposium, 30-31 October 2000, Bonn, Germany.

management, “as an hygienically safe, circular and holistic alternative to conventional solutions”[3]. The latter however will not be part of this analysis.

In the Southern African Region (mainly South Africa, Zimbabwe, Mozambique and lately Botswana) the priority of most Ecological Sanitation (Eco-San) projects that were initiated was to address sanitation and health problems. The developments have been manifold and results are very different. Only very few were directly linked to the idea of closed-loop sanitation. Why? Which processes are driving these projects? What are the aspects of a successful implementation of Eco-San projects in the Region? Is Eco-San a solution? Will the loops close? These are only some of the questions we have asked ourselves in analysing country case studies and compiling lessons learnt. The paper is subdivided in paragraphs containing information on general experiences in the different countries, whereas the boxes contain lessons learnt from a methodological point of view in each country. The paragraph on “Overall Lessons Learnt” is an analysis of both experiences and lessons learnt.

In the Region three main Eco-San systems were tested: the Fossa Alterna, the Urine Diverting (UD) systems and the Arbour Loo. The Fossa Alterna is a composting toilet with two vaults, when the first vault is full it is left unused for composting and the second vault is used. The UD-system is a dehydration system where urine is immediately diverted either into a container or a soak away and the faecal matter remains dry. The Arbour Loo is a composting system with a light superstructure based on a very shallow pit. Once the pit is full the superstructure is moved away and a tree can be planted into the full pit.

## Experiences in Mozambique

In Mozambique, the introduction of Eco-San started after the collapse of the country’s centralised slab-construction programme that had left the sanitation sector uncertain about the way forward. The Sanitation policy is unclear, particularly at Provincial level. In this context, since 2000/1 ESTAMOS, a Mozambican water supply, sanitation and HIV/Aids prevention/education NGO, and WaterAid, a British water supply and sanitation NGO, have been implementing Eco-San projects in the Niassa Province. Geographically the Niassa Province (Northern Mozambique) is the most sparsely populated province in the Country. The Province is characterised by poor infrastructure, a weak cash-based agricultural economy, and political and social isolation.

The initial idea was to implement water and sanitation activities in Lichinga in collaboration with the Municipality. During a participatory process water- and sanitation-related health problems (e.g. malaria and diarrhoea) emerged as being key concerns among local residents. During the same exercise residents realised that their latrines were contributing to these by being breading area for mosquitoes and by polluting the underground drinking water supply. Out of a number of options (Improved Pit Latrines, Two pit latrines, traditional latrines and Eco-San systems) the latter were identified as the most appropriate to solve the problems.

The concepts that underpin ecological sanitation were surprisingly well received and interest in Eco-San grew following the installation of demonstration models at leaders' houses. Households with the new latrines, mainly Fossa Alterna, spoke with their neighbours about these healthier and cleaner systems, that are odourless, fly-less, easy to build (shallow and stable), aesthetically pleasant and that can be combined with the washing area (often a tradition in the country). Aspects related to the re-use of by-products were also positively received and people were looking forward to use the compost to transform their yard. The enthusiasm increased especially after the first pits had been excavated, when users and authorities could see that the compost was of extremely high quality, thus assisting in the acceptance of a possible closed-loop use of the systems. A further advantage of Eco-San systems was that people perceived them as permanent solutions in contrast with pit latrines that once filled were relocated. In addition a few Arbour Loos were also constructed and fruit trees were tested

including guava, mango, orange, avocado, as well as a range of local fruit trees. The latter system did not prove very popular in the villages because of lack of space around the houses, but was more popular and affordable at the fields where the systems could be built with local materials. Nevertheless, reasons for the acceptance of Eco-San can be very different and families were not only interested in sanitation for health reasons, but also for reasons of status and convenience. Many users referred to Eco-San systems as "modern toilets", given their recent introduction in the Province.

**Lessons Learnt in Mozambique:**

- ✓ Initiatives that allow families to choose between "Improved Latrines" and Eco-San systems proved to be more successful and people consistently prefer ecological sanitation over others.
- ✓ The acceptance of Eco-San systems is easier when people understand their problems and identify solutions by themselves.
- ✓ Interest in EcoSan and a closed-loop approach has subsequently grown as people have seen the contents of the pit and fears about excavating „unprocessed" faeces have diminished. People understand the concepts behind ecological sanitation, as they are simple, especially with demonstration models in place. (Learning by Seeing)
- ✓ Awareness raising and outreach programmes play an important role when introducing Eco-San (combination of participatory work and social marketing principles).
- ✓ The desire to build a "new", aesthetically pleasant and permanent latrine that eliminates problems of smell, flies and mosquito habitats while protecting groundwater is proving to be powerful enough to overcome cost considerations.

Monitoring and evaluation (M&E) also proved to be essential in providing critical information (especially at a technical level), thus strengthening the understanding of sanitation in Mozambique. Some of the more important observations made through M&E included that: people used too little soil/ash mixture because of the fear that the pit would fill too quickly; ash only is less effective against odours than the mixture; some kept their Pit Latrines for visitors because they were afraid of witchcraft and also wanted to keep the compost "clean"; during the rainy season Eco-San required greater management and care as the hole becomes quite damp and it becomes difficult to find dry soil to add to the mixture etc.

In Mozambique Eco-San seems to be a viable option both in peri-urban and rural areas, and evidence suggests that many people will invest in Eco-San systems over better promoted alternatives even if they already have a conventional pit latrine.

Looking at closed-loop Eco-San, Mozambicans recognise that the systems can have an added economic value. The closed-loop concept seems to be culturally acceptable as in the past many people in the Province planted trees and vegetables in disused latrines. The acceptance of Eco-San has been overwhelmingly positive in the Niassa Province and the use of the compost from the toilets for vegetable gardens has proven to be a considerable incentive for people who depend on farming. However, most of the new pits haven't filled-up yet and some questions still remain open: will people really excavate their pits once the faeces and urine have been converted to compost, and once the second pit is full? Will they really use the compost and fertilisers from the toilets for agricultural purposes and in their gardens? Those who have started applying the by-products to fields or home gardens have had positive results especially with maize and many are now testing on tobacco.[4]

## Experiences in South Africa

In South Africa Eco-San was first piloted in 1997 through the CSIR (Council for Scientific and Industrial Research) and the ECATU (Eastern Cape Appropriate Technology Unit) in the Umtata area (Transkei). Since its very start it was directly associated with the UD-system, which was introduced as the only Eco-San option and was piloted as a new and better technology (compared to VIPs). Shortly after the start of the pilot project, the „National Sanitation

[4]Breslin and dos Santos (2001); Breslin (2002)

Programme“ that aimed to ensure that everyone had access to adequate sanitation systems [5], experienced problems of difficult geological conditions, precluding the construction of VIP. Eco-San was then introduced as an alternative solution[6] to VIPs for areas with these difficult conditions (e.g. rocky, sandy, high water table). The Mvula Trust, a local NGO, on behalf of the Department of Water Affairs and Forestry, started carrying out larger sanitation programmes and introduced UD-systems mainly in the Northern Cape.

As the UD-system was introduced following the Central American example, the “main research objectives” of the pilot project in the Transkei “were to test the basic acceptability of the technology and to determine the potential for resource reuse” [7] in the Southern African context. During the same pilot, issues related to the use and maintenance of UD-systems as well as cultural taboos and beliefs were also addressed. Community and Household involvement were immediately considered to be crucial and consultation processes were undertaken. Initial worries on how to store cleaning material or on the collection and re-use of urine for example were integrated into project implementation, thus not hindering the use of these new systems.

**Lessons Learnt in South Africa:**

- ✓ Sharing experiences with others around the world is crucial (the introduction of the UD “technology” was based on experiences from various countries including Central America, Mexico, Sweden and Vietnam).
- ✓ Political will and tensions within Communities/Areas can influence Eco-San.
- ✓ When introducing Eco-San social and cultural considerations are of utmost importance.
- ✓ Cash-subsidy stifle self-initiatives and continuous access to funding is required to maintain momentum on highly subsidised projects. A subsidy in kind (e.g. pedestal, some building material) could motivate households/communities to get on with improvements by themselves.
- ✓ In order to be successful and to increase rates of coverage a wide selection of methods and materials must be made available so as to meet the need and aspirations of different households/communities.
- ✓ Social interventions and health and hygiene awareness programmes should always accompany sanitation programmes, not only during the planning and implementation stage but also for a period of monitoring and follow-up.
- ✓ Sustainability is only achieved when the community wants and accepts the level of service provided, is able to pay for it and the skills are available locally to service the systems

Whilst introducing UD-systems some further cultural and technical aspects had to be covered: “men must sit down when urinating unless a separate urinal is provided; toilet paper does not decompose in the vault (because it is a dehydration and not a composting process); what do you do with the urine and with the faecal matter”[6], the system would only be appropriate if households were prepared to handle the by-products, etc. These questions were promptly addressed and the acceptance of UD-toilets was relatively positive.

During the implementation of the National Sanitation programme, it was noticed that Eco-San was accepted mainly because the system met people’s expectations around privacy, dignity, safety and convenience rather than health. Although the UD-toilets required more input in terms of maintenance, families appreciated the fact that the structure was permanent and could be built inside the house; that it required lower building, operation and maintenance costs, and that it was odourless. These perceived benefits meant for many households that the inconvenience of handling dry excreta was less disturbing than the inconvenience of moving a toilet or of using the bucket system.

Although the added value of high fertilisation and conditioning potential of the by-products had been recognised, the questions related to the re-use of these and a closed-loop approach were only promoted during the pilot project in the Transkei and not during the National Sanitation programme. In fact in South Africa there is not a culture of re-use and the UD-system was introduced solely to solve sanitation problems. The by-products of the toilets were not re-used

[5] Defined as a minimum of a Ventilated Improved Pit (VIP) toilet;

[6] Holden, R. and Austin, L.M (1999); [6] Austin, A and Duncker, L. (1999)

directly, the urine was led to a soak pit (and possibly taken up by adjacent trees) and the dehydrated faeces was simply thrown into the mealie fields, burned, in some cases buried or composted. The strategy of introducing Eco-San by emphasising on social aspects rather than on the added value of a closed-loop approach has been one of the success factors for the introduction of the systems in South Africa.

There is more to Eco-San than the acceptance by individual households. Community requirements to improve their sanitation systems, their willingness to be involved in sanitation processes as well as their ability to solve their problems themselves were felt to be extremely important aspects.

In South Africa the importance to adopt a holistic and multi-sectoral sanitation programme where successful implementation is linked to a “step-by-step” approach has been recognised and pursued. Toilet construction is seen as part of a bigger programme that includes: change of personal behaviour, improved water supply and storage, safe disposal of domestic waste and proper handling of food towards improved health and quality of life.

Although research on the safe use of urine and faecal matter for agricultural purposes has been undertaken, projects implemented have mainly been looking at improved sanitation, health and safe disposal of faeces. In South Africa there isn’t a culture of re-use and some taboos are still alive. However, people are slowly becoming more receptive to re-using the by-products. Some pits are now being emptied and some people have thrown the faecal matter on the mealie fields and are now starting to realise that mealies grow better.



## Experiences in Zimbabwe

The main reason for introducing Eco-San in Zimbabwe in 1997 was to address problems related to sanitation and health in peri-urban areas and soil impoverishment in rural areas. Since then, the Mvuramanzi Trust, a local NGO, has implemented projects in both informal peri-urban settlements around Harare (Porta Farm, Dzivarasekwa extension and Hatcliffe Extension), and in rural areas of the Country (Guruve and UMP district, Mashonaland, Central and Eastern province).

Eco-San started with the experimentation of Compost Pit latrines and at a later stage (since 1999) the Arbour Loo, the UD-system and the Fossa Alterna.

In the peri-urban context mainly sanitation and health problems had to be addressed as in some cases 1 toilet squat was used by more than 100 people. In these very needy areas Eco-San was positively appreciated mainly because of its private use, being user-friendly and easy to maintain. As Eco-San had the added value of providing compost, the systems were quickly considered to be a household asset. An evaluation study based on a 20% sample of the people with Eco-San toilets in the informal peri-urban areas near Harare was undertaken to assess the acceptance of these systems.

Generally Fossa Alterna systems were preferred to UD-bucket systems (people didn’t want to carry the buckets with the faecal matter, they did have some problems with pipe blockages, and the toilets were smelling). Only 30% of the households did not use the by-products, mainly due to the lack of knowledge on how to use them safely. People did not know whether compost from others could be used or only own compost, whether urine would burn plants (although this only happens when directly poured onto the leaves) and whether it was generally safe to use the untreated by-products. Results also showed that whereas the majority of families used the compost (80%) most of the households didn’t want to use the urine alone (61%). The use of faecal matter seemed to be acceptable on high-standing crops (maize, sunflowers, trees, flowers etc) but not on vegetables. There were fears that, because of lack of space for gardening, very quickly problems related to the disposal of the compost within the settlements would arise (the supply being greater than the demand for use).

In the rural areas of Zimbabwe the introduction of Eco-San systems was of a different nature. In fact, following the price increase of fertilisers and the poor over-cultivated soils some Eco-San projects started-off straight away with the major purpose of introducing cost-effective ways to restore/improve soil fertility in poor rural areas. In these areas UD-systems and Arbour Loos were tested.

**Lessons Learnt in Zimbabwe:**

- ✓ In very difficult situations (e.g. overpopulated poor peri-urban settlements; poor over-cultivated rural areas depending on agriculture) where people are desperate for solutions the introduction of new systems as Eco-San can be easier.
- ✓ The acceptance of a closed-loop approach is higher in rural areas where people depend on farming and easily recognise the added value of using the by-products.
- ✓ Proper training on Eco-San and a closed-loop approach need to be guaranteed but also a bigger involvement of all the family members pursued (too often only women carry the burden of sanitation, health and gardening, this should be avoided).
- ✓ Technical problems on the re-use of by-products can create confusion and jeopardise a process that is already difficult. This can be overcome with proper awareness raising and adequate research.
- ✓ The introduction of Eco-San and a closed-loop approach seem easier in countries where the culture of re-use has existed for a long time. In Zimbabwe most households traditionally have already composts for example.

After initial resistance to use the by-products, households finally started using urine for the production of a number of crops like rape, beans, peas, tomatoes, onions, maize, cotton and fruit-trees. Observations showed very quickly that results differed a lot depending on which crops urine was used on and many technical questions on the proper use of it were raised (concentration, application distance, timing, frequency and volumes of application). Further research on the improved use of urine and faecal matter for agricultural purposes had to be undertaken. Some rural communities that had seen the added value of using Eco-San systems in a closed-loop approach were prepared to start trials on the use of urine as fertiliser, provided they were given sufficient information and health safety assurance. In these rural areas both systems met with success: the Arbour Loo being easy and cheap to build and mobile (ideal for the fields and for planting fruit trees), the UD-system being also easy to maintain, cheaper to build and permanent.

Finally, through the generation of income at household level, Eco-San together with a closed-loop approach had an important economic impact that also contributed to the acceptance of these systems in Zimbabwe. The use of faecal matter and urine in crop production improved crop yields from backyards and fields, thereby improving household food security and increasing household income opportunities. It was quickly understood that a closed-loop approach could allow for an improved crop production with reduced inputs (especially on fertilisers) and thereby improve livelihoods in both rural and peri-urban areas.

## Experiences in Botswana

Mid 2001 IUCN (The World Conservation Union) and PTB (Permaculture Trust Botswana), a local NGO, started an integrated resource management project in Botswana. The main aim was to pilot a household centred approach where the management of all natural resources used by the households would be integrated (water, waste, gardening, veld products). As part of the strategy, Eco-San was introduced in an attempt to close the loop. The start-off has been slow as proper awareness raising needed to be undertaken with participating households. Results are yet very little but from the experiences of the past 2 years households seem to accept Eco-San (they all chose UD-systems) mainly because: the toilets do not smell, the structures are not too expensive to build and local material can be used for it, little water is needed and the depth of the pit is shallow hence not dangerous. Households acknowledged the importance of a closed-loop approach for the improvement of soil fertility and are looking forward to use the by-products in their gardens. Will they really use them? A huge challenge is still ahead!

## Overall lessons learnt

In the Southern African projects, Eco-San systems were positively received as appropriate sanitation systems. When people could chose between conventional and Eco-San systems they preferred Eco-San. People accepted the systems mainly because they are user friendly, permanent, aesthetically pleasant, odourless, easy to maintain, and "private".

However, the response to the different systems available in these countries varies. For example, in peri-urban areas of Zimbabwe and densely populated areas of Mozambique, the Fossa Alterna system was preferred to UD-systems, whereas in rural/rocky areas of South Africa the UD-system was preferred. In both Zimbabwe and Mozambique, Arbour Loo systems have been well received in rural areas (at the fields) but rejected in more populated areas. Generally the closed-loop approach was more acceptable in rural areas where people depend on farming and recognised the added value of using the by-products for agricultural purposes. Whereas in peri-urban areas people seemed more preoccupied in addressing sanitation and health problems first and were more reluctant in manipulating the by-products, thus choosing those systems where less handling was required. In all cases, it seems uppermost important that people are given the choice and that social as well as cultural aspects are considered.

The choice of Eco-San over other systems and eventually the choice of adopting the closed-loop approach were easier when people identified by themselves that sanitation was the main cause to their conditions (poor health and poverty). The use of participatory methods and social marketing tools seem to have provided a good basis of understanding in most of the projects. Successful Eco-San projects (whether looking at closed-loop or not) need also to be accompanied by proper awareness raising campaigns, adequate capacity building and intensive social interventions from their initial stage. One of the successful methods to do so has been the "learning-by-seeing/doing" approach whereby people accepted Eco-San and the idea of closing-the-loop when they could see the high quality of the compost, they were trained on how to safely handle the by-products, and when knowledge had been shared.

When projects were driven by government priorities of quickly addressing major health and sanitation issues (e.g. South Africa), the closed-loop approach was not promoted. As those governments respond to a critical situation that needs a fast solution the closed-loop approach is far too time consuming. It was noticed that projects that start with the sole idea of addressing sanitation and health issues have difficulties in integrating the closed-loop approach at a later stage. Experience has also shown that when the processes are driven and financed from outside the communities, thus increasing dependence on "others", they can be instable and fail once financial and institutional support weakens.

Was the added value of Eco-San really appreciated though; are the experiences in the Region pointing at a closed-loop approach? In Mozambique as well as in Zimbabwe, the closed-loop approach seems to be acceptable (especially in areas depending on farming). Generally, when users are made aware and sensitised about the added value of having an Eco-San system and using the closed-loop approach from the very start they have time to appreciate this advantage slowly. It also became evident that in Countries where there is already a culture of re-use of waste (e.g. Zimbabwe), it is easier to introduce the closed-loop approach. In these Countries the use of by-products (when accepted) was applied mainly to crops and trees and less to vegetables, indicating that although the concept is acceptable fears are still alive and efforts should go towards alleviating these fears by providing tangible results.

## Conclusions

Since 1997, when the first compost latrines and dry systems were introduced in the Region, some progress towards closed-loop sanitation has been made. Research on safe handling and re-use of by-products has been undertaken and is already informing the projects in

Mozambique, South Africa, Zimbabwe and the pilot in Botswana. Although users have to manipulate urine and faecal matter, often considered a taboo and dirty, households are slowly starting to see the advantages of a closed-loop approach and the systems are becoming more and more accepted. In Southern Africa, the closed-loop approach seems to be generally more acceptable to poorer populations and farmers, who more easily recognise the added value of using Eco-San systems. In more populated areas people seem rather preoccupied by health and sanitation problems and do not recognise the immediate benefit of using the by-products. Even though Eco-San is still very young in the Region it seems to be a suitable option to address sanitation and environmental concerns, but there is still a long way to go before the loops will be closing in Southern Africa.

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# Experiences with ecosan in Danish allotment gardens and in development projects*

**Henrik Bregnhøj,**
**Ann Marie Eilersen,**
**Martin Krayer von Krauss**

Environment and Resources DTU
Technical University of Denmark, Bygningstorvet 115
DK-2800 Lyngby, Denmark
e-mail: hb@er.dtu.dk
e-mail: ame@er.dtu.dk
e-mail: mkk@er.dtu.dk

**Arne Backlund**

A & B BACKLUND ApS
Ordrupvej 101
DK-2920 Charlottenlund, Denmark
e-mail: backlund@backlund.dk

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## Keywords

Ecosan, dry no-mixing sanitation, urine collection, developing countries, allotment garden

## Abstract

Experiences from four projects dealing with the implementation of ecosan toilets are presented. The projects took place in Denmark, Afghanistan, Burkina Faso and Guatemala. The approaches to implementation and the arguments that "sold" the idea are evaluated. The paper discusses how the experience gained in the four projects can be used in practise when implementing ecosan. In general, the main priority for end-users was to have an affordable and comfortable sanitation facility. In some places recycling of nutrients is already a priority, and in other places it seems to be possible to promote it. Whether or not people experience eco-san positively seems to be dependent on whether or not the eco-san toilets are used correctly. Demand must be created through information and mutual engagement in order to achieve a successful result. It is equally important to ensure involvement of the users in all aspects of the implementation and running of the toilet system. Communication, both before and after implementation, is paramount.

## Introduction

The latest WHO/UNICEF assessment (Year 2000) indicates that in Africa, Asia and Latin America, the percentage of the urban population with access to sanitation is 84/78/87%, respectively, in urban areas, while in rural areas the percentage is 45/31/49%, respectively. There has been some improvement in Asia and Latin America since 1990, but in Africa the expansion of the sanitary infrastructure has barely kept up with the increase in population. The daily number of diarrhoea related deaths (mostly children under five), due to poor sanitation, hygiene and water supply, is equivalent to the crash of 20 jumbo jets.

There are also reasons to be concerned about the food production in some of the poor regions. Approximately 800 million people are affected by hunger according to the World Food Programme and approximately 250 million people are directly affected by desertification according to FAO. Exhaustion of land due to the insufficient addition of fertiliser is common in poor regions.

*This paper has been peer reviewed by the symposium scientific committee

The resolution from the Earth Summit in Johannesburg 2002 states that the number of people without access to sanitation facilities should be cut down to half before the year 2015. Although in principle the statement is positive and encouraging, implementation projects carried out in practice have faced severe problems in introducing sanitation. There is a great need for looking into better arguments and approaches to “selling” sanitation to local populations.

Dry No-mixing sanitation with urine collection provides a number of benefits that can be used as arguments for implementing sanitation. The hygienic collection of faeces and urine, the reduction of pathogenic organisms in the waste products during storage, the comfortable low-smell atmosphere, the protection of groundwater from contamination, the potential for reusing the nutrients in the fields, plus the resulting increased crop production are some of the main benefits associated with these sanitary systems. These benefits may lead to a higher interest from people without access to or with poor latrines.

The current paper discusses four eco-san implementation projects: one in Denmark, one in Afghanistan, one in Burkina Faso and one in Guatemala. The discussion will focus on the approaches to implementation and the arguments that "sold" the idea. On the basis of these four projects, the paper discusses how the experience gained can be used in the current practise of implementing ecosan.

## Methods

The method used to evaluate the experiences with dry no-mixing sanitation with urine collection is implementation and interviews with the users. The extent of implementation and stakeholder participation varies between the projects. The specific conditions for each project will briefly be described in the following.

In Denmark dry toilets with urine collection were implemented in 89 allotment gardens, (Backlund et al., 2003). Eight different models of diverting/no-mixing sanitation systems without water flush for separate collection of human urine and human faeces were established in 1999-2000. The aim of the project was, through user participation in both planning and decision making, to find a more sustainable alternative to chemical and water flushing toilets and to gather the users experiences with the systems. The stakeholders that took part in the project were: the Danish Allotment Gardens Association, the municipalities, local allotment gardener organisations and voluntarily participating owners of allotment gardens. The incentive for the Danish Allotment Gardens Association to initiate the project was the fear that municipal authorities would demand the construction of sewers.

In rural areas of Herat Province, Western Afghanistan, a local modification of the Vietnamese two-chamber urine-collecting toilet was developed and a study of the inhabitants’ sanitation habits was conducted in the year 2000. An interview investigation of 49 questions was made with 55 men and women about their perceptions and practise of hygiene and sanitation and their interest in using ecosan. 17 latrines were implemented in 2000 and evaluated the year after.

**Figure 1:** Moulding of slab and implemented result in Herat, Afghanistan *(Photo: Dorthe Eriksson)*

An interview investigation was carried out in Sabtinga, a rural community of 3000 inhabitants, 20 km North of Ouagadougou in Burkina Faso.10 male heads of families comprising a total of 160 people were interviewed regarding their habits and attitudes towards sanitation, hygienic practises and interest in ecological sanitation, using a questionnaire of 44 questions. The investigation was made in preparation for a possible pilot implementation program for UNICEF and a local organisation, CREPA.

In Guatemala three villages in Laguna Lachua National Park were briefly examined. 101 Ecosan latrines of the LASF type (Esrey et al. 1998) had been implemented in 1997-1999. The latrines were examined in 2000 by inspection and people were interviewed about their use of and experience with the latrines.



## Results

*Allotment gardens in Denmark*

A successful implementation of diverting/no-mixing sanitation in the allotment gardens was achieved. Personal engagement on behalf of the project management and stakeholder participation in planning and decision making lead to the effective transfer of enthusiasm and knowledge about ecosan to participants, which was key to the success of the project. The majority of the 176 residents who took part in the project were within the age of 41-70 (typical for allotment gardens), and the distribution between sexes was fairly equal. Prior to the introduction of the diverting/no-mixing toilet systems, most of the residents had a chemical toilet.

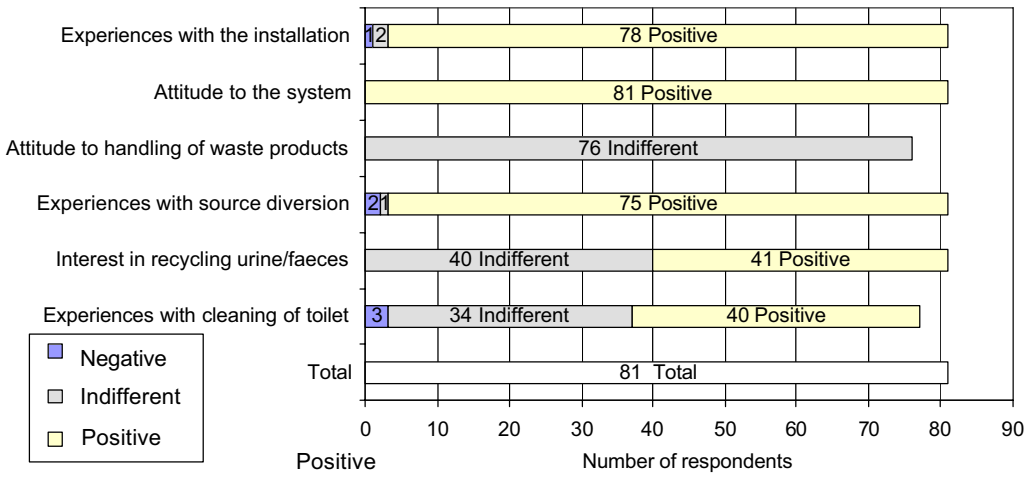


**Figure 2:** Attitudes towards and experiences with the ecosan systems in allotment gardens in Denmark. The answers have been lumped together in three groups to illustrate whether the attitude or experience was negative, indifferent or positive.

By interviews the participants were questioned about their attitude toward the toilet systems, see figure 2. The installation of the system went very well, there were some minor problems, which was solved with a help from the supplier. Some of the participants would have liked a manual in Danish instead of Swedish. In general the participants were rather indifferent towards the handling of the waste products urine and faeces. The general remark was that it could be a little smelly, but it was not a problem. The source diversion went well; there were two elderly women who had some problem with the urine collection, in that the urine went into the faeces container. Some minor children had to get used to the system. The interest for recycling the waste products to the garden was very high. However, it was not possible to obtain a permit to do so from the Danish authorities. People have therefore been instructed to bury it in the

ground. Regarding cleaning of the toilet, the participants were either positive or indifferent. Only 3 participants found it more difficult to clean the present than the prior toilet, all 3 used to have water closets. The attitude towards the system in general was positive to very positive. Descriptions like clean, nice and brilliant, were used. A few participants mentioned that it could be a problem for visitors to use the system, others that the visitors would like to get one too. In general the participants were happy that they did not have to use chemicals as was the case with when they used a chemical toilet. They thought that it was a very good and cheap alternative to the installation of sewers. The price for the toilet systems varied from 200 to 1.200 US$. 72 % of the participants chose a solution in the price range of 700 – 770 US$. The estimated costs for implementation of sewers are around 7000 US$ per household. Aside from the higher cost, another disadvantage of sewer implementation is that it forces all families to use the same system, regardless of their preferences and lifestyle.

**Figure 3:** A+B: Backlund H1; C: Separett Villa 9000

Regarding implementation, it is very important to meet the expectations of the participants or, if it is possible, to go beyond their expectations. Good and continued communication can eliminate unrealistic expectations and secure that the more realistic expectations are fulfilled. Such extensive communication is very time consuming, but essential for success. The basis of the project was the free choice of the participants. Participation was voluntary, and a range of flexible solutions at different prices, was presented to fit individual needs. This promotes decision-making and self-management of the participants. It was often the woman who took the initiative to be part of this project. Here, as in many other countries, women often take the initiative to change the living conditions of the family. The participation of the woman in the family can, for many projects, be important in order to secure a new technology gets deeply rooted in the society.

The personal experiences of the users are of the greatest importance for the development of the technology. They contributed personally to the development of new technology by their evaluation of the systems and comments to sitting heights, design etc. The development of the new toilet "Separett Villa 9000" is partly based on the experiences of the participants of this project. "BACKLUND H1" is directly based on experiences from the project.

Overall, the response is that dry ecosan systems are excellent inexpensive alternatives to traditional systems. The advantages of establishing diverting toilets, as opposed to solutions with sewers, are among others water savings and recycling of nutrients. Furthermore, the economical advantages for the allotment gardens are considerable.

*Vault latrines in rural areas in Afghanistan*

The typical sanitation system in rural areas in Western Afghanistan is a raised single vault latrine, which can be emptied when full, or a pit latrine, which is not emptied. In this investigation 55 people were interviewed in 2000, before the implementation of ecosan systems started, hereof 29 males and 26 females. The people interviewed were chosen to cover the diversity within the community and they are representatives of >10% of all families in 9 villages in Herat

Province, Western Afghanistan. Males and females were interviewed by an interpreter of their own sex. 62 % of the respondents had a latrine, see figure 4. 65% of the latrines were of the vault type and 86% of families with vault latrines used the mixed excreta as fertiliser. Thus, approximately 35 % (62%*65%*86% = 35%) of the population in Herat are already applying excreta on the fields according to this investigation. After emptying the latrines the excreta is either buried (53%) or stored in a heap covered with earth (47%) for an extended period of time before it is applied on the field. The main risk of disease transmission is therefore on the men who empty the latrines, which contain some fresh excreta.

Out of the 21 families without latrine, 19 would be interested in having one, the two others were migrants who were not motivated to invest in property they didn't own. All 19 would contribute labour and 63% also materials, but cash payment is a problem among the poor people. All respondents were asked about their attitudes towards using urine collection and recycling of faeces and urine on agriculture. As it can be seen from figure 4 practically all of the respondents supported this method of recycling nutrients. However, for religious reasons, it was considered problematic to mix urine (considered unclean) with water (considered clean). The diverted urine could therefore not be applied by sprinkling on the fields.

The main reasons for having a latrine were that: It provides a visual shelter from the public (65%), it isolates the dirt in one place (58%), it is clean/hygienic (compared to bushes) (42%) and it yields fertilizer (16%). Vault latrines are usually used for depositing all kinds of dirt from e.g. sweeping (but not food waste) because it helps to keep smell reduced. 73% could not see any disadvantages of having a latrine, but 22% mentioned smell and 5% emptying as adverse effects.

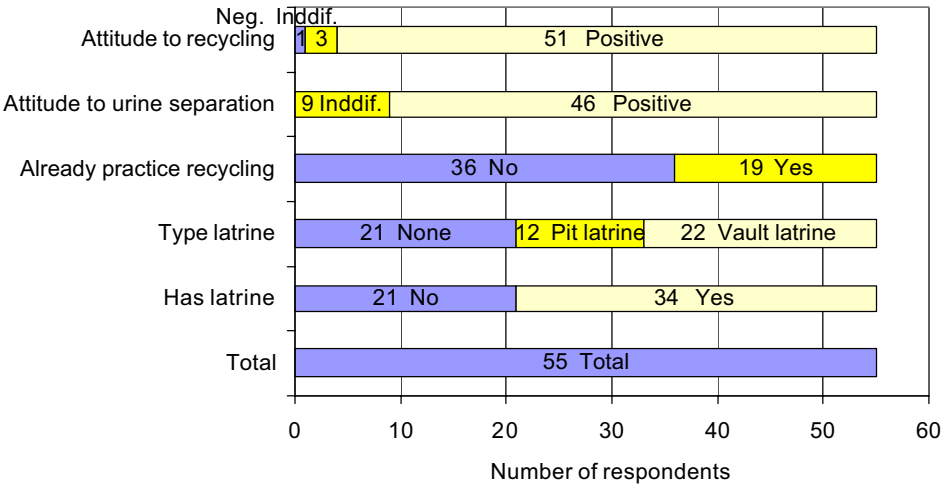


**Figure 4:** Latrine types and attitudes towards recycling of urine and faeces among 55 families in Herat, Western Afghanistan.

Based on the positive attitudes a design for a double vault latrine with urine collection was developed, inspired by the Vietnamese type (Polprasert et al. 1981). The design was developed together with the NGO Danish Committee for Aid to Afghan Refugees (DACAAR), and implemented by 17 families in 2000.

The latrine has a slab with two sets of holes and two vaults, to be used one at a time. The two units share a common urine collection system. Unlike the Vietnamese system, urine is led to a soak pit outside the latrine. The idea is that the soil in the soakpit could collect most of the nutrients from the urine and be used as fertiliser regularly.

In 2001 a follow-up survey was carried out. The main findings were that:

Latrines were being used by all household members and the users found them to be an improvement over their old type in terms of being of a good size, not as smelly as the old latrines, and the numbers of flies are less.

The separation of urine from faeces seemed to be working as it should.

The urine recycling method had not worked at all. It is not clear if it was because they did not receive sufficient instructions, if they did not understand the instructions, or if they are not willing to follow the instructions given.

The latrine was not replicated. This is exactly the same situation as with the DACAAR single vault type of improved latrine, which was also very seldom replicated. The problem seems primarily to be that the cost was found to be too high, but also that the latrine takes up too much space in the compound.

A lot of efforts have been stalled by the war and poor weather conditions, but the design is still being considered as an optional design in DACAAR's water supply, sanitation and health education program.

*Interest for ecosan in Burkina Faso*

Out of the 10 families interviewed in Sabtinga, Burkina Faso, 7 were Catholics, 2 Muslims and 1 animist. Only a few households in the whole village had pit latrines, but none of them were included in the interviewed sample. 90% of the interviewed were dissatisfied with not having a sanitation facility, and they argued that they lacked the money for constructing latrines. The reasons for wanting a latrine were 1) Improved health conditions, 2) privacy, 3) fear of snakes in the bushes and 4) the fact that certain animals eat faces and people later on eat the animals.

The family chiefs saw no conflict with their traditions in handling human excreta and using it as fertiliser. Their interest for ecosan was high, mainly because of the fertilizer it provides. People showed by words and by delivering building materials that they were interested and ready to participate in the construction, but they would not contribute money for it. A double vault latrine design was developed, and UNICEF Ouagadougou was interested to carry on with the idea.

*Double vault latrines with urine collection in Guatemala*

Our final investigation in Guatemala was an examination of previously implemented double vault latrines with urine collection of the LASF-type in villages in the Laguna Lachua National Park. It was found that the majority of the latrines were either not used or in a very poor state. Those in use were stinking, the faces vaults were wet and disgusting, and faeces ran out on the ground from open lids behind the latrine. According to the villagers, they did not receive proper information, or in some cases any information at all, about the use of the latrines when they were constructed. Some families did not participate in a capacitating course. Two single well functioning latrines showed that there were no fundamental technical or climate barriers for a proper functioning of the LASF-latrines. People were just not interested or did not know e.g. how to add soil and lime to keep them working.

## Discussion

*Motivation for procurement of ecosan*

The most well-known arguments for procurement of ecosan toilets has to do with advantages of recycling nutrients to agriculture and avoidance of pollution of the environment with pathogenic organisms via wastewater. For people without sanitation or with very poor sanitation facilities these may however not be the "selling" arguments.

In Burkina Faso and Afghanistan, where many people have no sanitation facilities, shelter/privacy was the main argument for procuring a sanitation facility. Improved health/pathogen control and cleanliness also had high priority. These arguments may sound

trivial to people who already use toilets, but should be included as prominent messages when selling Ecosan in these areas.

In Afghanistan recycling of nutrients in agriculture was also mentioned as an argument by 16% of the people, due to the fact that it already is a habit for some people in the area. Even though the fertiliser argument may not have the highest priority, it is still important to many people. In these countries the recycling aspects can be directly used as part of the selling argument to people without sanitation facilities and as a main argument in upgrading from e.g. a pit latrine.

The reduction in bad odour and flies due to the source diversion was another feature of ecosan that was appreciated in the Afghanistan implementation project, and this would presumably be a useful argument for people that are used to more smelly latrine types.

In the Danish project the selling arguments were different, although the main interests were similar. People saw the ecosan option as a cheap alternative to the very expensive solution with sewers.

The price argument is exactly opposite in Afghanistan and will be the same in other poor rural areas of the world; ecosan is generally more expensive than other options, such as various types of pit latrines. Here the additional arguments of less smell and flies and improved production in agriculture have to be conveyed carefully together with the arguments of health/pathogen control and privacy.

Generally the people of e.g. Denmark, Afghanistan, Burkina Faso and Guatemala seem to share the desire for an affordable and comfortable sanitation facility.

*Implementation of ecosan*

The experiences in implementation differ widely in the four examples we have looked into. This is natural because of the extreme differences in settings and cultures. However, one similarity is that whenever ecosan toilets were used properly, people perceived it as a good solution. In addition to this, there are also lessons to be learned from the ways the projects were promoted.

The importance of how the message is delivered is illustrated by the differences of success in Guatemala and Denmark. In Denmark the marketing of the ecosan toilets was combined with participation of the users and other related stakeholders in both the planning and decision making, and was followed up by continuous contact with the users after implementation. The project even resulted in development of a modified design based on user preferences. This is in total contrast to the Guatemalan project where the toilets were implemented without even explaining the daily operation procedures to all households.

Although ecosan is not too complicated, the daily operation is important for the well-functioning of the toilet and user satisfaction. In the simpler models for developing countries, operation involves adding an appropriate amount of dry material, while experience show that this is not necessary for odour removal in the Danish models furnished with ventilators. Follow-up after implementation makes it possible to correct mistakes and answer small and large questions, and will raise the satisfaction with the project.

Simple solutions adjusted to the needs and interests of the participants, based on a source diverting technology and local materials and manpower, should be developed and implemented. The point of departure could be based on already existing relations, and the establishment of local demonstration projects.

Cost recovery aspects of implementation also play an important role. Both the Danish and the Afghanistan project involved partial subsidisation of the facility. In Burkina Faso people stated that they were mainly able to provide labour and some materials for construction. It is in all cases motivating that prices are low or lowered and has contributed to the success. Considering the general difficulties in selling sanitation in rural areas of developing countries, it may in fact be necessary to subsidise in order to get implementation started. However, when the campaign

is over, there is not necessarily a spreading effect. This was demonstrated in Afghanistan where people continue to construct pit latrines because they can be constructed for free. It will continue to be a problem among poor people, but when the benefits of ecosan for agriculture, and thereby income, have been more widely demonstrated in an area, it may result in larger demand.

The use of urine as fertiliser seems to be a difficult task in certain areas, even though most of the nutrients in the toilet waste are found in the urine. In Afghanistan people didn't use the urine, perhaps due to poor information, lack of tradition, or the labour involved in emptying the urine pit. The same rejection of the urine has generally been found in projects in Latin America (Esrey et al. 1998). More demonstration and information work should be done in this field, because of the high fertiliser value of urine.

## Conclusions

The four different projects have illustrated that people can have a positive attitude toward the use of ecosan whether they are Danes, Guatemalans, Africans or Afghans. There is a lot to be learned from the successes and failures of these projects. Whenever the sanitation facility is used correctly, it has been shown that it can work in practise, and that people in general have a positive experience from, and attitude to, the use of ecosan. The success depends largely on whether or not the demand is created through information and mutual engagement, and on whether or not people are involved in the design of their own facility through a close communication. Involvement of relevant organisations and economic support in the establishment phase is important as well. More success stories and engagement from sanitation implementing agencies in ecosan solutions is needed for the continuous spreading of the system.

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# Psychology and sanitation: a personal perspective

**Isabella Wilke**

Box 32703, Braamfontein, 2017, South Africa
e-mail: isabi@iafrica.com



## Keywords

Psychology, constructs, change

## Abstract

Promoting ecological sanitation involves confronting potential users on a psychological level. I illustrate this through my personal experience as a user of a dry urine diversion system. However, everyone's experience will be different. George Kelly's concept of 'personal construct' is a useful concept towards describing the multitude of attitudes, preferences and taboos people may have surrounding sanitation.

Asking people to change the sanitation system they're accustomed to, is asking a lot. It amounts to asking potential users to change their particular and ingrained personal construct regarding sanitation. How does one convert potential users to accept ecosan? From my experience I have crystallised four key concepts which played a major role in successfully changing my 'flush-loo' personal construct to incorporate ecosan. These are motivation, choice, supportive environment and experience.

## Introduction

At a very early age, we learn our toilet habits from our parents. The way we use and experience our sanitation solutions are almost as old as we are.

Children are ready to be toilet trained, depending on their maturity, from the age of about eighteen months. In time we learn also, for instance, how to use a knife and fork, or how to independently perform many other small but important tasks essential to our daily living. But it's often our ability to use the toilet properly that comes first.

The rituals surrounding relieving ourselves are tied up with our parents views and habits plus our broader cultural and economic context. What we learn from these sources, become a 'personal construct'.

This term 'Personal construct' is a concept I borrowed from George Kelly's Cognitive Personality Theory.

## George Kelly's cognitive theory of personality and personal constructs

George Kelly (1905 – 1967) was an engineer turned psychologist. He proposed a personality theory called the 'Cognitive Theory' in which he develops the concept of 'Personal Constructs'.

According to Kelly, a 'personal construct' is an attitude we acquire through experience. It's a bundle of habits, views, attitudes and preferences about issues such as work, retirement, marriage, family life. Anything and everything about our lives. This must then includes sanitation.

Should one confront an individual with sanitation systems other than what he/she is accustomed to, one is, broadly speaking, appealing to that person on two levels.

The first is the intellectual level, possibly involving understanding technical or environmental issues. The second very important issue is the psychological one. One would be confronting that individuals personal construct regarding sanitation.

## The personal construct threatened

Kelly maintains that changing our core personal constructs create stress. We experience anxiety, even fear. The object of change presents a threat. It may even produce aggression.

This brings me to my personal journey with ecological sanitation. Initially, I experienced urine diversion as a threat to my personal flush-loo, non-involvement construct of sanitation. I wasn't exactly scared of it. And it most certainly didn't make me turn to violence! But I did experience some anxiety.

## My story: a personal perspective

I have zero interest in toilets. I have zero interest in promoting ecological sanitation. Despite this, I use a dry urine diversion system on a daily basis, as a matter of course.

I am a middle class woman living in Africa. I explore and intellectualise about religion, socio-economic issues – just about everything. I find new ideas exciting. After all, I'm a South African. We live with change. It's routine for us. In short, I regard myself as being open minded.

So - when my husband suggested putting urine diversion into our home I was all for it. I intellectualised about it much as I would on any other issue. It was quite exciting. I'm always ready to try out something new. Besides, my husband is happy to go with all my mad-cap ideas. I might as well support him in his. Intellectually, I also accepted that urine diversion would work on a technical level. I simply assumed that all the good people promoting ecological sanitation know what they're talking about.

Despite my conscious acceptance of ecological sanitation, it still wasn't part of my long standing, deep seated personal construct of toilet behaviour. I didn't realise this. So when it came to the crunch, and out of the blue, urine diversion presented as something of a threat and cause me some anxiety.

This became clear only once I was confronted with a urine diversion pedestal in my own en suite bathroom.

## The psychological journey: that 'uh-oh' feeling

In my journey with ecological sanitation, I had four hurdles to over come.

*The first hurdle*

That first 'uh-oh' feeling came when I was confronted by the new urine diversion pedestal in my comfortable, familiar bathroom. I felt mild anxiety. I was running scared.

In a subtle way, I tried to postpone using it. I told my husband I'd start using it in a few days, after he'd explained to me at length what the procedure was.

'It's simple', he said, and, to my dismay, outlined what I should do there and then. 'Just use it as normal,' he added.

I crossed my first hurdle, sat down and used the system. This was a big step.

It worked. I was beginning to break down my existing personal construct through experience.

*The second hurdle*

The next anxiety-inspired 'uh-oh' feeling surfaced. Much as I was assured that I could use the toilet 'as normal', I still didn't trust the system. I made a point of urinating and defecating separately. That way I was guaranteed that everything went where it should go.

In time, and through experience I came to fully accept that I could really simply sit on the toilet, and let go. But it took a while, all of about eighteen months.

*The third hurdle*

I felt another vague, 'uh-oh' anxiety about having a bucket of yucky pooh only a few meters away from the bed where I sleep. Right in the inner sanctum of my home.

Through experience I learnt that it didn't make any difference, because it was, in a sense, invisible. It didn't smell. So that became okay as well.

*The fourth hurdle*

My final problem related to cleaning the toilet. An important part of my personal flush-loo kind of sanitation construct is that I will have nothing what so ever to do with faeces. That is non-negotiable.

My husband was the one who took the bucket from under the toilet and emptied it into the compost heap. That was *his* job.

By him doing it, I saw with my own eyes that it wasn't the revolting job I expected it to be. It was no different to tipping a bucket of sand into our kitchen waste.

I am pleased to report that I can do it too! Through experience, I modified my attitude.

In each case, experience changed my personal construct regarding sanitation. What struck me was that even in an extremely supportive environment, I still had to confront anxieties. It showed me what a complex issue sanitation is.

## Conclusion: summary and suggestions

One may say that people don't jump at the chance of using ecological sanitation because 'human beings resist change', that 'they're stuck in a comfort zone'. Or they don't care about saving the planet. There are all kinds of cliché's one could drag up.

Statements such as these have negative overtones.

For me, Kelly's theory explains in a more positive way what people go through when confronted with new or different ideas. People have deep seated core personal constructs about all aspects of their lives. Also about sanitation.

Don't be fooled. Even a person like myself who is ecologically aware and overtly open-minded may have misgivings and anxieties.

George Kelly says that constructs aren't finite. They can be modified. People can opt to choose alternative constructs.

Well - we don't need Kelly to tell us that people can change their ideas about their world. We know it is the case.

The question is, how does one go about introducing new ideas to people successfully? How does one go about changing people's sanitation constructs?

There is no definitive answer to this question. Instead, I've crystallised four key issues that may be useful since, in my case, it ensured my successful and sustained conversion to ecosan.

1. Motivation

   I was motivated to use ecosan because I could see the ecological advantage (saving water) and I'm excited by new ideas.

   Inspire potential users. Talk their language. Show them why ecosan is a good idea.

2. Choice

   I was given a choice. If ecosan had been forced on me, I would probably have resisted using it. Potential users need to voluntarily buy into ecosan.

3. Supportive environment

   We've made some changes to our urine diversion system since it's installation. For instance, I insisted my husband remove the vent pipe since it caused an icy draft during winter. I couldn't make this modification myself. I needed someone I could rely on to listen to my complaints and act on it. That way I could make changes to suit my needs. If this wasn't the case, I would have removed the entire system and reverted to a flush toilet system.

   After installation of ecosan, listen to complaints and support users in any way possible.

4. Experience

   I learnt through experience that my misgivings about ecosan were unfounded. Where possible, give potential users the experience of using and cleaning a new sanitation system so they can see for themselves what it's like. At the very least, have an existing user tell his/her story to potential users.

In principle, all the above amount to on-going communication and support. Discuss psychological issues. Workshop psychological issues with potential users. Even where potential users have inferior technical solutions, one would still be challenging existing personal constructs. There would be existing comfort zones and ingrained habits and attitudes. Talk about it. And give support.

In essence, my point is this. Sanitation isn't a purely technical issue. Psychology kicks in – big time! Awareness and sensitivity to this are important when promoting any form of sanitation. Open dialogue between sanitation expert and potential users, as well as on-going support are essential.

# Source separation - new toilets for Indian slums

**Johannes Heeb**
seecon gmb
Bahnhofstrasse 2, 6110 Wolhusen
e-mail: johannes.heeb@seecon.ch

**Ken Gnanakan**
ACTS-Ministries
MIG 54 KHB Colony, V Block Koramangala,
Bangalor 560095
e-mail: tbtindia@blr.vsnl.net.in



## Keywords

Source separation toilets, slum toilets, urine utilization, fecal composting, closed loop concept

## Abstract

A new toilet center has been constructed in a slum in Bangalore/India, which allows separated collection of urine and feces. Urine is used directly as a fertilizer on an agricultural education campus. The feces are professionally composted. The compost is used to grow medical plants on the campus as well as for banana production. A new sustainable development concept is being tested here, one which tackles the problems of sewage water and feces and creates an opportunity for one aspect of slum development: The income generated by the project (users fee, compost, bananas) can cover 50 % and more of the running cost of the toilet centers.

## New toilets for Indian slums

*Context*

Rajendra Nagar is a large slum with inhabitants belonging to different caste, religion and race. The majority of households in the Rajendra Nagar Slum do not have their own toilet, and have access to only one functioning communal toilet. The establishment of numerous compost toilet centers is considered to be of a matter very great urgency. The lack of toilets is only one indication of the appalling living conditions for many thousands of slum residents, particularly women. They have so far been forced to defecate in the open field before dawn or after dusk. Sexual harassment and rape has been an associated problem. These toilets are aimed to bring about considerable improvement in such conditions for women and children.

Apart from addressing the plight of women, the project also deals with the cultural and religious context of India in which the handling of feces is a stigma. People who handle feces, in particular those who are “scavengers” and earn their low income through sewage-disposal are condemned to the lowest level of social ranking. This project aims to initiate a process of changing attitudes. Specially designed toilets, a carefully devised logistical system for the transport of the feces, as well as thorough composting (which minimizes handling of feces) serves to demonstrate that the handling of feces can be conducted professionally yet simply and cost effectively and need not be a social stigma. On the other hand, it can become an innovative income potential for the slum residents. The project therefore contributes to fighting scavenger’s discrimination.

*Project objectives*

- Improving living conditions: establish toilet centers to improve living conditions in the slum and to minimize the risk of disease spreading during monsoon flood periods.

- Scavengers discrimination: The project shall open now income perspectives and generate a better social status for the scavengers community.
- Integrating faeces and urine into its appropriate environmental perspective: When faeces and urine are accepted to contain valuable nutrients which are otherwise lost. They will be seen to be integral to soil enrichment and a valuable part of the nutrient-chain.
- Compost and fertilizer production: collecting urine and faeces (by using urine separation toilets) for the production of compost and fertilizer.
- Generating income for slum development: the compost and urine can be used use in agriculture (mainly for non-food production but research into food production is also to be conducted). The income will be used for paying the running costs of the systems.
- Integrating slum dwellers and self-responsibility: the slum dwellers will be instructed to operate the toilet systems themselves. Representatives of the slum shall be involved in the project. The project will maintain an emphasis on women and children, but total participation from the whole community will be sought to ensure success of the program.
- Changing values in a long-term perspective: in the cultural context of India handling faeces is a social and cultural taboo. Since the sanitary problem is considered to be key problems of low-income settlement, solutions to solve these problems are urgently required. Resolving a cultural stigma is the key to solve this problem and therefore a long-term goal of this project.

*Finding an appropriate solution*

The following figure 1 shows the procedure of the participatory decision-making process carried out together with representatives of the slum population. Based on a need - demand evaluation as well as on considering economical and ecological aspects the decision was made to establish a toilet center with source separation toilets:

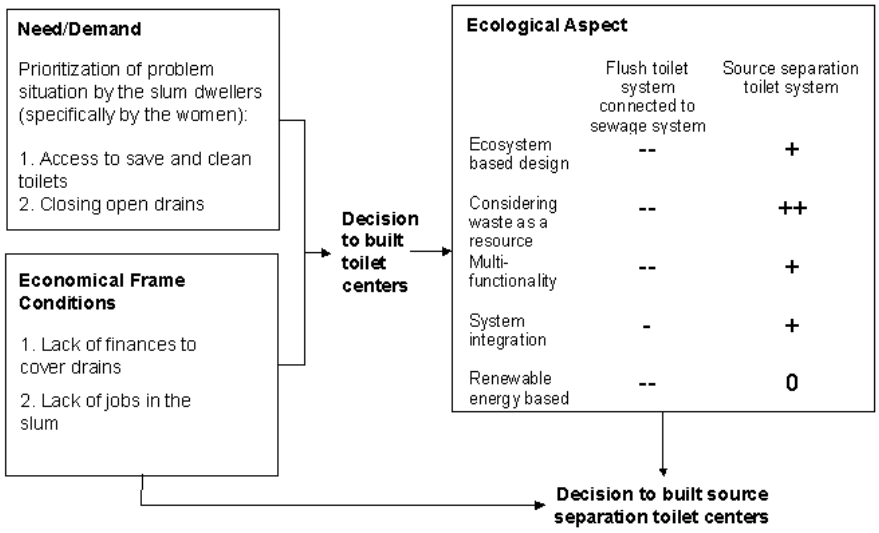


**Figure 1:** Decision making process

*System design and system operation*

The Bangalore project is based on implementing a closed loop concept (see Figure 2). A toilet center (with 4 toilet rooms for women and 4 toilet rooms for men) is serving 600 – 800 users per day. In the toilet center feces, urine and wash-water are collected separately (see figure 3 & 4).

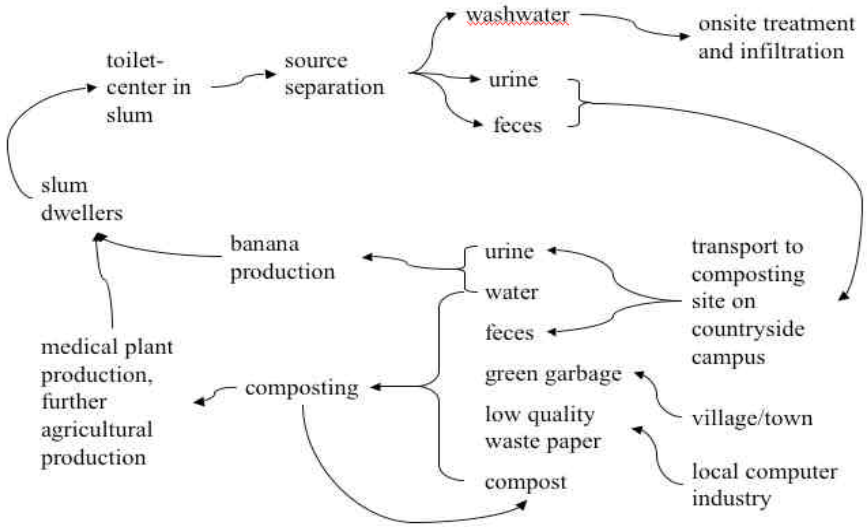


**Figure 2:** Closed loop design

The wash-water is being treated onsite in a small sand-filter system planted with Papayas and Bananas. The feces and the urine are separately collected in 120 l PE bins. Each day clean and empty bins replace the filled ones. One third of the volume of the clean fecal storage bins is filled with waste paper before it is placed in the service chamber. The paper soaks water from anal washing. No waste paper is filled into the urine storage bins! The full bins are transported to the composting site. It is realize that transport of the “resources - feces and urine” is needed to close nutrient cycles between urban and rural areas. On the composting site the feces is mixed with waste paper and biodegradeable garbage. The compost and the urine are used for agricultural production. The agricultural production can be sold on the local market.

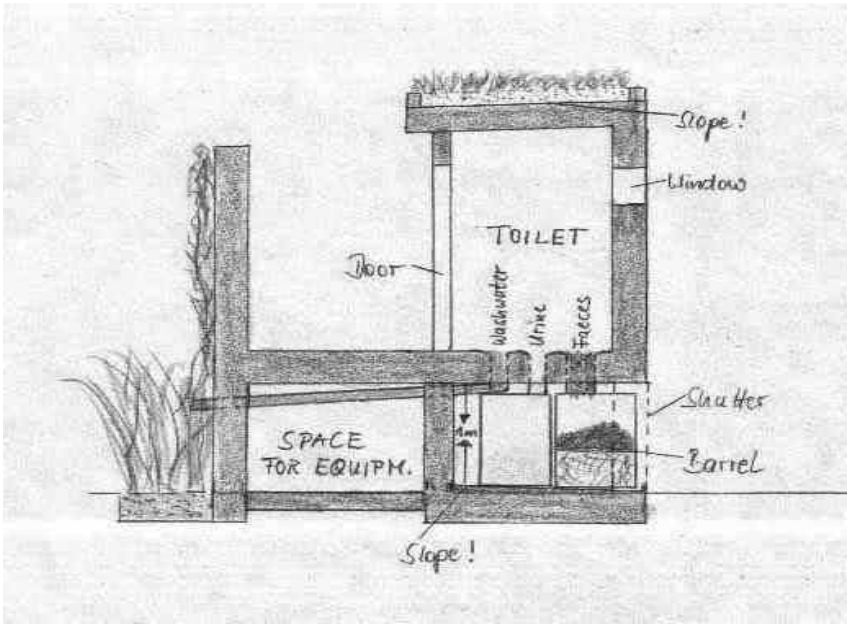


**Figure 3:** Cross section of the toilets

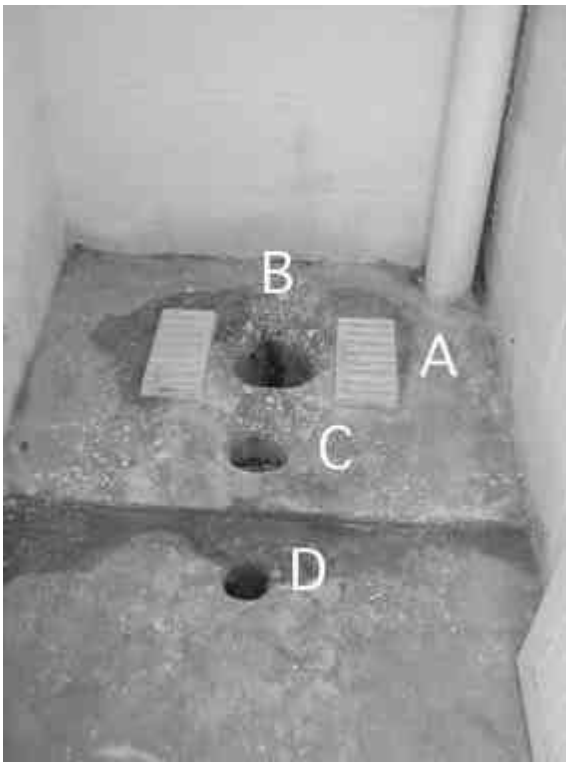


**Figure 4:** Squatting platform (same type for men and women). A: Footrest B: fecal hole, 20 cm Ø C: urine hole, 10 cm Ø D: wash-water hole, 10 cm Ø. Distance between holes: 25 cm.

On the composting site fresh feces is poured on a pre-prepared bed of compost and waste paper, when covered with green waste and compost (see figure 5). The first turning of the "compost sandwich" is done after 3-4 weeks. Further turning of the compost has do be done every 2-3 weeks.

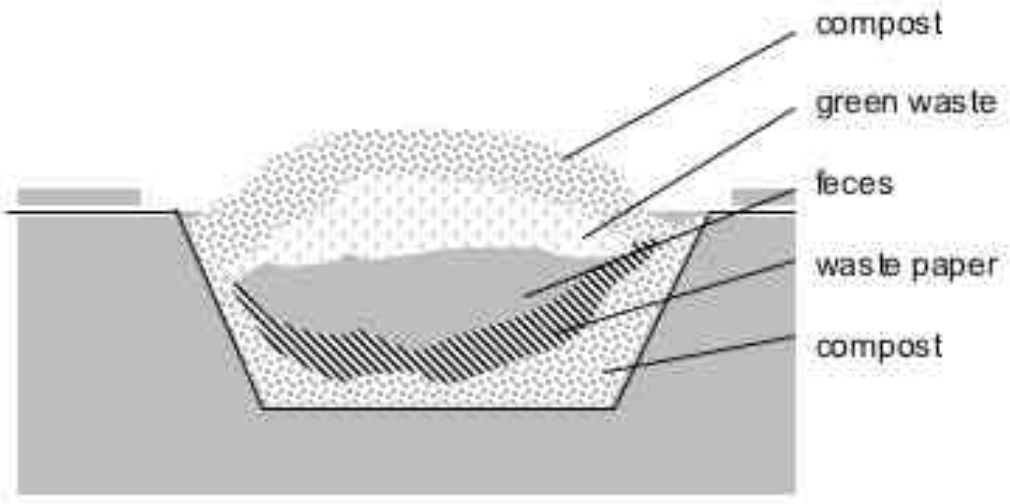


**Figure 5:** Composting process step 1

After 2-3 months the compost of the “Compost Sandwich” material is moved to the compost heaps (see figure 6). The heaps are covered with tarpaulin in order to avoid water loss caused by evaporation and in order to regulate the temperature in the compost heap in an optimal range of 45 and 55 °C. A digital rod thermometer is needed to control the temperature. From time to time the tarpaulin has to be removed for watering (e.g. during rainfall). The compost has to be kept humid but not wet. The compost has to be turned every 3-4 weeks. After 2-3 months the compost is ready for utilization.

*Safety aspects*

All work staff involved in the project was served with a comprehensive vaccination program. While working at the compost facility the work staff has to wear special working clothes (trousers, jacket, gloves, boots). It is strictly forbidden to smoke, eat or drink on the composting site. Working clothes and tools are kept separately. The working clothes are washed once per week. The tools are cleaned at the end of each working day. Injuries of the skin must immediately be disinfected and protected from further infection by dressing the wound.

**Figure 6:** Composting process step 2

*Controlling the compost process*

Among the most important controls is the daily check of the temperature in the compost heaps. This allows to be sure working within the safety zone for hygienization (45 and 55°C). The temperature is measured with a digital rod thermometer. While the composting process on the stacks lasts, humidity has to be controlled at least each time the material is restacked. If necessary it has to be corrected by adding liquid or by mixing with dry or wet compost.

| Agronomic Parameters of Compost Sample | | | |
|---|---|---|---|
| Parameter | Result | Guide Number | Limit |
| pH | 6,5 | | |
| dry matter (dm) | 59,3 % | 46 % | |
| org. matter | 46,3 % | 35 % | |
| total N | 31,1 kg/t dm | 13 kg/t dm | |
| P | 10,7 kg/t dm | | |
| P2O5 | 24,4 kg/t dm | 7 kg/t dm | |
| K | 7,8 kg/t dm | | |
| K2O | 9,4 kg/t dm | 9 kg/t dm | |
| Mg | 6,8 kg/t dm | 8 kg/t dm | |
| Ca | 32,1 kg/t dm | 70 kg/t dm | |
| Pb | 43,5 kg/t dm | | 120 kg/t dm |
| Cd | 0,4 kg/t dm | | 1 kg/t dm |
| Cu | 155,0 kg/t dm | | 100 kg/t dm |
| Hg | 0,6 kg/t dm | | 1 kg/t dm |

**Figure 7:** Compost analyses (sample taken in August 2002)

*Urine and compost utilization*

The urine has to be diluted (dilution rate: 1:20) before used as a liquid fertilizer. The urine can be used for all kinds of highly Nitrogen consuming agricultural crop.

*Costs/economics*

The 600 – 800 users produce 200t of urine and 100t of feces per year. This leads to a yearly production of 50t of compost and 50t of bananas. Figure 8 shows a first estimation of the economics of the system.

| | | | |
|---|---|---|---|
| **Investment** | | | |
| Construction of Toilets | $7.000 | | |
| Construction of Compost site | $4.000 | | |
| **Running costs per year** | | **Income per year** | |
| Salaries (8 Workers) | $8.000 | Users Fee | $3.000 |
| Transport | $2.220 | Bananas and Medical Plants | $5.000 |
| Administration | $1.600 | Nutrient Value of compost and feces | |
| Maintenance and Depreciation | $3.250 | ($ 750) | |
| Total Running Costs | $15.070 | | $8.000 |
| **Net Costs** | **$7.070** | | |
| **Cost per user and Year** | **$12** | | |

**Figure 8:** Economics of Bangalore system

*Further development*

The project is still under development. The experiences of the first project phases prove the feasibility of the concept. The following aspect will be in the focus of the next years:

a) Process optimization:

- Optimization of urine utilization (e.g. for banana production), faeces composting and faecal compost utilization
- Optimization of process, operation and maintenance (in progress)
- Using new additives like dry leaves, etc.
- Monitoring (nutrient and hygiene aspects)

b) Knowledge transfer and assessment

Education and Information (workshops seminar with NGOs, governmental officials, etc.)

- Knowledge transfer to rural villagers and farmer, schools, etc.
- Comparative assessment of the system (nutrients, energy, environmental impact, economic viability)

c) Product utilization

d) Training programs for poor farmers

*Scientific study*

Scientists from the Indian Council of Agricultural Research (ICAR) have been contacted for a scientific study of the compost. A significant level of interest has been shown and plans are being worked out for a systematic study of the impacts of the compost on various kinds of agricultural produce. If successful, the project will only be established as one that will need to be implemented on larger scales by the Government bodies, but will also result in enormous economic benefits to farmers who are struggling with severe agricultural land related problems.

*Results / impact / assessment*

By S.S. Wilsson, local project manager “The toilet-center in the Rajendra Nagar slum was built with the objective of separating urine and feces and converting feces into compost rich in nitrogen content, a practice ignored or shunned over decades. Initially it was feared that reintroducing the practice of converting feces would be opposed due to prevailing culture observed and respected by the people. Considerable time and effort was made to convince the people that human feces are not a waste product, but a rich resource for production of compost. To this date the toilet-system is working satisfactorily and to our expectations. For improvement, further methods are being tested to bring about greater efficiency and to curtail expenditure. Labor is the main constraint and must be dealt with carefully as otherwise workers will put down their tools and quit without notice. Scavengers are not freely available for employment hence replacements are difficult. Thus every part of the project is of paramount importance and must be handled with personal and constant supervision. Undoubtedly there is immense appreciation from the people using these toilet-facilities since they were suffering without toilet facilities for a long period. More specifically, the women are very grateful for providing toilet facilities. The women in particular are very happy and content because this toilet provides them all facilities such as water, electricity and reliable wardens who keep the toilet in a very hygienic state all the time. Above all women using the toilet have the assurance of safety and security because the project is run by a responsible organization that pays personal attention to all aspects of this project. Conclusion: After two years we have achieved the desired objectives and it is noteworthy to mention that the public has cooperated well and has accepted that human feces and urine are a valuable resource. Although initially there were some constraints with regard to

cultural practices we have comfortably overcome all negative thinking. It is hoped that this eco-friendly toilet will be replicated and the public will realize the value and benefits that could be derived from human waste and urine."

## Conclusions - lessons learned

- Cultural and social aspects: Even working in a cultural context where handling faeces is considered to be very problematic, the project proved to be feasible. But referring communication is a key prerequisite to success.
- Technical aspects: The entire design of the project proves to be feasible. More work has to be done in up-scaling aspects: The existing projects serves toilet access to ca. 600 users. The entire project design has to be adjusted for bigger scale applications.
- Economical aspects: The target of the project was to cover all costs investment and running costs by the generated income. The experiences of the existing project show what this can not entirely be achieved. But the average annual net cost of the project of ca. USD 12 per persons proved the project to be economically feasible.
- Agricultural aspects: Having started with mainly an interest in toilet centers, the long term effects on improved agricultural production is a challenge.
- Safety aspects: The experiences prove that a save handling of the faeces as well as the production of a high quality compost is feasible.



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# A methodology combination to expose and assess water and sanitation related household behaviour

**Helena Krantz**

Dept of Water and Environmental Studies and Sustainable Urban Water Management
Linköping University
S 581 83 Linköping, Sweden
e-mail: helkr@tema.liu.se



## Keywords

Case study, ecological sanitation, everyday life, methodology, time-diaries, user perspective

## Abstract

Replacement or alteration of water and sanitation systems motivated by ecological concern embrace transformation of three components: technology, organisation and user behaviour. The aim of this study is to develop a methodology to expose and assess households use of water and sanitation. A combination of methods, time-diaries, interviews and simple observations, was tried out in a case study with informants having a dry toilet system in Stockholm, Sweden. In the time-diaries the informants recorded water and sanitation use over five days. The simple observations provided information of the physical context, essential for the interpretation of the time-diaries. Used together they provided an image of informants' everyday life and how water and sanitation were integrated in everyday activities. The time-diary also increased the informants' awareness of own behaviour and habits. The methodological process, involving several contacts between informant and researcher, enhances the possibility to develop mutual trust. Hence, in the subsequent interview aspects otherwise hard to articulate could be discussed. Consequently, the triangulation is valuable in analysing various issues related to householders' interaction with and perspective on water and sanitation.

## The problem

By a simple manoeuvre water is pouring from the tap, generally of desired amount, temperature and quality. The used water is easily discharged to sewers. About 50 % of the metals and chemicals in wastewater treatment sludge supposedly originate from household activities (Eksvärd 1999). The opaque conventional water and sanitation structure tends to make users' activities habitual and not in need of contemplation. Due to criticism in terms of lack of sustainability, modifications or replacements of conventional water and sanitation systems are locally taking place. Examples of such transformations are installations of toilets with separate handling of dry faeces and urine, and the introduction of individual metering and billing for warm and cold water. These seemingly technical changes also alter management issues and user behaviour. Hitherto, user aspects of water and sanitation have mainly been studied in terms of attitudes, acceptance and mapping of user experiences (e.g. Haglund and Olofsson 1997, Naturvårdsverket 1998). However, system development needs a more comprehensive analysis and methods to go with it.

The choice of methodology is intimately connected to the aim of the study, in my case to analyse household use and behaviour related to water and sanitation, associated with changes of the conventional system motivated by ecological concern. The main focus will be on household perception of risks and possibilities since it may be the decisive factor in

implementing future system.

Studies of everyday life in households necessitate investigating a sphere considered as private. We also tend to view routine activities less rewarding to study since we all are well aquatinted with them. Interview methods are appropriate for collecting empirical data for qualitative social research, but have limited applicability for studies of habitual behaviour since people have difficulties articulating such activities (Ellegård and Wihlborg 2001). However, used simultaneously with other methods the prospect of getting sufficient information improves. The aim of this paper is to evaluate the appropriateness of a methodology using triangulation of time-diaries, interviews and simple observations, for answering questions of how, when, where and why water and sanitation is used in everyday life.

## About the method

Time-diaries are developed as methodology in a time-geographical and interdisciplinary milieu. It is thought of being capable of visualising habits and routines and aims at identifying everyday contexts. The time-diary must however be combined with other methods if we want answers of why certain behaviour occurs. To use time-diaries prior to interviews makes it possible to approach values and standpoints otherwise difficult to articulate (Ellegård and Nordell 1997, Ellegård and Wihlborg 2001). Time-diaries and subsequent interviews have previously been used in studies concerning issues of everyday life (e.g. Friberg 1990, Östlund 1995, Sjöberg 2000). Everyday aspects essential to study depends on study focus, but generally it is what you do, why, where it takes place and with whom (Ellegård and Nordell 1997). The time-diary is structured accordingly with headlines like time, activity, locality and other persons involved, but it is also possible to add headlines covering issues of particular interest. What finally is included or excluded in the time-diary, is however entirely in the hands of the informants.

The time-diary is introduced in a meeting between the researcher and the informant, preferably in the home of the latter. At the same time some observations are made, like features in the kitchen and bathroom, distance to the faecal heap etc. The observations are important for the interpretation of the time-diary and the interview. Ideally, the informants write time-diaries for a week as activities could differ in character between weekdays and weekends. But, as the writing is demanding and time-consuming, the duration may be shortened, but still include both weekdays and weekends. The time-diaries are analysed in a computer program developed for this purpose. Various activities, places and relations are given individual codes. With this information the program creates graphs, giving an overview over the individual's projects and activities in space and time. This information is then used in composing the interview protocol.

## Case study Stockholm

The most pronounced difference between a conventional WC and a dry toilet is the excreta management. What the WC flushes away to a distant place for treatment, are kept in the dry toilet. To be able to examine how this fact affects user behaviour, residents in a condominium with dry toilets were asked to participate in a study. They aim at living ecologically and consequently have chosen the dry system out of environmental reasons. The urine from all 32 households is collected in three tanks while each household takes care of its faecal matter. Out of the participating households, two were singles and two were households containing couples with children, one with younger kids and one with teenagers. All adults in the households participated and one of the teenagers also took part, thus in total the study involved seven informants in four households. They were asked to write a time-diary for five days, including three weekdays and one weekend. A minimum requirement was that all water-related activities were recorded as well as activities indicating the person's presence in the home.

Everyday life is made up of activities. Writing a time-diary becomes an additional task that

disturbs the normal routines to some extent, and therefore it is often viewed as demanding and time-consuming. This study makes no exception. The informants believed that the diary affected everyday life to some degree, as the writing became an interruption in itself. Most of the informants thought it was demanding, especially after a couple of days when the interest diminished. Some found it hard to remember to bring the diary along and to keep writing. All informants tried to write continuously but some considered it difficult when many activities vied for restricted time. Occasionally reconstructions had to be made. Different strategies were adopted to enhance the writing, e.g. several water activities were clustered into one main activity and standards were set for frequent behaviours.

Even though the informants have full control over the information in the time-diary, the participating women felt ambivalent. They considered some water and sanitation related activities as too private to write down. Omitting these activities was considered but came in conflict with the wish to accomplish. Again, strategies were adopted, e.g. to record the activity but not in detail. Many believed that the time-diary made them more observant about their behaviour, but also that it did not affect their thoughts about water. Being a resident of the condominium involves continuous discussions about various environmental issues. Also, the residents have actively chosen systems for sanitation and waste handling that demands ecological awareness for being managed properly. This provides them with a line of thought somewhat different from what could be expected to find in conventional residential areas.

The time-diaries gave valuable information concerning when, where and what activities took place. However, they did not expose why certain activities were undertaken and the considerations affecting the decisions. Therefore interview questions were developed, of both common and exclusive character. Each interview lasted 1.5-2 hours. Interviews were transcribed and analysed along with the information in the diaries and the simple observations.

Each household has to empty the faecal bin regularly, varying between once a month to once every four months. How often depends mainly of family size and problems with flies. Some have noticed that a more frequent emptying partly eliminate the fly-problem, which incidentally is the most stressed drawback of the system. It seems like this is a job for adult men in households where this option is available. The most obvious argument is that the bin could be quite heavy conditional on amount of excreta and paper, in turn mainly determined by emptying frequency. Some households also have their bin in the basement with only an unwieldy manual elevator to their disposal. Another, not that evident cause, is that the women seem to rather not deal with this task at all. One believed it just occurred to become her husband's task, maybe a remnant from her latest pregnancy when she was not inclined to deal with faecal matter. She also asserted that her husband did not seem to mind. Another woman confirms the picture; her husband also did not bother. The biggest dilemma is she having difficulties standing the smell. Hence, in trying to avoid the faecal bin filling up too fast, and by that having to empty more often, she puts the urine paper in a basket next to the toilet.

## Evaluation of methodology usefulness

The above is an example of information achieved from the study. The time-diary was only written for five days and no faecal bin was emptied during these days and consequently not displayed in the time-diaries. Despite this fact, aspects of faecal management could be fruitfully discussed. The time-diary together with the simple observations gives the researcher an image of the informants' everyday lives. Writing the time-diary also increases the informants' consciousness about their everyday routines and behaviour. The fact that habits and behaviour are displayed makes them feasible to discuss. In the interview all related questions could be addressed, even issues not present in the time-diary. The time-diary has narrowed the scope for the informants why all kinds of associated issues could be given some attention in the interview. Maybe the introspective effect was less pronounced in this particular study because

of the informants' atypical environmental awareness. The process behind the triangulation also has positive side effects. Having contact on several occasions, over the phone making up appointments, personal meetings in introducing the time-diary and in making the interview, increases the possibilities to develop mutual trust between informant and researcher. Trust is important in studies touching upon personal issues as it may open some shut doors. The combination of the three methods also makes it possible in collaboration with the informant, to identify and disentangle inconsistencies between written and oral information. Thus discrepancies between narrated and actual behaviour could be reduced.

Finally, the method is sympathetic from an ethical point of view. The informant can control the empirical data, which is proper when dealing with private matters. It may also be an important aspect for the informants' willingness to participate. On the downside, albeit not an exclusive problem for this method, it allows the informants to leave possibly interesting activities aside. It makes it difficult to evaluate the comprehensiveness of the empirical material. The risk of omitted information could be somewhat reduced if the researcher succeeds in establishing trust.

## Conclusions

Plain mapping of behaviour is not interesting without scrutinising the ideas and intentions behind certain actions, like risk reduction for personal as well as environmental protection. The three separate but interrelated data collecting methods makes it possible to expose and assess water- and sanitation related behaviour. The diary answers mainly the questions how, where and when, while the interview mainly answers the question why. The simple observations support the interpretation of the diary and subsequently the interview. Used together they could answer various research questions related to householder's everyday life. To better understand human everyday behaviour is an important factor in the making of a sustainable society.

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# Factors which have influenced the acceptance of ecosan in South Africa and development of a marketing strategy

**Richard Holden**
The Mvula Trust
Box 32703, Braamfontein, 2017, South Africa
e-mail: richard@mvula.co.za

**Riana Terreblanche, Mary Muller, Nawasan**
Posbus 621, Springbok, 8240, South Africa
e-mail: rianater@kingsley.co.za

Session B

## Keywords

South Africa, social marketing, dry urine diversion

## Abstract

This paper contends that the marketing of ecological sanitation is no different for any other sanitation technology. People are motivated by reasons other than health to improve their sanitation such as no smell, safety, security, comfort, privacy, convenience, minimum handling of excreta and the quality of pedestals and structures. At present many promoters of ecological sanitation focus on re-use, as the primary motivating factor for people to adopt the technology. The results of the South African Sanitation Programme, however, have shown that by marketing the product to people's aspirations ecological sanitation can be successfully introduced at a wide scale in a sustainable manner, whilst at the same time satisfying the Governments desire to provide access to sanitation to all. This paper sets out how ecological sanitation was introduced as an alternative technology into the Sanitation Programme in the Northern Cape Province, political support gained, and introduced subsequently into other Provinces.

## Introduction

"It doesn't smell!" These are often the first words, which people utter, when literally faced with the mixture of soil, ash, faeces and toilet paper from a dry urine diversion toilet. No one mentions that it looks like good manure or that the separated urine can be used as fertiliser.

The lack of smell together with least handling of excreta; low capital and maintenance costs; security of an indoor toilet, privacy and comfort are the factors, which influence people's choice of sanitation technology. Health is rarely a motivating factor in choosing a toilet and the same holds true for ecological concerns.

The context, therefore, for your normal average householder, in which ecological sanitation is promoted is no different from any other sanitation technology. The contention of this paper is that from the experience in the South African, Department of Water Affairs and Forestry Sanitation Programme, householders do not primarily choose ecological sanitation from the point of closing the loop but from it being the technology that most ably satisfies their aspirations and physical requirements.

Until the proponents of ecological sanitation understand this and let people take informed choices, rather than insisting that it is ecological sanitation or nothing, ecological sanitation will remain an interesting side-show rather than a mainstream solution in the quest for sustainable sanitation.

## Context

Ecological Sanitation was not introduced into South Africa as a distinct separate programme, but as part of the Department of Water Affairs and Forestry, Sanitation Programme. This programme is guided by the "White Paper on Basic Household Sanitation", September 2001, which contains the following 12 principles:

1. Sanitation improvement must be demand responsive, supported by an intensive Health and Hygiene Programme
2. Community participation
3. Integrated planning and development
4. Sanitation is about environment and health
5. Basic sanitation is a human right
6. The provision of access to sanitation services is a local government responsibility
7. "Health for All" rather than "all for some"
8. Equitable regional allocation of development resources
9. Water has an economic value
10. Polluter pays principle
11. Sanitation services must be financially sustainable.
12. Environmental integrity

The Sanitation Programme, which targets the poorest households, is based on a subsidy of R600 (recently raised to R900) per household, for materials and labour with the household contributing the remainder in cash, materials or labour. Since the people, whom this programme targets, do not have on-site water the programme promotes dry sanitation. Although the programme was supposed to promote technology choice the reality in most projects was the single pit Ventilated Improved Pit (VIP) toilet with a choice of top structures.

A central theme of the Sanitation Programme has been that good sanitation is required for improved health. Thereby educating people around the dangers of poor sanitation you will get households to construct toilets and alter their behaviour patterns [1]. The programme also made the assumption that people had poor behaviour, from an attitudinal point of view, and it needed to be changed. This attitude has persisted despite the evidence that people do not respond to these messages (Eales 2002[2]). At the same time the Department of Housing and Provincial and Local Government were also running sanitation programmes. These programmes frequently promoted waterborne sewage without considering the ability of people to pay for such a service.

It was thus in this context that ecological sanitation was introduced, at scale, in South Africa.

## Introduction of ecological sanitation into the sanitation programme

Alternatives to the VIP were first sought in 1997 when in Namaqualand, Northern Cape, hard rock on the surface made it impractical to build VIPs. If jackhammers were brought in it would have been too costly and the community could not have replicated the toilets, when the programme finished.

Expert opinion promoted the use of double pit VIPs but this proved to be impractical, as a VIP

[1] "Water Supply and Sanitation Policy, White Paper", November 1994: South Africa

[2] Social Marketing and Behaviour Change in Rural household Sanitation Projects in South Africa" Kathy Eales, November 2 002

needs soil surrounding the substructure to allow the liquids to seep away. Also the households rejected them, as the floor was too high above the ground, making entry difficult and exposing them to the world when using the toilet.

In 1997 at the workshop on Ecological Sanitation, held at Ballingsholm, Stockholm, Sweden it was realised that the dry urine diversion toilet, as used in Mexico, might provide the solution. In 1998 a number of moulds were purchased from Mexico and the first units installed[3]. Given the geological conditions the option the community had was either to try the dry urine diversion toilet out or carry on using the bucket system until collection stopped and revert to using the veld. Initially this was the main marketing strategy to the communities, that the urine diversion toilet was the only affordable option available to them given the geology of the area.

The first dry urine diversion toilets installed were generally double pits (either next to each with a moveable pedestal or one pit behind the other with a fixed pedestal) with capacity for several years and the urine was led to a soakaway. Households were encouraged to plant trees around the soakaway to take up the nutrients and moisture. By doing this it was hoped that people would see the effectiveness of the urine as a fertiliser and be encouraged to experiment further (In Namaqualand there is a high degree of mineralisation in the soil and groundwater and plants are naturally salt tolerant). The question of dealing with the faecal matter was left to a later stage when the pits required emptying.

Two methods of dealing with the toilet contents have emerged:

1. To burn the contents: This has been successful due to the very dry climate and the use of hard instead of soft toilet paper; and
2. Composting/burying: This has only been recently introduced as the 1st pits have required emptying. On opening the pits people have realised how innocuous the contents are and have had no problem in emptying the pits. Generally households buried the contents. However after a year people realised that a transformation of the contents had taken place and have been planting pumpkins, potatoes and onions. This step did not take place naturally but occurred due to the strong support and encouragement of one of the fieldworkers, Maria Wildschutte. As a result of the 981 households who have accepted the dry urine diversion technology in the Kammiesberg Municipality, Namaqualand, 50 are now practising ecological sanitation.

An interesting development in Namaqualand was the construction of double VIP toilets against the houses with access from the inside. These have proved very successful. On opening them, however, it was realised that due to the dryness of the area the pits had remained dry and there was in fact very little difference between them and the operation of dry urine diversion toilets. This again made the marketing of dry urine diversion easier as people saw very little difference with what they were accustomed to and what was being promoted.

Another significant event was the construction of social housing in the villages with all the fittings for waterborne sewage but no water connection nor treatment facility for the sewage, either on or off site. A local woman, Maritjie Meyer, after seeing the pictures of Cesar Anorve's bathroom in Mexico, reckoned she had nothing to lose by installing a dry to urine diversion toilet in her bathroom. This inspired all residents with similar houses to install dry urine diversion in their houses, and the National Sanitation Operations Manager of the Mvula Trust to convert his house. This served to demonstrate that a dry urine diversion toilet is a permanent installation inside a house unlike a VIP toilet, which is outside the house and needs to be moved when full (if a pit emptying service is not available, as is generally the case).

All of this was happening at a local level with support from the local politicians (total population of the municipality 11,000). However, for the programme to be implemented on a wider scale it

[3] "Introduction Of Urine Diversion In South Africa" R D Holden & L M Austin, South Africa. 25th WEDC Conference Addis Ababa, Ethiopia, 1999

needed to overcome opposition to dry sanitation at provincial level.

## Gaining of political support

Any sanitation programme cannot function without political support. In the Northern Cape the sanitation programme was well supported at local level. The Premier of the Northern Cape, Manne Dipico, however, went on record stating that his objective was to eliminate the 25,000 buckets in the Northern Cape and replace it with waterborne sanitation. He also stated that dry sanitation was a second class technology, which would continue to deprive the historically disadvantaged people of an acceptable standard of living. The Premier was not alone in this view, which was supported by many local government councillors.

This presented a few problems since the communities where buckets were prevalent could not afford to maintain waterborne sewage and often there were not the water resources as well.

A twin strategy was conceived to overcome this:

1. To gain the Premiers support for dry sanitation; and
2. To demonstrate that dry ecological sanitation provides exactly the same level of convenience and service in a middle income house.

To overcome the first obstacle, in July 2000, the African National Congress caucus in the Leliefontein Transitional Local Council (TLC) invited the Premier to an Open day in Nourivier, Namaqualand to demonstrate to him the success of dry sanitation and request his endorsement and support. Councillors and officials from other municipalities were also invited to share the experience. At the start of the Open Day the Chairperson of the Leliefontein TLC, Gert Maarman stood up and stated that in Namaqualand, where there is little water and little money dry sanitation, is the ONLY solution.This statement might not sound much, but it was made 5 months before local government elections in a climate where everything was being promised free to residents (such as free basic water). After seeing the village and listening to the people the Premier not only reversed his stance but also allocated significant sums of money to dry sanitation. Gert Maarman went on to become the Mayor of Kammiesberg, the new, and very much bigger, local municipality.

The second obstacle was overcome by the National Sanitation Operations Manager of the Mvula Trust installing a dry urine diversion toilet into his own home in central Johannesburg. This installation was coupled with greywater recycling and served to demonstrate that with minimal intervention from the household dry ecological sanitation produces the same level of convenience coupled with significant cost servings. It also demonstrated that on a stand with a garden area of 200m$^2$ no form of off site treatment is required[4]. Due to the central location of this house it has been visited by over 300 national and international visitors, been shown on national television 4 times and has served as a central point of the advocacy campaign for the acceptance of ecological sanitation in South Africa. An interesting point was at the same time, October 2000, the house was converted another two influential players in the Northern Cape Water Services programme agreed to convert their houses but to date have not. The main reason appears to be psychological (Wilke 2003)[5] and this needs to be noted in any marketing campaign.

## Introduction of ecological sanitation to other rural and urban areas

It was recognised from the beginning of the Sanitation Programme that people would not readily

[4] "The use of Dry Sanitation in the Urban Environment" Case Study No.7, 2002: Mvula Trust

[5] "Sanitation And Psychology : A Personal Perspective" Isabella Wilke 2003

accept a new technology and they would need to see the physical toilet, not a model or pictures, before committing themselves[6]. One way of overcoming this is to take people to communities where the technology is already in use and this has been used very successfully in the Northern Cape to spread knowledge about dry ecological sanitation and in other parts of the country, around VIP toilets. Also the technology needed to be introduced to urban as well as other rural areas.

Unfortunately Namaqualand is far from most areas of habitation being 600km from Cape Town and 1200 km from Johannesburg and without any adequate air links. It, therefore, has proved extremely difficult to get people to visit the villages in terms of both time and cost to experience ecological sanitation.



Since it has not been possible to take people to ecological sanitation the focus has been on taking ecological sanitation to the people. Five strategies have been developed:

1. By taking politicians, officials, community members etc. to the house in Johannesburg it has enabled them to gain firsthand experience of ecological sanitation in an upmarket house. Over 300 people have now visited the house, some returning with colleagues for a second visit;
2. By consistently raising, with municipalities, the issue of sustainability of water services, and highlighting the every rising incidence of the failure of waterborne sewage systems, it has encouraged municipalities to look at alternatives. The most notable success has been with Ethikewni (Durban) and Majareng (Warrenton). In Ethekweni the officials came to the conclusion that they could not extend waterborne sewage to all areas and that they did not have the means to empty VIPs. Their conclusion was that outside a set boundary, households would either have to provide and run their own treatment works or accept the dry urine diversion system provided by the municipality. Although their logic in choosing dry urine diversion is impeccable doubts have been expressed about the method of introduction in that households are given no choice about a technology, which many might feel offensive. The test will come in 2 years when the pits will need to be emptied. If the household empties the pits, or they are prepared to pay someone to empty them then it will be successful. If not the technology could easily be discredited. In Majareng there was initially great opposition to anything but waterborne sewage. Officials and councillors, were in fact, some of the first visitors to the house in March 2001 and at stage they were not convinced. They continued to submit applications to Provincial and National Departments for grant funding to expand the reticulation and build a new treatment works. In the Northern Cape, however, the departments have an integrated approach to water services and unless the municipalities can prove, through current payment for services, that they can sustain a waterborne system, capital finance is not granted. After having their application turned down they then started to look at alternatives and now fully support the programme. Their most recent initiative was to convert 2 municipal houses from a flush to dry urine diversion to reduce service costs to the occupants who could not afford the cost of emptying the conservancy tank.
3. When difficult ground conditions, or dense settlements, preclude the construction of VIPs, using the opportunity to introduce dry ecological sanitation. Using this strategy ecological sanitation has been introduced in 5 of the 9 Provinces in South Africa (KwaZulu-Natal, Limpopo, Western Cape, North West, and Gauteng)
4. Marketing dry ecological sanitation around the issues of as no smell, safety, security, comfort, privacy, convenience, quality, minimum handling of excreta and low capital and operation and maintenance costs. This in fact appeals most to households and the difference between a cheap plastic toilet seat and a wooden toilet seat has been used to successfully market ecological sanitation.

[6] "Guidelines Implementation Manual for DWAF Funded Household Sanitation Projects" July 1997: Mvula Trust

5. Introducing the concept gradually and allowing for people to change back. Where people are already on waterborne sewage the first step is to introduce greywater re-cycling and garden composting. This has an immediate financial benefit and they see how the soil is improved. The next stage is to introduce the dry urine diversion toilet. It is, however, imperative to allow for conversion back to a flush toilet so that the resale value of the house is not affected and people do not feel forced into a corner (a re-conversion takes 8 hours).

In Northern Cape all 5 strategies were successful mainly due to the financial support of the Department of Water Affairs and Forestry and the focus on integration and sustainable services with other Departments. Dry sanitation is now no longer an issue and it is estimated that 80% of households choose dry urine diversion over VIP toilets. In other provinces similar success has not yet been achieved for a combination of reasons, the main one being the reluctance of professional staff to accept and promote the technology.

## Social marketing to households

Once a sufficient number of dry urine diversion toilets had been installed, including a number inside houses, the principle of how the toilet works can be demonstrated to a wider audience. The technology is then marketed around the advantages of being inside the house and a permanent structure, compared to a VIP.

A dry urine diversion toilet inside the house offers:

1. No smell: To ensure there is no smell from a dry urine diversion toilet the faecal matter must not start decomposing whilst in the chamber underneath. The addition of soil and ash and the use of a bucket to prevent external moisture reaching the faeces ensure this.
2. Safety: Pits are very much smaller than VIPs and children do not have the fear of falling into the sewage;
3. Security: Going to an outside toilet can be dangerous. In rural areas people have a fear of snakes and in urban areas fear of attack (so much so that even where the toilet is flush they will use a chamber pot at night rather than risk visiting the toilet);
4. Comfort: An inside toilet is generally well lit and warm compared to an outside toilet, which in winter is cold and draughty. To ensure that a dry urine diversion toilet offers the same level of comfort the pits have been reduced in size so that the bucket used to catch the faeces just fits and there is no ventilation pipe to produce cold draughts.
5. Privacy: An inside toilet means that no-one sees you going to the toilet and can comment on your habits;
6. Convenience: At night the convenience of an inside toilet is immeasurable. No getting dressed, getting wet if it is raining etc. The only negative aspect of the dry urine diversion toilet, from a male convenience point of view is that a male must sit to urinate unless a separate urinal is provided. The fixed subsidy of the Sanitation Programme overcomes this by simply saying that if a separate urinal is required then the owner must pay for it. For example in the house in Johannesburg a separate waterless urinal of a comparable quality to the rest of the bathroom fittings would have cost R1500. This prodded the males in the household to drop their trousers and now it has become so natural that no more thought has been given to installing one.
7. Quality: In South Africa, it has been demonstrated as has by Cesar Anorve in Mexico, that the quality of installation of a dry urine diversion toilet, is equal to that of a flush toilet. This is a major selling point and is often overlooked when promoting ecological sanitation.
8. Minimum handling of excreta by the household: One of the reasons for preference for VIP and flush toilets is that the household does not handle any excreta. It either drops in a pit,

and the pit filled in hen full, or is flushed away for someone else to deal with. To gain acceptance of dry urine diversion systems have been developed whereby the urine and excreta is handled as little as possible in its raw form, thereby increasing acceptability. To this end the programme now promotes the use of a 45-litre bucket underneath the toilet. This has sufficient capacity for a month and can be easily lifted out compared to using a rake and shovel. In communities where use of chamber pots is prevalent the reality is that they are already handling excreta once a day, generally without thinking about it. Once this is pointed out the resistance to handling faecal matter once a month drops away.

9. Low capital costs. Of all the systems urine diversion has found to have the lowest capital cost R1500 compared with R2000 for a VIP and R10,000 for waterborne; and
10. Low operation and maintenance costs. The external costs of a dry urine diversion system, if a householder is practising ecological sanitation is R0 per annum compared with R200 for a VIP and R1200 for waterborne systems.

The marketing of the toilets has been around giving households information about the different technologies and allowing them to make a choice depending on their individual circumstances and preferences[7]. When presenting the different sanitation technologies the most frequently asked question around the dry urine diversion toilet is around smell and the handling of the faeces. This is understandable given the desire of people to handle excreta as little as The most effective way to answer this is to have samples from the toilet and the compost heap available so that people can physically smell (or not) the faeces and see how it decomposes. Once they are satisfied that there is no smell and the job of emptying the toilet will not be unpleasant then they are willing to accept the technology on the basis of the above points rather than marketing it around the reuse of excreta.

## Impact on health

The emphasis on social marketing has lead many people to ask if the programme has lost sight of the main objective of the Sanitation Programme, that is improvement in health.

The question on how to measure the impact of the Sanitation Programme on health has bedevilled it since its inception since no reliable statistics have been available at project level, nor in many cases at hospital level. In many settlements people do not visit the public health system but use traditional healers for reasons of proximity and respect. Also to carry out detailed epidemiological studies per settlement are not achievable nor cost beneficial.

By taking a leaf out of the water industries book, where multiple treatments, (barriers) are used to prevent transmission of disease, a simple survey has been developed which measures the number of barriers to transmission of disease in a household. The more barriers the more difficult for disease to be transmitted. This survey can be administered at the beginning, during and at the end of the project to assess the impact of the project. The information is valuable for the communities in deciding what interventions to target in order to improve their situation.

The findings have been remarkable:

1. The survey is simple to administer. In Thukela 18,000 households were surveyed in 3 weeks and in Jo'burg 4,000 households in 4 days with the community members themselves conducting the survey and capturing the data.
2. In many cases the survey showed that households were already doing the maximum they could, given the conditions they lived under. To improve health required an infrastructure intervention rather than a behaviour change. The results below are from the baseline survey, Baldaskraal, KwaZulu-Natal. They show that BEFORE any project intervention over

[7] "Position Paper On Sustainable Sanitation", R D Holden, Appropriate Technology Conference, Johannesburg, 2001

72% had an acceptable score (more than 8) indicating that with the majority of people hygiene awareness was not a problem. This allows the intervention to be focused on the households at greatest risk rather than scattering a broad message, which would be rejected by most as patronising, across the community.

| Score | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| No. of HH | 0 | 2 | 5 | 6 | 12 | 12 | 22 | 23 | 57 | 51 | 51 | 33 | 16 | 5 | 10 | 0 | 0 |
| Distrib. | 0% | 1% | 2% | 2% | 4% | 4% | 7% | 8% | 19% | 17% | 17% | 11% | 5% | 2% | 3% | 0% | 0% |

**Table 1:** Results of Household Survey, Baldaskraal, KwaZulu-Natal



## Results

Since 1994, in the various sanitation programmes, in South Africa, approximately 170,00 dry toilets have been installed of which 160,000 are Ventilated Improved Pit toilets, and the remainder various proprietary and dry urine diversion (approximately 4,000) systems. Most of the dry urine diversion toilets have been installed in the Northern Cape where there has been strong political support for the programme.

Although the initial marketing approach was offering dry urine diversion as the only alternative in difficult geological conditions households are now choosing it for other reasons, mainly because it can be built inside a house. Very few of the households intentionally practice ecological sanitation, that is the reuse of the excreta to close the loop. Where reuse does occur it is by default during the disposal of the excreta rather than a deliberate act. However since the decomposed faeces are returned to the soil and the urine disposed of in the root zone where it can be taken up by plants the same effect is achieved. This success has been achieved by marketing to people's aspirations rather than promoting reuse of excreta, which is a major turnoff to most people.

## Conclusion

The introduction of ecological sanitation, in the form of the dry urine diversion toilet, has been achieved on a large scale in South Africa by marketing it around social factors rather than the benefits of the reuse of the excreta. The wide scale acceptance is attributed to the fact that householders were given a choice of technologies and because ecological sanitation satisfied the social requirements the best, given the water, geological and cost constraints. A further factor, in its acceptance, has been the long-term support (4-5 years) provided by the programme to ensure the cycle is completed before households are left to their own devices.

Although the programme has been largely in rural areas the concept is now being introduced into the urban areas and it is found that the same factors influence its acceptance. To gain wider acceptance a broad marketing campaign is required promoting its social advantages rather than the ecological advantages.

Although it is difficult to compare the South African Sanitation Programme to individual projects in other countries, it is believed it is significant that a technology, only introduced at a large scale in 2000 has captured 2.4% of the market, with people choosing the technology, rather than be told what to accept.

The recommendation from the South African Sanitation Programme would be to market ecological sanitation through its social advantages rather than reuse. This experience mirrors the Bangladesh sanitation programme, which achieved a high rate of coverage through social marketing[8] rather than health promotion.

[8] "Private Sector-just a new (hope)?" Report on the 15th AGUASAN Workshop. June 1999

# Integrated management of water resources in projects of German financial cooperation

**Uwe Stoll,**
**Bernd Schönewald**

Kreditanstalt für Wiederaufbau – KfW
Palmengartenstrasse 5-9, D-60325 Frankfurt, Germany
e-mail: uwe.stoll@kfw.de
e-mail: bernd.schoenewald@kfw.de



## Keywords

Financial cooperation, urban sanitation, rural sanitation, wastewater re-use, sewage sludge re-use

## Abstract

This presentation reflects KfW's past and present experience in the field of Integrated Water Resources Management and lessons learned, to be further considered in future actions, thus embedding them in the framework of the Millenium Development Goals. We will highlight a few examples from our current project portfolio, which demonstrate concepts for water and nutrient reuse at different levels with regard to decentralisation and technological standards, including the relevant framework conditions necessary to implement sustainable projects. Projects to be presented are on rural water supply and sanitation, wastewater reuse in North African and Middle East Countries, sewage sludge reuse in agriculture, reuse of effluent for potable water and anaerobic treatment of municipal sewage.

## Introduction

As part of the German Official Development Assistance , KfW, commits investment loans and grants of some EUR 260 Million per annum for water supply and wastewater and sanitation projects in more than 25 developing countries. This is about one fifth of our total commitments within German Financial Cooperation, which is thus one of the world's largest bilateral sources of financing for this sector.

We have been active in the area of urban and rural water supply, wastewater and sanitation for many decades. In line with the Millenium Development Goals adapted solutions which account for the access of the population, especially poor income groups to safe drinking water and basic sanitation are a top priority. As postulated in the Agenda 21 a holistic approach taking into account the ecological sustainability (integrated water resources management), financial viability (ability and willigness to pay by consumers), the participation and acceptance of user groups for adapted solutions are key elements for the successful implementation of projects. Therefore, such investments are usually accompanied by campaigns to build capacities, raise awareness for water as a scarce resource and encourage hygiene. Following sectoral reforms, to which we contribute in cooperation with GTZ and the donor dialogue, new operating concepts have been established and tested recently in many countries.

In our present work we note that the following aspects are increasingly gaining importance:

- the availability of water resources and their management (i.e. groundwater mining, desalination),
- the increasing competition over the use of water resources among private, industrial and agricultural users,

- the need to develop integrated approaches strongly emphasising on the economic and the social framework in the planning and the implementation of appropriate technological solutions,
- the weak legal and institutional framework in many countries,
- rising water quality problems, and
- the need for considering water and nutrient cycles (i.e. effluent and sludge reuse).

Comprehensive project concepts are being developed and implemented in accordance with the specific demand and needs of the population to be served and the specific circumstances of the project area. These include water and nutrient reuse schemes with different levels of decentralisation and technological standards. For example:

- In our rural water supply and sanitation projects, predominantly in Africa, we promote traditional **on-site sanitation systems** using feaces in agriculrure.
- A number of wastewater projects are under preparation which fulfil the requirements for the **re-use of treated wastewater**, among others in Tunisia, in Jordan and in Yemen. In the latter two countries, comprehensive studies of the possibilities of re-using treated wastewater in agriculture are being carried out.
- In Turkey, concepts for **using sewage sludge in agriculture** have been successfully developed. Thus far the practical implementation of these concepts has generated satisfactory results.
- In Namibia a plant for purifying pre-treated **wastewater to produce drinking water** went into operation in 2001. In coming years this plant will supply up to 40% of the capital's requirements. In the case of Namibia we linked our financing to significant improvements in demand management by way of price increases and water conservation campaigns, the results of which have proven highly successful.
- New innovative and cost-saving technologies are being tested, such as **anaerobic processes to treat municipal sewage** in Ecuador and in Egypt.

With regard to new wastewater and sanitation concepts and the use of "appropriate or adapted" technologies in general, where ECOSAN plays an important role, we would like to point to the following lessons learned so far:

- Conventional wastewater treatment systems do have their merits both in ecological and financial terms, particularly where sewerage systems already exist. And this is frequently the case in the Middle East and North African countries, for example. By expanding these options, significant results may be achieved with limited funds.
- We will not conceal the fact that the delimitation of centralized vs. decentralized solutions in city outskirts, slums and scattered settlements can be very difficult. The same holds true for design parameters and for treatment standards. The wishes of our partners as well as suggestions made by consulting engineers sometimes exceed the limits of ecological and economic viability. Frequently, we have to adjust expectations and apply concepts for gradual expansion. Therefore, in most of our projects central sewerage is limited to high-density settlement areas whereas in the remaining areas on-site systems are promoted.
- Solutions for re-using treated wastewater and sewage sludge to close water and nutrient cycles are gaining priority, specifically in very densely populated arid regions. However, based on our first experience this undertaking can be highly complex and challenging from a technical, socio-economic, legal and institutional point of view.
- In our view promoting "appropriate technology" implies that we focus on the very problems to be solved: thus, depending on local conditions, in principle a wide range of technical

solutions from simple latrines to sophisticated treatment facilities may emerge as being "appropriate". In any case, there are no universal solutions.

In urban and periurban areas conventional sewerage continues to be the appropriate concept which is therefore being applied internationally by all DC institutions. A major reason for this is certainly that there are still no proven alternatives that could be implemented on a wide scale, for instance according to the ECOSAN concept. Incidentally, the industrialised countries also have a lot to catch up on in this respect as well because it is here that it must be demonstrated first whether these concepts work before we can get our partners in the developing countries to accept them.

KfW is participating and collaborating in the efforts towards more effective and efficient wastewater and sanitation projects and is actively supporting the GTZ-ECOSAN project in preparing and implementing pilot schemes in order to gather practical experience in our partner countries.



## Examples of KfW-financed projects

*1. Lesotho, Sewage disposal in 13 villages (Phase II), latrine programme*

The purpose of the project was to build latrines in all 13 urban centres of Lesotho with the exception of Maseru, the capital, for which there was a parallel programme financed by British development cooperation. Around 160,000 people live in these towns in total. The construction of central sewage disposal facilities was financed under a parallel sewage disposal project in 11 of these small towns which was also financed under German FC, and here the systems were put in place only in selected parts of the towns, where central sewerage is applicable.

The funds from the Latrine Programme were used to finance: a) the work of the Urban Sanitation Improvement Team (USIT), which headed the campaign to spread the construction of latrines in Lesotho's urban settlements and b) financial support for the construction of latrines and the measures necessary for the treatment of pit contents.

The USIT advised the buyers of latrines on the selection of the latrine site, on the suitable latrine type, on the purchase of suitable materials and in the search for qualified craftsmen whose training was also imparted by USIT. In this context the strong and continuous participation of the user groups was a key element to guarantee acceptance and effective operation of the latrines. During the eight years of its implementation the project contributed towards the construction of more than 12,000 VIP latrines (ventilated improved pit latrine) in private households and around 1000 school latrines. This means that around half the population in the project locations has access to this form of sanitation. After the latrines are emptied the contents of the pits are dried, making them suitable for application on farmland, for which they are being at least partly utilized.

In some cases private companies have now been commissioned to empty the latrines with cesspool cleaners. The cost of emptying a latrine, which is done about every seven years, is roughly EUR 25.

The total cost of the project was around EUR 1.5 million.

*2. Tunisia, use of treated effluent*

The reutilization of treated effluent is increasingly gaining importance because of the growing water scarcity in the arid regions of central and southern Tunisia. According to ONAS (Office National de Assainissement) statistics between 25% and 28% (1997: 21%) of treated effluent is currently being used for irrigation of around 35 irrigation perimeters with a total area of 6,900 ha, mainly for tree crops and cereals.

To increase the share of effluent use in agriculture the ONAS in 1998 began to implement a

programme for the re-utilisation of treated effluent which was initiated by Tunisia's President. This programme provides for around 20,000 hectares of farmland to be irrigated with treated effluent by the year 2010. ONAS argues that for this programme to be implemented under the current legal framework it will be necessary to have an additional treatment stage for disinfection the effluent. ONAS has devised a programme to retrofit the existing sewage treatment plants with additional treatment stages, and new treatment plants should already be equipped with such treatment stages when they go into operation.

KfW is supporting the ONAS and the Ministry for Agriculture, Environment and Water Resources in the following priority aspects, starting in the framework of the sector dialogue:

c) In order to promote the reutilization of treated effluent in agriculture and to justify investment in additional treatment stages the legal framework in Tunisia will have to be reviewed for consistency and completeness and adapted to international standards.

d) In addition, given the limited financial capability of ONAS the financing of operating costs for additional treatment stages for disinfection of the wastewater, which usually lead to a 10% increase of operating costs, will have to be defined. The financial contribution of the users of the treated effluent will have to be agreed with the Ministry for Agriculture, Environment and Water Resources.

One important aspect in the discussion on the use of treated effluent in agriculture is the problem that the farmers have difficulty accepting it, which has been observed in the past. For one thing, farmers and local authorities have socio-cultural misgivings against using treated effluent in irrigated farming, and for another there is often fresh water available for irrigation at a low price, particularly in the northern parts of the country. In addition, the Ministry for Agriculture, Environment and Water Resources and the regional departments of agriculture so far do not appear to have much interest in treated effluent.

*3. Jordan, re-use of treated wastewater in irrigated agriculture in the Jordan Valley*

Jordan is one of the most water-stressed countries in the world. At present, around 70% of total water consumption is used for irrigation purposes. Since the total water consumption has exceeded the renewable resources the agreed Jordanian-German co-operation aims at the protection and efficient use of the existing ground and surface water resources by, among others, substitution of fresh water for agricultural irrigation by using treated effluent. The present and future co-operation is based on the "Joint Approach of Jordanian-German Co-operation in the Water Sector and Related Environmental Aspects" dated November 2001, which includes aspects of irrigated agriculture with the overall objective of improving the water balance of the country.

Within the framework of Financial Co-operation (FC), the German Government has committed around EUR 89 million for the extension of the sewerage system of the Greater Irbid Area in the northern uplands of the Kingdom. The investment programme includes the implementation of three sewerage networks with advanced-technology wastewater treatment plants (WWTP) for densely populated urban areas and is supposed to be completed by the year 2005. These three wastewater collection and treatment systems supplement the Central Irbid sewerage system and treatment plant that started operations in 1987. Based on the mid-term projections, towards the year 2015 the daily volumes of treated effluents from the WWTPs would come to some 550-600 l/s.

The overall objective of the programme currently at feasibility stage is to define and implement measures for the re-use of treated wastewater on existing agricultural irrigation perimeters, in order to substitute the use of freshwater in irrigated agriculture and thus improve the water balance of the country. As a consequence, the use of treated effluent on additional or new perimeters is excluded. This shall be supported by an integrated irrigation and water use programme for the Jordan Valley North Area, considering the available treated effluents, a

reduced use of fresh water resources and natural rainfall.

Because of a number of negative experiences in recent years, when water supply for irrigation was affected uncontrolled by effluents from wastewater treatment plants in certain regions, a low acceptance rate by farmers and markets is said to dominate. This is why the project concept is to be supported by professional guidance and control and, most important, by an official public awareness campaign confirming product qualities and health standards. It is to motivate the farmers, the markets, and the public to understand and accept the reuse of treated effluents for irrigated crop production. On the other side, in order to improve the farmers' acceptance of the use of reclaimed water, the monitoring and quality control of the outflow from the WWTPs must be permanently guaranteed by the responsible authority i.e. operator of the plants, and the respective laws and regulations must be enforced, leading to countermeasures and/or sanctions in case the standards are not fulfilled. Further, the Jordanian Government has to adapt its legislation concerning treatment standards in order to allow an efficient and safe use of treated wastewater in irrigation.



*4. Namibia, water reclamation plant Windhoek*

The population of Windhoek has grown strongly particularly in the years after independence and today totals around 300,000 inhabitants. Until the end of the 1950s the drilled wells utilised since 1928 and the Avis Dam which was built in 1933 and has been dry for quite some time were sufficient to supply the population of about 36,000 inhabitants with water. After 1959 the water supply came not only from the drilled wells but, initially, from the Goreangab Dam, the water of which was treated in a treatment plant. The water supply was later expanded into a central Namibian integrated water supply scheme. To that end three new dams were constructed by the Namibian government. The water resources thus available to the city of Windhoek are not sufficient to secure the water supply in the future, especially because long periods of drought, erratic precipitation and high evaporation lead to great fluctuations in the available quantities. The additional supply of Windhoek by an extended long distance bulk water trunk line from the area of Otjozondjopa (200 km distance) or the Okawango river (500 km distance) is not feasible from economical and ecological point of view.

Since 1968 the world's first water reclamation plant for converting wastewater into drinking water has been in operation in Windhoek. Over the years this plant was gradually expanded by the city of Windkoek and modernised (14,000 m³/d, treatment stages with flotation/sedimentation/filtration/activated carbon filtration/final chlorination). The rehabilitation and enlargement of this plant to a capacity of 21,000 m³/d was supported by an FC project.

According to the overall concept, the treated effluent from the existing municipal treatment plant (18,000 m³/d, 6.5 mn m³/a), which possesses treatment stages of nitrogen removal, phosphorous removal and maturation ponds, is blended with water from the Goreangab Dam (secured available water 1.5 mn m³/a). This way almost one third of the entire water consumption can be covered by wastewater for reclamation.

The total cost of the treatment plant amounted to EUR 13 million and was three-quarters financed from FC funds. In return the city of Windhoek was obligated to a) introduce tariff increases and a stronger consumption-related progression, b) make efforts towards a substantial reduction of specific water consumption and c) significantly reduce water losses. As a result of the tariff increases, surplus revenue on basis of operation costs is already being achieved and the collection efficiency is around 87%. Technical losses are being reported at 8% and the commercial losses (for instance from water meters not read) are estimated at 10%.

The wastewater reclamation plant of Goreangab was put into operation in 2002 and is being operated by the private operator WINGOC. In the preparation of the management agreement the city of Windhoek was supported by a transaction adviser financed from FC funds.

However, this solution has to be considered as an exemption, taking into account the difficult

framework conditions and the specific capacities with regard to wastewater reclamation of the city Windhoek. The high conversion costs per cbm, the strong institutional framework needed - in the case of Windhoek a private manager will operate the plant -, the sophisticated operation of the plant and the need for a secure water quality monitoring system are risks which are difficult to handle, especially when considering the general framework in developing countries.

*5. Egypt, wastewater disposal Amriya/Alexandria*

The district of Amriya, located in the western part of Greater Alexandria, experienced strong population growth over the last 20 years without adequate water and sanitation infrastructure development. In the entire district, but mainly in the densely populated settlement areas where housing standards are mostly low, large portions of the population are exposed to health hazards from numerous sources of contamination, particularly from the sewage and faeces stagnating in the streets. The discharge of untreated sewage into the canals and the wild waste dumps alongside the canal embankments also cause severe pollution which leads to considerable mephitis originating from anaerobic processes in the waters. The planned project, in which the densely populated settlement areas have been chosen as a priority for the construction of a sewerage system and connection to a central sewage treatment plant, represents the first expansion stage in the planned development of the sanitation infrastructure in the Amriya district and currently can make the most effective contribution to improving the health and environmental situation in the district. Furthermore, the capacity of the sewage treatment plant will be large enough to accommodate the sewage produced by the new settlements already connected to sewers.

The project will assume a pioneer role with the planned mechanical-biological treatment plant for 300,000 PU in the first expansion stage. A combined anaerobic-aerobic treatment process will be applied – initially for only a portion of the sewage, however. In a first anaerobic stage around 70% of the organic waste will be eliminated without aeration while the second aerobic stage will serve as secondary treatment for compliance with the prescribed effluent standards. Operating costs are estimated to be around 50% lower a) as a result of lower energy consumption for aeration and b) as a result of lower costs for sludge treatment because the excess sludge quantity obtained from the anaerobic process will be only around 10% of the quantity of the aerobic process which will accrue already in a stabilized form. Savings can also be achieved in the cost of the investment.

The sewage sludge produced by the sewage treatment plant is to be composted following mechanical dewatering and then used in agriculture for farming purposes. Positive experience has already been gained in this respect from the treatment and utilization of sludge in two sewage treatment plants already in place.

The overall investment cost of the project is estimated at EUR 55 million, of which EUR 33 million will be financed from FC funds. The project is to be implemented in the next two to three years. A management agreement with a private operator is to be concluded for the operation of the sewage treatment plant.

A sewage treatment plant financed by FC funds with an anaerobic first stage and downstream settling ponds for 65,000 PU went into operation in Babahoyo, Ecuador, in 2002. The first operating results reported from there confirm the above data concerning sewage treatment performance and costs.

## Conclusions

The application of ECOSAN concepts, which are per definition highly decentralized and apply high-level separation and reuse of water and nutrients, needs further demonstration in developed as well as in developing countries, especially in urban areas, to gather practical experience and prepare for large-scale implementation. This is still a challenge because the

following questions, among others, have to be answered:

- What particular technical and operational concepts are most appropriate?
- What socio-cultural considerations have to be made?
- How to secure reliable operation and thus manage potential health risks?
- How to proceed with a restrictive legal framework and standards for re-use elements?
- How strong is the ownership of local partners and their willigness to support appropriate technologies?

KfW is participating and collaborating in the efforts towards more effective and efficient wastewater and sanitation projects and is actively supporting the GTZ-ECOSAN project in preparing and implementing demonstration projects in order to gather practical experience in our partner countries.

# Ecological sanitation in Mozambique: baseline data on acceptability, use and performance*

**Rebecca J. Van der Meulen, Christine L. Moe**
Rollins School of Public Health of Emory University
1518 Clifton Road, Atlanta, GA 30322 United States
e-mail: rjvande@sph.emory.edu
e-mail: clmoe@sph.emory.edu

**Edward D. Breslin**
WaterAid – Mozambique
CP 276, Lichinga, Niassa Province, Mozambique
e-mail: wateraid-mz@teledata.mz



## Keywords

Acceptability, ecological sanitation, latrine, Mozambique, sanitation

## Abstract

Households using ecological sanitation ("ecosan") latrines in Niassa province, Mozambique, (n=76) were surveyed regarding the factors contributing to the adoption, acceptability, use, and maintenance of these latrines. Neighbors without ecological sanitation latrines were also surveyed, for comparison. Biosolid samples taken from in-use latrine pits had a mean temperature of 23°C (16.1°C–30.4°C), pH of 8.3 (5.7–10.2) and moisture content of 48% (13-88%). Most users learned of ecological sanitation through the non-governmental organization (NGO) WaterAid and its partner organizations. Households chose ecological sanitation for a variety of reasons, including the design, construction, maintenance, and health benefit of the latrines. Users found ecosan latrines very satisfactory, and were following maintenance directions. Based on the low average temperature and varying moisture contents of the latrine samples, we recommend prolonged storage (1-2 years) and that precautions be taken when using the biosolids for agriculture.

## Introduction

Prompted by the educational outreach work of the international NGO WaterAid and its Mozambican partner organizations, households in the province of Niassa, Mozambique, are rapidly adopting ecological sanitation ("ecosan") technology in which human wastes are stored until safe and then reused as fertilizer for agriculture. ESTAMOS, a community organization that promotes food security, HIV/AIDS prevention, and safe water and sanitation, is the partner organization that works in the districts of Lichinga and Mandimba, where this study was conducted. Lichinga is the provincial capital of Niassa, Mozambique's poorest and most remote province, and Mandimba is a large district capital within the province.

The primary ecosan design promoted by WaterAid through ESTAMOS is the "fossa alterna," which consists of two permanent, partially lined, shallow (1.25 – 1.75 meter) pits and a movable concrete latrine slab. This slab covers the pit that is in use, and a wooden cover protects the pit that is not in use. Thatched straw walls surround the two pits and a private bathing area, which is attached (fig. 1). Fresh excreta are covered with a mixture of ash and soil. When the first pit is full-after approximately one year of use-it is covered and its contents are allowed to decompose. The second pit is then used until it is full, at which point the first pit is prepared for reuse: its

*This paper has been peer reviewed by the symposium scientific committee

contents are removed and are further decomposed or used immediately as fertilizer. Since the spring of 2001, communities throughout Niassa have requested assistance with constructing more than one thousand fossa alterna ecosan latrines, and more than three hundred of these have already been built.

This study highlights the attitudes and behaviors of ecosan users as they begin to use ecological sanitation. At the time of the study, few households had begun using the second pit. This study therefore does not address the impact of ecosan latrines after the decomposed excreta have been removed. Instead, building on WaterAid's regular monitoring and evaluation of Niassa's fossa alterna latrines, this study documents baseline information on 1) latrine preference and ecosan acceptability, 2) the use and maintenance practices of ecosan latrines, and 3) selected physical and chemical characteristics of the biosolids in the latrines.

**Figure 1:** Fossa Alterna Latrine

## Methods

*Eligible population*

This June 2002 to July 2002 study investigated all households known to have fossa alterna latrines in the peri-urban towns of Lichinga and Mandimba and in the surrounding rural communities. Latrines that had been completely built but which were not in use because they lacked a concrete slab were included in the study. Also included in the study were the one or two closest households neighboring each household with an ecosan latrine. Eligible respondents in all households were people who were over 18 and were responsible for latrine maintenance (if applicable).

*Field survey*

In June and July 2002, interviewers fluent in local languages (Portuguese, Nyanja, Macua, and Yao) conducted surveys of households with fossa alterna latrines (n=76) and of their closest neighbors (n=110). The in-depth surveys asked up to 338 questions. The type of latrine owned (if any), the number of latrines owned, and whether the owned latrines were in use determined which questions were asked in each household.

The research team visually inspected latrine construction and maintenance and noted evidence of use. Using PVC pipe of 3.8 cm diameter, the team took core biosolids samples from 48 in-use and two full (dormant) pits. Ambient and sample temperatures were taken on-site, and the samples were taken to the lab in plastic bags.

*Physical and chemical measurements*

Moisture content of the core samples was determined by comparing the initial weight of a 20-60 gram sample with the weight of the same sample after the sample was dried. Samples were dried in the sun in metal weighing dishes, on a concrete slab covered with black plastic. Samples were covered with plastic overnight and during inclement weather. The pH of the

sample was measured with a standard pH probe. If necessary, the sample was diluted with small amounts of neutral water until the pH could be measured.

*Analysis*

Two households with ecosan latrines are omitted from analysis because their respondents were younger than 18 years. In order to reduce the potential bias of a varying sample size, direct comparisons between households with ecosan latrines and their neighbors used only one comparison neighbor, even if two comparison neighbors were surveyed.



## Results

*Background demographics*

Communities that are farther than a 30 minute walk from the administrative centers of Lichinga and Mandimba were classified as rural (n=32); others are classified as peri-urban (n=42). Thirty study households were in Lichinga, and 44 in Mandimba. The mean household size was 5.5 people in houses with ecosan latrines and 5.1 in houses without ecosan latrines. About 61% of households were Muslim, and 39% were Christian. The materials used to construct houses indicate poor economic status: 79% of ecosan households had roofs made of straw, 81% had walls made by free hand, and 81% had dirt floors. Regarding property, 55% had bikes, 56% had radios, 4% had televisions, and 15% had access to electricity. Households with ecosan latrines did not differ significantly from their neighbors by socio-economic indicators.

Seventy-six percent of households with ecosan latrines grow food in machambas (agricultural fields that are away from the home) or in home gardens. Research on agricultural practice, conducted in Mandimba only, found that all of the ecosan households that grew food used fertilizer, thought that their land was not fertile, or thought that fertilizer would help their land.

In terms of health, 18% of respondents from households with ecosan latrines thought they had worms, 18% thought that their youngest child had worms, and 24% reported that their youngest child had had diarrhea in the past week.

*Knowledge, preference and acceptability*

When asked how they heard of ecosan, 63% of people with ecosan latrines identified ESTAMOS as the source of their introduction to ecological sanitation. Ten percent reported having heard of ecological sanitation from a community leader (such as a chief, secretary, or sanitation activist), and 10% reported having heard of ecosan on the radio. When asked directly regarding whether they had heard about ecosan on the radio, 36% of households with ecosan latrines and 35% of their neighbors responded affirmatively.

Among owners of fossa alterna latrines, 23% chose this type of latrine for its structural aspects (design and construction), and 14% chose ecosan for aspects relating to its use or outcome (maintenance, health, or fertilizer, for example). A substantial proportion of all ecosan owners, 41%, reported not having chosen this type of latrine for themselves (table1).

| **Why ecosan owners chose ecosan latrines (n=70)** | **%** |
|---|---|
| design | 17 |
| construction | 5.7 |
| maintenance | 7.1 |
| health | 5.7 |
| fertilizer | 1.4 |
| generally attractive/other | 19 |
| did not choose ecosan latrine | 41 |
| don't know | 2.9 |

**Table 1:** Factors in latrine choice

The majority of ecosan owners reported that their hands felt dirty after defecating (88%), that they were accustomed to washing their hands when they didn't feel dirty (95%), that feces were dangerous (85%), and that latrines improve health (82%). For these attitudes, there were no significant differences between ecosan owners and their neighbors. Ecosan owners were significantly more likely to think that using composted feces and urine from a latrine on agriculture would improve health (p =0.0098).

Ecosan users, but not their neighbors, most commonly identify fossa alterna latrines as the healthiest type of latrine and as the type of latrine they hoped to have in two years (fig.2). Both households with ecosan latrines and their neighbors viewed traditional pit latrines as the hardest to maintain. Improved pit latrines are defined by their concrete slabs, whereas traditional pit latrines have platforms made of poles.

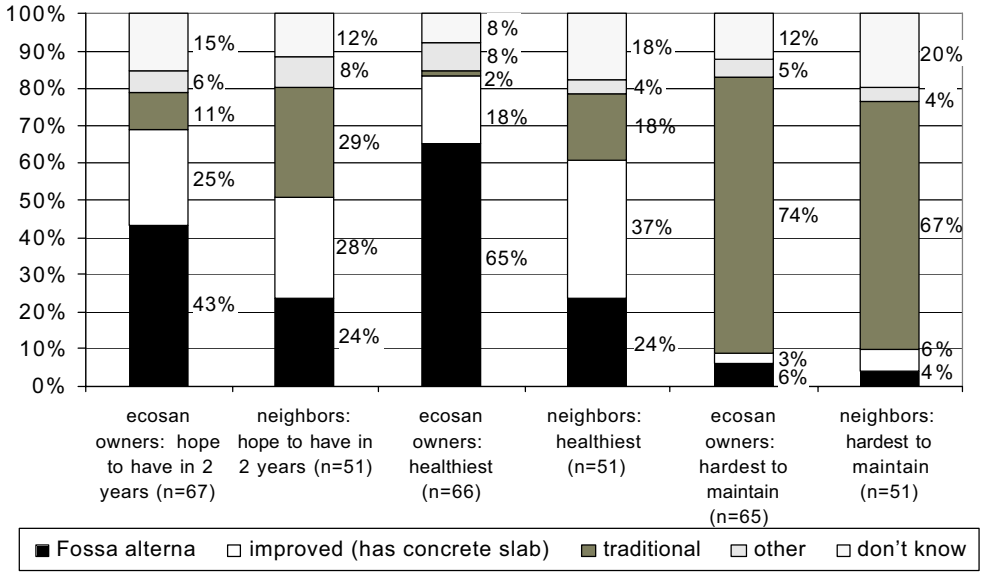


**Figure 2:** Perceptions of latrine types

All respondents reported receiving assistance in ecosan latrine construction, but only 18 percent of households with ecosan latrines reported that they would have built the same latrine without assistance. Ninety-one percent reported having received help with materials, 83% with construction advice, and 61% with construction labor, and none reported having received monetary assistance. In contrast, although the sample size was smaller, no owners of other types of latrines reported having received any construction assistance. Few people knew the cost of constructing their latrine (table 2)[1].

| | ecosan latrines | non-ecosan latrines |
|---|---|---|
| received assistance in building latrine | 95% (69/73) | 0% (0/23) |
| would have built the same latrine without assistance | 18% (12/66) | not applicable |
| know cost of constructing latrine | 0% (0/72) | 15% (4/26) |

**Table 2:** Assistance in constructing latrines

Ecosan users nearly universally reported satisfaction with their ecosan latrines, and many reported that they would recommend this type of latrine to someone else (tab.3)[2]. Comparing ecosan users in Lichinga with their neighbors who had functional latrines, ecosan users were significantly more likely to report latrine satisfaction ($p<.0001$) and willingness to recommend their type of latrine ($p<.0001$). When given the response options of improved health, worsened health, and health that has not changed, 86% of ecosan latrine users reported that their family

[1] The numbers in brackets indicate the number of positive responses divided by the total number of households interviewed."

[2] "The numbers in brackets indicate the number of positive responses divided by the total number of households interviewed."

had experienced improved health since the construction of their latrine. Upon probing, people elaborated with comments like, "we do not have diarrhea problems" and "we are not frequently sick." Users of non-ecosan latrines also reported similar improved family health since latrine construction.

When asked to identify latrine aspects they liked, 56% of ecosan users mentioned construction in general or some specific construction aspect, such as the walls, the concrete latrine slab, or the roof. Thirty-one percent of users also specifically noted liking the latrine's two pits. When specifically asked to identify what they disliked, 43% declined and responded simply that they liked the latrine. Despite the overall affinity towards ecosan latrine construction and design, 11% of ecosan owners disliked the depth of the pits, and 14% identified the walls as problematic. They described the walls as weak, and some explained that they would prefer walls of brick.

| | ecosan latrines | non-ecosan latrine |
|---|---|---|
| satisfied with latrine | 98% (65/66) | 80% (33/41) |
| would recommend this type of latrine to someone else | 88% (53/60) | 51% (18/35) |
| problem with smell* | 17% (10/59) | 33% (5/15) |
| problem with flies* | 16% (9/58) | 71% (39/55) |
| health improved since latrine construction* | 86% (51/59) | 87% (13/15) |
| more flies before construction of latrine* | 13% (7/56) | 40% (6/15) |

*among households whose latrines are in use

**Table 3:** Acceptability of ecosan latrines

*Use and maintenance practices*

Ecosan users most frequently reported reducing latrine-related smell and flies by adding ash and dirt and by covering the latrine. Users of other types of latrines also reported adding hot or boiling water and hot ash. Although users of other types of latrines reported adding ash to reduce smell, only ecosan users reported adding a mixture of ash and dirt.[3]

The majority of ecosan users follow the instructions given by WaterAid to regularly add dirt, ash, or a mixture of ash and dirt: 83% reported doing so (tab.4)[4]. Upon inspection, 85% of all in-use latrines had ash, dirt, or a mixture available inside the latrine. 82% of all ecosan owners thought they should add dirt, ash, or a mixture. Only 3.4% of ecosan users add grass, straw, and/or kitchen scraps to their latrines, and 2.7% of all ecosan owners thought that these substances should be added to a fossa alterna latrine. No ecosan users reported adding trash to their latrine, and only 1.6% of all ecosan owners thought that trash should be added. 91% of ecosan users had handwashing sites with evidence of use.

| | ecosan latrines |
|---|---|
| add dirt, ash, or mixture* | 83% (49/59) |
| think dirt, ash, or mixture should be added | 82% (61/74) |
| add trash* | 0% (0/39) |
| think trash should be added | 1.6% (1/64) |
| add grass, straw, or kitchen scraps* | 3.4% (2/59) |
| think grass, straw, or kitchen scraps should be added | 2.7% (2/74) |
| has hand washing site with evidence of use | 91% (50/55) |

*among households whose latrines are in use

**Table 4:** Maintenance attitudes and actions

*Physical and chemical characteristics*

Samples taken from the in-use pits of fossa alterna latrines had temperatures similar to the ambient temperature, with a mean

[3] On average, 3.2 adults and 1.8 children use each ecosan latrine, and all household members use the ecosan latrine in 89% of ecosan households. Among ecosan households, 26% have more than one latrine. Before constructing ecosan latrines, 6% reported defecating in the open; others reported using their neighbors' latrines.

[4] "The numbers in brackets indicate the number of positive responses divided by the total number of households interviewed."

temperature of 22.8°C (standard deviation 3.28°C). Mean moisture content was 47.6% (standard deviation 21.3%) and mean pH was 8.28 (standard deviation .88) (table 5)[5].

| | temperature (in °C) | moisture content (%) | pH | depth (in cm) |
|---|---|---|---|---|
| n | 47 | 47 | 48 | 52 |
| mean | 22.8 | 48 | 8.28 | 113 |
| std deviation | 3.28 | 21 | 0.88 | 37 |
| minimum | 16.1 | 13 | 5.68 | 20 |
| maximum | 30.5 | 88 | 10.22 | 180 |
| | temp≤18°C: 4.3% (2/47) | moist≤25%: 13% (6/47) | pH≤8: 23% (11/48) | depth≤60: 9.6% (5/52) |
| | 18°C <temp<24°C: 62% (29/47) | 25%<moist<65%: 62% (29/47) | 8<pH<10: 75% (36/48) | 60<depth<120: 42% (22/52) |
| | temp≥24°C: 34% (16/47) | moist≥65%: 26% (12/47) | pH≥10: 2.1% (1/48) | depth≥120: 48% (25/52) |

**Table 5:** Physical and chemical characteristics of contents of in-use latrine pits

## Discussion

*Knowledge, preference and acceptability*

In these communities, there were no clear associations between the adoption of ecosan latrines and economic factors or attitudes towards sanitation. There is insufficient information in this study to determine if the association between ecosan latrine ownership and the belief that putting composted feces and urine on agriculture would improve health preceded and helped predict ecosan adoption, or was a product of ecosan adoption. Compelling reasons for adoption varied from household to household, pointing to the need for further ecological sanitation promotional efforts to be correspondingly diverse.

To questions about what types of latrines are the healthiest, easiest to maintain, and would be most desired in the future, fewer than 4% responded with the answer of flush toilets. Although the question asked refers specifically to “latrines” (not to “latrines or toilets”) it is notable that flush toilets are not widely perceived as the best sanitation options.

A large proportion of households with ecosan latrines reported not having chosen their type of latrine. Noting that those closest to the problem of inadequate sanitation are best able to diagnose its solution, and that long-term project sustainability is associated with a household's actively having chosen that project, WaterAid is committed to having communities, and even individual households, make their own informed decision about what type of sanitation technology is best for them. This apparent lack of user choice is not in line with the WaterAid’s policy that users should make their own decisions regarding water and sanitation. In the past, WaterAid has recognized that in Mandimba, for example, fossa alterna latrines are the only latrines being built, and has flagged the need to ensure that "communities are getting the chance to really choose, and not simply being given a list of choices but being guided into a pre-determined choice made by government, activista or NGO staff" (Breslin 2001). WaterAid is leading participatory workshops in which the benefits and drawbacks of various types of sanitation-not just ecological sanitation-are discussed. In December 2002, the District Directorate of Public Works had over 700 applications for latrines, of which 59% were for fossa alterna latrines; the other applications were for improved latrines or for minor improvements to existing latrines, solicited by people who intend to convert to fossa alterna latrines when old

[5] “The numbers in brackets indicate the number of positive responses divided by the total number of households interviewed.”

latrines are full.

Although some households reported not having chosen fossa alterna latrines, the choice was also not made by WaterAid, but by local community leaders. In some communities, for example, leaders targeted the elderly to be the first beneficiaries of ecosan latrines. In this study sample, a user who had not actively chosen the latrine was no more or less likely to recommend the latrine or to care for the latrine by adding ash and dirt. Those who did not choose this latrine were, however, less likely than ecosan owners who chose their own latrine to report satisfaction with their latrine ($p=0.04$).

While household ownership may be important for sustainability, committed NGO involvement seems to be crucial in the introduction and implementation of ecological sanitation: the majority of ecosan owners cited ESTAMOS as their source of introduction to ecosan, and nearly all reported that they would not have built their latrine without assistance. WaterAid's mass education through the radio seems to have been heard widely throughout the study communities, both by ecosan owners and their neighbors.

*Use and maintenance practices*

Ecosan users are instructed to add a mixture of dirt and ash to their latrines, and to wash their hands after using the latrine. The evidence of addition of dirt and ash to the pit and use of handwashing sites therefore serve as proxies for compliance with NGO advice. Compliance with the instruction to add ash and dirt may be prompted by the tangible outcome: users perceive adding ash and dirt as a way to reduce smell and flies, and even users of traditional latrines reported this action.

*Physical and chemical characteristics of latrine biosolids*

For latrine biosolids to be useful in agriculture, they must be safe to handle and not contaminate food crops with human pathogens. Microbiological analyses of biosolids were not performed in this study, but the measured physical and chemical characteristics of samples taken from in-use latrine pits can help predict the likelihood of pathogen inactivation. Previous studies have described the range of conditions associated with microbial die-off, but their application to this study is somewhat limited because they focus on storage conditions, not on in-use conditions.

In general, high temperatures (55-65$^{o}$C) are associated with rapid microbial die-off, and are generally indicative of thermophilc aerobic composting. The maximum temperature observed in these samples was 30.5$^{o}$C, indicating that aerobic composting is not occuring. Most fundamentally, aerobic composting requires oxygen. Regular turning of the pile contents allows each part of the pile to have access to oxygen. Manipulation of the contents of a fossa alterna ecosan latrine, however, is not practical. Although the free air space of a pile (and its oxygen content) are often inversely related to moisture content, moisture content alone does not determine free air space levels. Strong fibrous materials, such as straw, allow free air space to be maintained in spite of high moisture content, while granular substances like ash and soil cause the material to become compact with increased moisture (Gotaas 1956). Although large-scale aerobic composting is unlikely in the fossa alterna latrine, appropriate additives could facilitate pockets of aerobic composting.

If the moisture content is low enough, cells lack the water necessary for metabolism (Redlinger 2001) and die through desiccation. Desiccation may be occurring in Niassa in six ecosan latrines that had moisture content less than 25%. However, because the moisture level in the pits is sensitive to environmental humidity and these samples were taken during the driest season of the year, the average moisture content in the latrine pits is probably higher than these observed values. When pits are in use, they also regularly gain extra moisture through the addition of urine. We predict that these latrines are able to attain lower moisture levels when they are full, left dormant, and are not subject to further urination.

Other studies have shown a strong association between very high pH and pathogen die off (Moe and Izurieta 2003). At pH levels greater than 10, faecal coliforms die much more rapidly than at lower pH levels. Three-quarters of the fossa alterna samples had pH values between 8 and 10, but only one of the 48 latrines sampled in this study reached a pH of more than 10.

The most likely mechanism for pathogen destruction in fossa alterna latrines is anaerobic composting. Anaerobic composting occurs when a solid is tightly packed, with 40-75% moisture, or is surrounded by liquid, with 80-99% moisture (Gotaas 17). Successful pathogen die-off through anaerobic composting depends largely on time. Because fossa alternae have two pits, waste products in the first pit are able to compost as that pit fills, and are also able to compost for the entire duration of the filling of the second pit. This extended period of time (perhaps as long as two years) is critical for substantial pathogen die-off in anaerobic composting conditions, but may not be sufficient.

## Conclusion

Ecological sanitation in Niassa is off to a promising start: users are choosing ecological sanitation, are using ecological sanitation, and are satisfied with ecological sanitation. WaterAid's work demonstrates that household sanitation can succeed in a very poor population. Ecological sanitation is especially relevant agriculturally-driven economies like this one.

Although the self-reported worm infections in the study population have not been confirmed by lab diagnoses, they suggest the possibility of widespread helminth infection and alert researchers to the importance of thorough pathogen destruction in composting excreta. Further studies should be done to compare the physical and chemical characteristics of the materials from in-use and stored latrine pits, and microbiological analyses would provide information on which conditions best promote pathogen die-off and result in a safe endproduct. Because the microbiological safety of the end product of these pits remains unknown, the storage should be as prolonged as possible, and precautions should be taken when handling the biosolids and using it in fields. Potential precautions include letting the biosolids sit on the top of the field, exposed to the sun, before planting occurs; applying the biosolids to land only before planting occurs (instead of as an added fertilizer after growth has begun); and using it with crops whose edible portions do not touch the ground. Ecological sanitation is being promoted well and implemented well, with the support of WaterAid and its partner organizations. Public health education about the safe use of excavated biosolids will enable the end product also to be used well, strengthening the health of both agricultural crops and people.

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# Urban household perception of urine-excreta and solid waste source separation in urban areas of Ghana*

**George Danso**[1,2]

[1] Dept of Economics, Faculty of Agriculture, Kwame Nkrumah University of Science and Technology (KNUST)
Kumasi, Ghana
e-mail: ceegeorge@yahoo.com

**Pay Drechsel**[2], **Lucy Gyiele**[2]

[2] International Water Management Institute (IWMI)
PMB CT 112, Accra, Ghana
e-mail: iwmi-ghana@cgiar.org



## Keywords

Urine excreta separation, solid waste source separation, resource recovery, urban household perception, urban agriculture, Ghana

## Abstract

Attaching resource recovery and reuse options to the sanitation system could create win-win situations for urban and peri-urban farmers and city authorities. In a study carried out in different Ghanaian cities (Accra, Kumasi, Tamale), the level of interest of urban households to separate organic from inorganic solid waste as well as their attitude towards toilet facilities, which separate urine from excreta, was explored. 2500 households were interviewed with focus on source separation, and about 650 households to assess perception, knowledge and interest in reuse of human excreta and urine.

Approximately 70-80% of the sampled households showed no objection to source separation. Despite the generally positive attitude, actual waste separation trials in Kumasi showed that its efficiency is declining after some weeks independent of living standard. This was attributed to lack of follow-up after an initial training.

With respect to toilets separating human excreta and urine, 70% of the household had a positive perception. Most households suggested that urine could be used as medicine while dried excreta are good manure. Although only a few households were interested to sell their new resources, about 60-80% believed that there should be a market. Current pilot trials with eco-toilets in Kumasi do unfortunately not consider this potential.

In general, household interest and perception is **not** the limiting factor for resource recovery but any technology has to be tested in close collaboration with the households concerned.

## Introduction

Urban and peri-urban areas in developing countries are among the most polluted and disease-ridden habitats of the world. Much of this pollution is caused by inadequate and inappropriate urban sanitation infrastructure and services. As cities expand and urban populations increase, the situation is growing worse and the need for safe, sustainable and affordable sanitation systems is becoming even more critical. The challenge that this growth presents to decision-makers and planners in meeting the needs for food, shelter and waste management is complex. The waste challenge can best be described by the fact, that in all Ghanaian cities, 50-75% of the municipal budget is used to tackle the ever-increasing waste generation. And the waste

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problem is increasing the deficit of the communities. While in Kumasi the total costs of waste collection and transport (without salaries) sum up to 18 billion cedis[1] per year, the revenue from related fees is not exceeding 7 billion cedis (KMA, unpubl. Data, 2002).

In view of the importance of urban and peri-urban agriculture and the need for affordable fertilizer, it appears appropriate to explore options of nutrient recycling from municipal waste (Drechsel and Kunze, 2001). However, although resource recovery and reuse are desirable options, they are still the big exception in developing countries (Furedy, 2002; Drechsel et al., 2002).

According to the Environmental Sanitation Policy, ''sanitation in Ghana leaves much to be desired'' (Government of Ghana, 1999). Indeed, less than 40% of urban residents are served by solid waste collection services and less than 30% by an acceptable household toilet facility. Insufficient financial, technical, and institutional capacity of the municipal authorities to collect, transport, treat and/or dispose solid and liquid wastes is one of the major urban problems. There are for instance three human waste treatment facilities in Accra, with a new one running below capacity due to the short innercity sewerage system, and two stabilization pond systems which are broken down (but still used) since years. As a result, at least 30% of the municipal excreta are dumped into the ocean after collection (GTZ - AMA, unpubl.)

## Approach and rationale

In view of the general high potential for municipal waste composting in the study area (Leitzinger, 2001; Salifu, 2001; Fobil et al., 2000), the *International Board for Soil Research and Management* (IBSRAM)[2] targeted in a corresponding study three cities in Ghana to develop decision support on waste composting. The study received support from IDRC/IWMI and the French Government. The overall project aims at developing recycling strategies to close the rural-urban nutrient cycle.

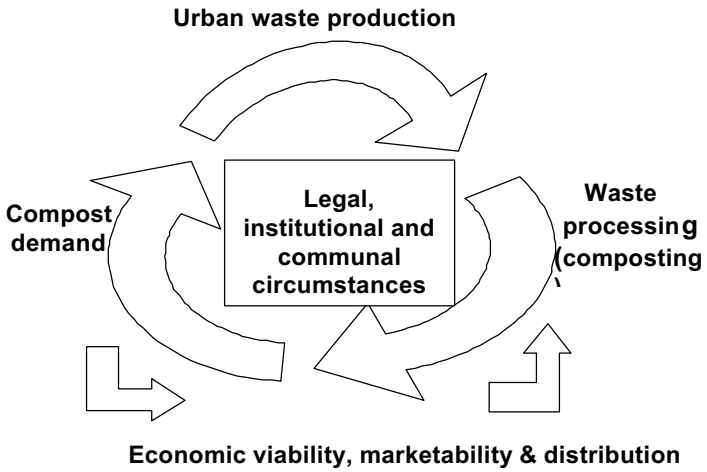


**Figure 1:** The recycling loop (Drechsel et al., 2001).

In this project a general model has been proposed (Drechsel et al., 2001) which follows the "Recycling Loop" (Fig.1) with the following five study segments: 1) waste or raw material supply, 2) recycling/composting process, 3)compost demand, 4) legal, institutional and communal settings, and 5) economics and marketing.

The model thus tries to qualify and quantity: organic waste supply by households, agro-industries, markets, etc, (1), waste collection, transport and processing on composting stations (2), the demand and willingness to pay by farmers, estate developers etc. for the product (3), and all this under consideration of the legal, institutional and communal settings (4) and the viability of any recommendation (5). It becomes obvious that such a project requires a multidisciplinary approach going far beyond a simple technical "composting" one. Some results from the different segments have been presented elsewhere (e.g. Danso et al., 2002; Vazquez et al., 2002).

[1] 8500 cedis = 1 USD (2002/3)

[2] In April 2001, IBSRAM became incorporated into the International Water Management Institute (IWMI).

The issue we tried to address in this paper is the public perception of Resource Recovery and Reuse, especially the level of interest of urban households to separate organic from inorganic solid waste to support municipal compost stations and their attitude towards toilet facilities which separate urine from excreta.

## Study area and methodology

The study was conducted in and around three cities in ecological zones of Ghana. These are Accra (Coastal savannah zone), Kumasi (Humid Forest Zone), and Tamale (Guinea Savannah zone). Accra is the capital with about 1.7 million inhabitants. Population growth rate of Accra is 3.4% per year. Kumasi is the capital town of Ashanti Region and the second largest city in Ghana with a population of 1,170,000 and annual growth rate of about 6% (Ghana Statistical Services, 2002). This figure refers to Kumasi's night population since its famous and gigantic market attracts an additional 0.5 to 1.0 million people per day. Tamale is the administrative/regional capital of the Northern Region and has a population of about 200,000 with a growth rate of 2.5 % (Ghana Statistical Services, 2002).

Each city area is divided into different sub-metros which were used as base for household interviews and data recording via schoolchildren (age 13-16). About 60 schools were randomly selected from the different sub-metros in the three cities under consideration of local population density. The school pupils received questionnaires to be filled at home with their parents. Care was taken to keep the study representative in terms of different social and religious groups. In southern Ghana, the proportion of Muslims is about 20%, in Tamale around 70%. In all, the pupils represented 2500 households in the three cities. Additional surveys through interviewers were carried out in 658 households within different communities in Kumasi to assess household perception, knowledge and interest in separation and reuse of human excreta and urine, for example, as soil conditioner for urban and peri-urban agriculture (UPA). Communities were differentiated according to their toilet systems.

## Results and discussions

Source separation and co-compost

It was explained to the households that organic waste can be turned into compost for urban and peri-urban agriculture (UPA), especially if source separation could be realized. About 70-80% of the sampled households showed no objection to separate their refuse into an organic and an inorganic fraction to help to make better compost. Only few households were not willing to separate their waste and about 10% would only separate it if it would be requested with extra fees for those who would not participate (Table 1). There was no significant difference between Christians and Moslems or households with different educational or occupational background.

| Source separation | Kumasi | | Accra | | Tamale | |
|---|---|---|---|---|---|---|
| | Frequency | % | Frequency | % | Frequency | % |
| Yes | 498 | 84 | 414 | 77 | 229 | 81 |
| No | 70 | 12 | 28 | 5 | 18 | 6 |
| Only if law | 24 | 4 | 94 | 18 | 37 | 13 |

Source: IWMI Ghana data, 2001/02

**Table 1:** Willingness in source separation in the three cities

The survey also asked whether or not the households would buy food that has been grown using co-compost, i.e. compost made from solid waste and human excreta. Table 2 shows that approximately 65-82% of the households would buy crops that have been grown using co-compost, while almost 15% would not buy such products and mentioned culture and possible diseases as their main constraints. About 10% of the sampled households could not express

their concern on the issue. Sixty-five percent of household stated that if it is well treated the compost could be applied to any crop including vegetables.

| Answer | Kumasi (%) | Accra (%) | Tamale (%) |
|---|---|---|---|
| Yes, I would buy | 79 | 65 | 82 |
| No, I wouldn't buy | 13 | 17 | 15 |
| Indifferent | 8 | 18 | 3 |
| Total | 100 | 100 | 100 |

Source: IWMI Ghana data, 2001/02

**Table 2:** Willingness to buy crops that have been grown using co-compost

The survey further asked who could be the most appropriate body to work with in waste management. About 65% of the households considered their assemblymen as most appropriate to coordinate waste related activities, followed by churches and private companies. This means that people at the grassroots level believe more in the assemblyman's effectiveness and capacity to organise community initiatives than in their city authorities or private companies, currently in charge of waste management. These results provide a first guide of the type of solutions that would be 'socially acceptable'. Interventions via the 'Assemblyman' imply participation at the grassroots level, good leadership, and a strong sense of self-reliance. This picture confirms the assertion that waste interventions need a strong linkage with the local municipal representative to be accepted, understood and successful (Vazquez et al., 2002).

The Institute of Mining and Mineral Engineering of the Kumasi University carried out a pilot study on household source separation in selected suburbs of Kumasi. A total of 90 households were selected with 30 per category from low, middle and high-income communities. Major criterion used in grouping the household was monthly accommodation rent, which ranges from up to ¢70,000 (low), 71-150,000 (middle) and above 150,000 (high income) at year 2000 prices[3]. Households waste characterisation analysis revealed that across all income areas waste consisted to 78-85% of food waste and 4 to 13% sand and wood ash amongst others. All households were provided with five containers with different labels describing what type of waste should be put in for a period of at least 8 weeks. Households were educated and sensitised before the commencement of the project on the need for source separation and the associated benefits.

All the necessary logistics for source separation were provided and the wastes in the containers were collected and disposed on daily basis. The containers were big enough for the households to fill them but none of them were fully filled at the time of collection.

| Low income (n = 30) | | Middle income (= 30) | | High income (=30) | |
|---|---|---|---|---|---|
| Weeks | Rate (%) | Weeks | Rate (%) | Weeks | Rate (%) |
| 2-3 | 40-50 | 2-5 | 30-50 | 3 | 20-40 |
| 7-8 | Less 10 | 6-8 | 20 | 6-8 | 25 |

Source: Asiama, 2002.

**Table 3:** Household sorting efficiency over 8 weeks.

The results indicate that, sorting rate was relatively high (40-50%) among all households in week 2-3 and even continuing up to 5 weeks in the middle-income group (Table 3). However, there was a general decline in commitment to 10-20% from about week 6 on. This implies that any sensitisation campaign has to continue also after introduction of the system. Households mentioned as difficulty the lack of motivation in comparison with their normal daily tasks and challenges, such as gaining their daily income. It was also realised that in most cases house waste collection and disposal was not done by the head or leaders of the household but the children and/or house helpers. Moreover, five containers might have been too much for this pilot

[3] 4000-6700 cedis = 1 USD (Jan-Dec. 2000)

trial.

## Sanitation facilities and re-use of urine and excreta

In urban low-income areas, the use of the Kumasi Ventilated Improved Pit (KVIP) latrine, other public pit latrines and free range (i.e. open defecation) is most common, while in the middle and high-income areas water closets are dominant. About 60% of the sludge produced in the 658 households interviewed is disposed off by the Kumasi Metropolitan Assembly (KMA) and subcontracted private companies, whilst 30% of households do not know how the sludge is disposed and 10% mention private conservancy workers. Three months is the modal period for the dissludging in low income areas and one year or more in the middle and high income areas. Fifty-five to sixty percent of households in the low and middle income areas mentioned problems with the sanitation facilities they are using. Most notable in low income areas is the method of dissludging, long queuing, and bad scent while leakage of septic tank was often reported in middle income areas (see also Frantzen and Post, 2001; Van der Geest and Obirih-Opareh, 2001). On the other hand, only 35% of the households in the high income areas experienced problems which were mainly due to water shortage affecting flashing of the toilet.

The survey further showed that 90% of household interviewed knew that excreta (i.e. animal manure) can be a valuable source of nutrients in agriculture. Only 10% of the households were concerned about health implications. Concerning the use of human excreta, still in average 72% had a positive perception (Table 4) again with regard to its use as manure. In fact, 80% also believed that there should be a market for dried excreta. About 60% also believed that there should be a market for urine especially as medicine.

| Household perception | Low income | | Middle income | | High income | |
|---|---|---|---|---|---|---|
| | Frequency | % | Frequency | % | Frequency | % |
| Positive | 185 | 72.5 | 167 | 69 | 119 | 74 |
| Negative | 70 | 27.5 | 75 | 31 | 42 | 26 |
| Total | 255 | 100 | 242 | 100 | 161 | 100 |

Source: IWMI Ghana data, 2002

**Table 4:** Perception on the use of composted dried human excreta in farming

The positive perception of urine separation might have been stimulated by a recent media debate about the pros and cons of a urine therapy. In general, nearly all household (94%) were interested in a toilet system which allows the separation of human excreta and urine, giving that it is provided for free. However, only 17% of the households were interested in selling dried excreta or urine themselves.

The strong public association of excreta with manure for soil fertility improvement supports those initiatives on ecological sanitation which emphasise the nutrient value of our faeces and urine (Esrey and Andersson, 2001). On the other hand, it contradicts a now two-year-old KMA initiative where about 70 “enviro-loo” toilets (with in total 210 seats) from South Africa have been installed in certain basic schools and as public toilets in some low-income communities. Here, the toilets are disslugged without the equipment which allows excreta-urine separation. Moreover, the users are not aware of the design of the system, thus ignore the flap lever which is used to push faeces in the right location for decomposition. The result is a mix of urine and excreta instead of their separation, unnecessary heat generation and many complains of bad smell and genital diseases affecting mostly women.

## Conclusion

The majority of the Ghanaian households asked had no objection to either source separation or the separation of urine and excreta and were willing to test such systems if the facilities needed are given out for free. This shows that also in low-income countries, resource recovery and

reuse might work if appropriate technologies are tested and further developed in close and continuous collaboration with the concerned households. Source separation trials might have to address education also at the school level as children are mostly in charge of household waste collection, transport and disposal.

Appropriate ecological toilet systems might best fit into middle- and high-income households with backyard farming. This might facilitate the use of excreta while market opportunities for the use of urine (in the medical sector) will have to be explored before systems are put in place.



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# Assessment of community knowledge attitudes, practice, behaviour and acceptance of ecological sanitation in peri-urban areas of Harare.

**Edward Guzha,**
**Cleophas Musara**

Mvuramanzi Trust
P.O Box Mr 103 Marlbrough
Harare, Zimbabwe
e-mail: 237612@ecoweb.co.zw



**Keywords**

Urine diversion toilets, participatory ecological sanitation education, acceptance of ecological sanitation, over-cultivation, mono-cropping

**Abstract**

Ecological sanitation was introduced in the peri-urban areas around Harare the for different reasons depending on the geophysical and socio-economic persuasion of the environment where it was being implemented. In the densely populated informal settlement ecological sanitation was introduced for purely for technological convenience. The informal settlements did not have any form of sanitation whatsoever, the settlement did not have reticulated water system to facilitate water borne sewage.

In the peri-urban informal settlements near Harare ecological sanitation was accepted purely on technological advantage and was mostly for family convenience, privacy and easy maintenance. In the rural areas ecological sanitation was readily welcome because it made nutrients urine and faeces accessible for use in agriculture. They were however concerns with respect to the user friendliness of the technology to women especially as it relates to sanitary pads change and disposal. Gender roles and burdens with respect to operation and maintenance of the ecological sanitation toilets were also other interesting findings of this study.

Using participatory approaches such participatory evaluation process (PEP), participatory rural appraisal PRA and Focus Group Discussions (FGD) any assessment was carried out to determine ecological sanitation knowledge, attitudes, practices and behaviour (KAPB) of communities in the peri-urban informal settlements and peri-urban rural areas in and around Zimbabwe. In order to quantify group responses with respect to specific issues such as reasons for preferring ecological sanitation toilets, preparedness to use human excreta for crop production and whether they would eat crops and fruits grown using human excreta secret ballot charts was employed. Cross tabulation and comparison was achieved by using household structured questionnaire for some of the issues discussed during participatory approaches. Data validation was done using the triangulation methods through comparison of the findings of the three approaches mentioned above. The findings obtained using the above approaches quiet comparable and some of them are outlined below.

76.5% of the respondents said they like the ecological sanitation toilets because they are convenient and private to the household. It is easy to supervise the use of the toilet by household members and ensure it is clean at all times. 6.7% of the people felt that there is little work involved in the maintenance of the ecological sanitation toilets. 6.7% of the people in Dzivarasekwa Extension said the toilet provided manure, and was a household asset.

| What they like (by %) | Hatcliffe Extension | Dzivarasekwa Extension | Total for two settlements |
|---|---|---|---|
| Privacy / Convenience | 80.3 | 60 | 76.5 |
| Little labour | 13.3 | 1.5 | 6.7 |
| Ease to construct / maintain | 7.6 | 0 | 6.2 |
| Health | 4.5 | 13.3 | 6.2 |
| Household asset | 0 | 6.7 | 1.2 |
| Source of manure | 0 | 6.7 | 1.2 |

**Table 2:** What communities like about ecological sanitation toilets

In Hatcliffe extension 83.3% of the households said the toilet was all right and 60% in Dzivarasekwa extension said the toilet was all right. However the community did not like the following on the ecological sanitation toilets:

*In Hatcliffe extension*

- 7.6% said the pit was too shallow
- 3% said rain comes in
- 3% said the toilet smells
- 1.5% said the squat hole was too big ( because it was not fitted with a pedestal seat)

*In Dzivarasekwa extension*

- 20% did not like carrying the faecal bucket
- 13.3% did not like blockages of the urinary pipe
- 6.7% said the toilets smell

20% of people in Dzivarasekwa extension said they did not like carrying the faecal bucket for fear of ridicule by neighbours. They said the perforations on the bucket had grown big so faecal matter drops through the perforations onto their heads and shoulders. Because they have no protective clothing, they feel it's a dirty job. Communities suggested that the faecal bucket should have a lid so that contents do not spill during transportation. Emptying faecal buckets is done at night to avoid other people noticing.

In Hatcliffe extension 84.6% of the households said they allow lodgers to use the toilet while only 12.5% of the households in Dzivarasekwa extension allow lodgers to use the toilet. The situation is different for neighbours. In Hatcliffe extension 50% of the households said they allow neighbours to use the toilet while in Dzivarasekwa extension only 13.3% said they allow neighbours to use the toilet. The table below summarises attitudes towards the use of toilets by neighbours:

| Attitude | Hatcliffe Extension | Dzivarasekwa Extension | Total sample |
|---|---|---|---|
| They mess the toilet | 21.2 | 60.0 | 28.4 |
| Good neighbourliness | 0 | 18.5 | 18.5 |
| Only when passing through | 16.7 | 0 | 13.6 |
| Should get one from the project | 7.6 | 20 | 9.9 |
| They will contaminate the environment | 12.1 | 0 | 9.9 |
| Do not want to handle other people's faeces | 3 | 13.3 | 4.9 |

**Table 3:** Attitudes towards sharing ecological sanitation toilets

The study sought to find what the community members know about ecological sanitation toilets. The following were the findings:

- 90% of people with ecological sanitation toilets have received instructions on their care and maintenance
- 54.3% knew how to use soil, ash or sawdust
- 25.9% said they knew about human manure
- 9.1% knew about alternating the pit
- 3.7% said the pit should always be dry
- 1.2% said deep pit toilets contaminate ground water

The communities in Dzivarasekwa extension felt that every household member could easily use the toilet. 92.8% of the people felt that men, women and boys could use the toilet with ease while 85.6% felt girls could use the toilet with ease and 71.4 felt the disabled could easily use the toilet. They however felt that the chamber needed modification to avoid the mixing of urine and faeces when girls are using the toilet.

The management of the toilet weighs heavily on women as the following table shows:

| Management activity | Mother | Father | Boy | Girl | Other (employee or both) |
|---|---|---|---|---|---|
| Refills ash/ soil/ saw dust container | 92.9 | 7.1 | 0 | 7.1 | 0 |
| Cleans toilet | 84 | 4.9 | 1.2 | 0 | 2.5 |
| Puts faecal bucket in place | 78.6 | 7.1 | 7.1 | 0 | 7.1 |
| Cleans faecal bucket | 78.6 | 7.1 | 7.1 | 0 | 0 |
| Empties faecal bucket | 71.5 | 14.3 | 7.1 | 0 | 7.1 |
| Responsible for the plot / garden | 64.2 | 18.5 | 1.2 | 3.7 | 3.7 |
| Attends meetings | 59.3 | 27.2 | 1.2 | 0 | 0 |
| Contributes labour during construction | 51.5 | 21 | 27 | 27 | 0 |
| Pays for construction | 42 | 50 | 3.8 | 0 | 3.8 |

**Table 4:** Gender roles in toilet management

The community said mothers are generally responsible for the family hygiene hence they do most of the maintenance work on the toilet. The health and hygiene programme should target women.

More than men because they handle excreta more frequently than any other member of the family do. Interestingly is the fact that mothers are responsible for cleaning and when they are away the duty falls on girl children and the fathers with boy child having the least responsibility.

While there is knowledge on the different uses of excreta, there was limited evidence of the actual use in Dzivarasekwa extension. Some members indicated that they prefer to buy vegetables from other people but would not eat their own vegetables in which they have re - used excreta. In Hatcliffe extension, the toilets are still new and have not yet filled up so communities have not really experienced re- using their excreta.

In Dzivarasekwa extension, the community said they would use excreta for the following:

- Planting flowers, maize and fruit trees
- Urine is used as fertiliser

Most people in Dzivarasekwa extension said they cannot use for growing vegetables as they

are uncomfortable eating vegetables knowing that they were fertilised from human manure. At the moment options for disposing have been limited to throwing the faecal matter on open ground or rubbish pits. Isolated cases were reported of faecal disposal on the road or in neighbour's yard. The community noted that they have limited space for gardening so in the long run the supply would be greater than demand.

In Hatcliffe extension there was no experience in handling (through excavating of old pits) and using through planting crops, as most pits have not yet filled up. During a voting session, women indicated that they would plant "things" or place the manure in the gardens. The feeling was that there is nothing embarrassing about handling of the faecal matter (23 women saw no problem). However two women in the group said they would not handle pit manure as it was dirty.

Some community members said they ate sweet potatoes planted where people used to dispose of their faecal matter and these did not test as good as those planted with ordinary manure. This finding is not conclusive since other factors may influence the taste. However 66.3% of the households interviewed said they put the faecal manure in their fields or gardens, 13.8% said they use it for tree planting and only 8.8 % said they throw away the manure. They throw away the manure because they either do not want to use it or they had no plot in which to apply the manure. 24 households (out of 80) were not using faecal manure for the following reasons:

- 11 said the manure was not treated.
- 6 because they had no knowledge on safe use.
- 4 said they did not want to handle faeces.
- 2 said they had no garden.
- 1 felt the manure might cause disease.

61.3% of the households said they would not use urine as a fertiliser because they said it would burn crops, 17.5% said it had a bad smell while 55% said they did not know that it could be used. 11.3% said urine is a good fertiliser and 12.5% said they would use urine because fertiliser was expensive.

The buying and selling of faecal manure is not taking place in the two settlements. Nurseries have bought manure from households. When asked if they could use manure from neighbours the response indicated that communities are uncomfortable doing that. (17 voted that they could not, 3 said they did not know while 2 said yes). However during the household interviews, 67.5% said they would sale their faecal manure. 35 households said they would sale to generate income, 24 households said they would sale if they have no need for it while 5 households said they would sale because they do not want to use it.

7.5% of the households felt it was a health hazard to buy faecal manure and 32.5% would not buy because they did not want to handle other people's faeces. However, 56.3% of the households said they would buy faecal manure from other people because:

- 23 said they would buy if the did not have enough.
- 22 households said it was good manure.
- 3 households felt it was cheaper than fertiliser.

The first reaction to ecological sanitation ideas was scepticism. In Hatcliffe extension, households indicated that their initial reaction was that there would be too many holes, too many flies and high incidence of cholera. Demonstration toilets, peer education and pressure brought about attitude change. Communities indicated that demonstration creates awareness and improved understanding. Visual aids enhanced understanding. Another motivating factor was that communal toilets were unbearable to use. During the rainy season, the toilets flooded

and faecal matter started flowing out of toilets. This and the education given promoted some members to try the Fossa Alterna toilet. Women in Hatcliffe extension indicated that hygiene education is best given during weekdays. In Dzivarasekwa extension, the initial reaction was one of discomfort at the thought of carrying faecal matter in buckets for disposal.

The motivation for change of attitude was demonstration toilets at the school supported by booklets. The community felt that demonstration works best. 55.6% of the respondents said Mvuramanzi Trust did the mobilisation, 23.5% got the idea from other people while 6.2% got the idea from Ministry of Health staff. Community meetings provided information to 14.8% of the respondents.

In 59.3% of the cases the mothers attended meetings on ecological sanitation which explains why mothers were the first to know about ecological sanitation in 60.5% of the cases. The father attended meetings in 27.2% of the cases and male children attended in 1.2% of the cases. The girls did not attend meetings and have therefore limited knowledge on ecological sanitation.

**What was evident in both communities is that there has been sufficient marketing of the toilets to an extension where demand has outstripped supply.**

Priority areas for hygiene awareness were:

- Hand - washing after changing baby napkin, before handling food, after using the toilet and after greeting people.
- Personal hygiene (including washing private parts when waking up).
- Cleaning the toilet.

*One woman had this to say" Well I thought they were giving us these toilets because we stay in Dzivarasekwa Extension and are a forgotten community"*

During the focussed group discussion, women said generally people do not practice good hygiene behaviours even when these are known. The Fossa Alterna toilet does not have hand-washing facilities making it difficult to wash after using the toilet. There was also an emphasis on body- washing.

In both communities the decision to construct the toilet is usually made by women. Children who request for improved sanitary facilities also influence this decision. It is logical that women make the decisions about the toilets as they attend meetings, are inconvenienced by lack of privacy. They also manage the disposal of faeces of the young children. However the investment into the toilet is shared among men and women depending on the breadwinner.

The ecological sanitation toilets have been well received and clearly the communities prefer them to communal toilets. However there are problems in the use of the toilets. Some households in Dzivarasekwa extension were not using the toilet during the time of the study. They said they did not have ash or dry soil to use in the toilet. The study was undertaken during the rainy season. The following table summarises the findings:

| Observation (%) | Dzivarasekwa Extension |
|---|---|
| Clean pedestal | 93.3 |
| Back slab in position | 85.7 |
| Faecal bucket in place | 64.3 |
| Faecal bucket in use | 64.3 |
| Tight back slab | 50 |
| Solids in the chamber | 21.4 |
| Blocked pipe | 14.3 |

**Table 5:** Condition of toilet

To validate findings from oral discussions we administered a checklist on a sample household toilets and the following were our the results:

- In 82.5% of the toilets there was evidence of soil /ash / sawdust.
- 73.8% of the toilets had soil / ash/ or sawdust containers.
- 71.3% of the containers had soil / ash / sawdust.
- 12.5% of the toilets had a bad smell.
- 12.3% of the toilets had evidence of fly breeding.

In conclusion we have seen that community attitudes have been influenced by practical demonstrations at schools. Attitudes towards excreta use need to be reinforced with practical demonstrations on the safe use of human manure. Production of human manure should be matched with safe use of the manure. Currently the project has not adequately demonstrated the advantages of using human excreta. There is therefore no concerted effort to harvest and use the manure. The manure is harvested to clean the bucket or to empty the pit not for its value.

Excreta management the project assumed that every household had a plot/ garden in which to use the manure. 10% of the households in the sample interviews did not have gardens or plots in which to apply the manure. Households with no gardens did not have alternatives but to throw the faecal manure away in the bush. The households should be encouraged to donate or sell their manure to the school or interested persons.

The project should build upon the ecological sanitation project to improve solid waste management in the two settlements. At present there is no refuse collection system. Households dump their refuse in rubbish heaps. The dumping site promoted the breeding of rodents. The abundance of rodents led to increase in snakes and fleas feeding on the rodents. People should be encouraged to separate waste and use the degradable matter in composites. This effectively reduces the amount of waste in the environment. If waste is properly managed, the rodents will be reduced because they have no food.

Contrary to popular belief the health and hygiene education encourages toilet use, in the two settlements the main reason was convenience. The health and hygiene benefits became incidental. The project has demonstrated that social reasons can promote the use of toilets. The project should now focus at other issues and not stick to health and hygiene education to promote the safe use of toilets.

According to the community in DZ, rubbish is thrown at the edges of the settlement and this includes faecal matter. This is seen as posing a health hazard since children often play in those rubbish dumps. The rubbish encourages fly breeding. The community indicated that it is their social responsibility to clean the surrounding on and off site. The problems being faced are related to poor community organisation and lack of hygiene education.

# Environmental alternative to sanitation and food sovereignity

**Alberto Ysunza-Ogazón,**
**Jaime Leyva S.,**
**Enriqueta Martínez M.,**
**Silvia Díez-Urdanivia,**
**Laurencio López N.**

Centro de Capacitación Integral para Promotores Comunitarios, CECIPROC, A.C.
Instituto Nacional de Ciencias Médicas y Nutrición "Salvador Zubirán"
Vasco de Quiroga No. 15, Tlalpan 14000 D. F., México City
e-mail: ceciproc@laneta.apc.org
e-mail: ceciproc@prodigy.net.mx



## Keywords

Ecosystem, education, environment, evaluation, didactic, sanitation.

## Abstract

The present research is part of a larger project related to Primary Health Care, based on the ecosystem approach to environmental sanitation. The project is based in a highly marginalized rural area, located on the Pacific Coast of the State of Oaxaca, Mexico. In this context, the ecological principles of sanitation are the most suitable alternative to dealt with health problems derived from environmental pollution, such as malnutrition and diarrhoeal diseases. The present paper emphasizes the high priority given to the implementation of a social sensitization-education process, supported by an education program oriented to the protection of the environment that may ensure the participation of the community in an interactive fashion.

The information presented here is still preliminary in the sense that the project is still on going. This report includes results of a 3-year long community program focused on the correct construction and adequate use and maintenance of Eco-San toilets, where three different sets of educational materials have been instrumented at the community level and evaluated in three different population groups.

The results show that the three interventions proved to be a good means to promote environmental education, and that, even though the level of knowledge acquired by the three population groups differed, the level of community sensitization was positive and significant in all three.

## Introduction

The Training Center for Community Promoters (CECIPROC after its name in Spanish) is a Mexican NGO, whose main objective is to embody the high-priority importance for community programs related to health and nutrition, particularly in the context of rural development. Specifically, this work is inscribed under Rural Sustainable Development Projects, which have as top premises Nutrition and Community Health activities carried out through the development of training programs for community health workers (Promoters) and the implementation of community development projects (Ysunza, et. Al. 2002).

The work reported here is part of a broader CECIPROC project, based in the Mexican state of Oaxaca, specifically in the southern coast of the Pacific Ocean. The region has a mixture of indigenous (Mixtec, Chatino) and Afro-Mexican Mestizo origin, and has the highest infantile and maternal mortality rate in the country. This is basically due to problems related to malnutrition and infectious diseases like diarrhoea. In other words, the health problems are derived form a

mixture of an inadequate food intake affecting both quality and quantity and inadequate environmental sanitation due to a lack of hygiene infrastructure in a highly polluted environment. To make the matters even worse, the state of Oaxaca has the highest household water supply deficit in the country, as only 46% of families have access to piped water. (Ysunza, 1996)

In terms of the underlying causes and direct consequences of marginalization, the conditions found in the state of Oaxaca are not different from what happens in other underdeveloped regions of the world: lack of financial resources, problems of water shortage, lack of institutional capacity to respond to these needs, among others, lead us to point out that the conventional solutions to environmental sanitation, such as "flush and discharge" or "drop and store", are not applicable in view of their high costs. The serious threats of water shortage throughout the world, including Mexico, and the severe problems of environmental pollution in sewer systems without adequate treatment have caused several problems, particularly in coastal regions such as those found in the Pacific Ocean coast of Oaxaca, where bacteriological contamination pollute tourist beach resorts, sometimes causing the presence of the "red tide" and other problems, which are increasingly present. (Esrey, et. al., 1998)

Hence, the ecological principle of sanitation, or Eco-San, in which human feces are safely recycled to fertilize the soil without using or contaminating the water, are potentially a suitable answer to the problem.

However, adoption of such practices is not spontaneous. For them to be properly used, it is necessary to carry out a reliable sensitization education process, aimed at people with low schooling and little or no previous exposure to previous use of such ecological alternatives, in such a way that the use of them may result attractive and understandable, and may lead to a high acceptance and adoption rate.

The main objective of the present research was to evaluate the educational material specifically designed for this purpose, as a pre-requisite to extend its use and be able to measure the health and nutrition impact at the community level.

## Methodology

*Characteristic of the study*

One of the most important characteristics of the methodology used was the **interactive community participation**. This involved all the social actors who participated in the different phases of the process, and included sensitizing the participants, the design and elaboration of the teaching material, the community diagnoses, the evaluation workshops, the construction of the Eco-San, as well as the follow-up and evaluation phases related to their use and maintenance. A second characteristic, which follows from the previous one, is the **longitudinal** design, by which we intend to measure the impact of our intervention throughout time. Lastly, the design called for a **comparison** between different communities as well as between beneficiaries and non-beneficiaries, based on the length of time Eco-San was used as well as the ethnic characteristic of the recipients of the intervention.

*Objectives*

To elaborate and spread out didactic material for environmental education that promotes the construction, use and proper maintenance of the Eco-San.

To measure the impact on health and nutrition at the community level of the appropriate use and maintenance of the Eco-San, comparing the different communities participating in the study.

To carry out an ethno-anthropological study on the community's perception about the management and disposal of human feces.

To increase family availability of food grown in the backyard based on the recycle of human waste.

*Working strategies*

- Selection of communities and organization of Community Assemblies.

  Six communities from two ethnic groups were selected for the study, based on two indicators:

  1. Time of use of the Eco-San.
  2. Predominant ethnic group in the community.

  Two control communities, consisting of no intervention, were included in the design.

The characteristics of the six participating communities are shown in table 1:

| Name of Community | Time of use of Eco-San | | Predominant ethr c group |
|---|---|---|---|
| | < one year | three or more y ears | |
| Palma Sola | | X | Mestizo |
| Charco Redondo | | X | Afro-Mexican |
| Cuauhtemoc | X | | Afro-Mexican |
| Loma Bonita | X | | Mestizo |
| Chacalapa | No use | | Mestizo |
| La Luz | No use | | Mestizo |

**Table 1:** Selected communities

In each community, we called for a local Assembly with the participation of local authorities and households, in order to explain the objectives of the program, its economic limitations, ant to organize an **environmental sanitation committee** who would be in charge of selecting the **beneficiary families**, as well as establishing the agreements related to the construction, use and maintenance of the Eco-San.

- Elaboration and dissemination of didactic materials

Videotape. A videotape was filmed using locations and characters that reflected the reality of the communities, in order to facilitate the identification of the participating people with the environment and images shown on it. The script focused on the general problems related to environmental sanitation and its ecological impact, from a health perspective. Other ite ms were included, such as local food production and the importance of **community participation** for the appropriate construction, use and maintenance of the Eco-San. A major advantage of a videotape as an educational tool is that it does not require people to know how to read or write.

Comics. Comics are a well-spread means of communication among the Mexican population, particularly in people with little schooling, as the colorful pictures and popular characters result physically attractive. Comics usually tell a love story or address a topic of popular interest. The comic produced to promote the Eco-San told a story of an imaginary Mexican rural town, where a schoolgirl who suffered from frequent intestinal infections went to visit a traditional doctor and a health promoter (as usually happens in real life). As the story develops, the health promoter participates in a community assembly and shows how the Eco-San is built, how it is used, and how the ecological sanitarian was properly maintained. The story ends with the girl, healthy once more after building and using the Eco-San, returning to school, and the family using the re-cycled feces to fertilize the backyard garden to produce food. While the use of the comic

required people to know how to read, in many cases the images were self-explanatory and the comic was well accepted even by illiterate people.

Poster. Posters made out of plastic material were printed, containing pictures and text that explained the proper use and maintenance of the Eco-San; do's and do-not's were clearly explained. The posters were permanently placed inside each Eco-San built in the communities. While users were expected to read the instructions, the images were self-explanatory.

- Design of the evaluation workshops.

The **beneficiary families** included 494 people, who participated in evaluation workshops carried out with the purpose of making them aware of the community health problems related with basic sanitation, as well as the benefits that Eco-San offered. Seventeen workshops were carried out in the six participating communities, involving three population groups: school-age children, adolescents and adult women.

The didactic materials previously described were evaluated according to the following scheme:

| Community | Women > 18 years old | | Adolescents (15-18 years old) | | School-age children (5-14 years old) | |
|---|---|---|---|---|---|---|
| | Intervention | N° of participants | Intervention | N° of participants | Intervention | N° of participants |
| Palma Sola | Poster | 13 | Comic | 21 | Video | 12 |
| Charco Redondo | Comic | 35 | Poster | 29 | All | 38 |
| Cuauhtemoc | Video | 25 | All | 20 | Poster | 45 |
| Loma Bonita | All | 26 | Video | 23 | Comic | 32 |
| Chacalapa | All | 32 | Video | 18 | Comic | 38 |
| La Luz | Video | 20 | NO | NO | Video | 41 |
| Subtotal: | | 150 | | 111 | | 206 |
| Subtotal: | Beneficiaries participants | | | | | 318 |
| | Non beneficiaries participants | | | | | 149 |

**Table 2:** Population groups and didactic materials evaluated.

Two qualitative evaluations were carried out at the group level, one before and the second one after the workshop. The evaluation was based on two types of questions health: related to environmental sanitation; and the construction, use and maintenance of the Eco-San toilets. Responses classified knowledge of the participants as: 1) Very low, 2) Low, 3) Basic, 4) Good and 5) Excellent.

Detailed activities of each workshop are described in technical specification cards, previously elaborated. As an example, one of the objectives was to develop different group dynamics, both to establish coexistence relationships correct answers, after the presentation of the corresponding didactic material. This way, five quantitative evaluation categories were settled down: Very poor (0-<50%); Poor, (50-<60%); Fair (60-<80%); Good (80-<90%) and Excellent (90-100%).

- Construction, use and maintenance of the Eco-San

The Community Committee of Environmental Sanitation and the beneficiaries had the responsibility of the organization and construction of the Eco-San, as well as the follow-up related to its use and maintenance.

After the workshops, the technical team of CECIPROC was in charge of follow up related to the use and maintenance of Eco-San, through home visits in which a questionnaire was applied to beneficiaries.

## Outcomes

The evaluation of the knowledge related to the didactic material by the different population groups after the workshop is presented in table 3.

Although all groups of women showed improvement, the greatest improvements (from low to good knowledge) were observed in communities $B_1$ i.3. after 1 year of use of Eco-San.

Adolescents who had good knowledge about the system after 3 years of using Eco-San showed no improvement, while those who used it for 1 year showed improvements from low of very low to basic.

School children showed improvements in all communities, the greatest increments were seen in those communities which had 1 year of use of the sanitation system, closely followed by those which had 3 years of use.

It is interesting to note that all population groups living in control communities showed improvements in their knowledge of the Eco-San system, though moderate and lower than intervention groups. However, their knowledge was generally lower than intervention groups at baseline.

| Type of community | Group of women | | Group of adolescents | | Group of school children | |
|---|---|---|---|---|---|---|
| | Pre-evaluation | Post-evaluation | Pre-evaluation | Post-evaluation | Pre-evaluation | Post-evaluation |
| $A_1$* Palma Sola | 4 Good | 5 Excellent | 4 Good | 4 Good | 3 Basic | 4 Good |
| $A_2$* Charco Redondo | 4 Good | 5 Excellent | 4 Good | 4 Good | 4 Good | 5 Excellent |
| $B_1$** Cuauhtemoc | 2 Low | 4 Good | 2 Low | 3 Basic | 3 Basic | 5 Excellent |
| $B_2$** Loma Bonita | 2 Low | 4 Good | 1 Very low | 3 Basic | 3 Basic | 4 Good |
| $C_1$*** Chacalapa | 3 Basic | 4 Good | 3 Basic | 4 Good | 3 Basic | 4 Good |
| $C_2$*** La Luz | 2 Low | 3 Basic | --- | --- | 1 Very low | 2 Low |

Categories or levels of knowledge

| | | | |
|---|---|---|---|
| A* | 3 years of use | 5 | Excellent |
| B** | 1 year of use | 4 | Good |
| C*** | 0 years of use | 3 | Basic |
| | | 2 | Low |
| | | 1 | Very low |

**Table 3:** Evaluation of the knowledge about Eco-San after the workshops according to years of use and population groups.

## Quantitative evaluation of didactic materials

Tables 4-7 show the evaluation of didactic materials. In general, adolescents showed the lowest level of correct answers, except for those communities in which the three didactic materials were evaluated, where adult women showed the lowest percent of correct answers (Table 7). The situation in Loma Bonita ($B_2$), where the three didactic materials were evaluated simultaneously, contrasted with that found in all other communities, where adult women usually

ranked highest in their percentage of correct answers to the evaluation applied.

School children ranked high in the evaluation of the videotape; low in the evaluation of the comic; and excellent in the evaluation of the poster and in the three materials evaluated simultaneously.

In relation to the didactic materials, the **videotape** showed the higher percentages of correct answers, followed by all the didactic materials evaluated at the same time, then by the poster, and lastly by the comic.

| Population Group | Community | Videotape: level of benefit | Correct answers |
|---|---|---|---|
| Women | $B_1$ Cuauhtemoc | Excellent | 100% |
| Adolescents | $B_2$ Loma Bonita | Poor | 50% |
| School children | $A_1$ Palma Sola | Good | 90% |
| Adolescents | $C_1$ Chacalapa | Good | 80% |

**Table 4:** Evaluation of the videotape

| Population Group | Community | Comic: level of benefit | Correct answers |
|---|---|---|---|
| Women | $A_2$ Charco Redondo | Good | 80% |
| Adolescents | $B_2$ Loma Bonita | Poor | 50% |
| School children | $A_1$ Palma Sola | Fair | 70% |
| School children | $A_1$ Chacalapa | Good | 80% |

**Table 5:** Evaluation of the comic

| Population Group | Community | Poster: level of benefit | Correct answers |
|---|---|---|---|
| Women | $A_1$ Palma Sola | Good | 80% |
| Adolescents | $A_2$ Charco Redondo | Very Poor | 30% |
| School children | $B_1$ Cuauhtemoc | Excellent | 100% |
| School children | $C_2$ La Luz | Good | 80% |

**Table 6:** Evaluation of the poster

| Population Group | Community | All level of benefit | Correct answers |
|---|---|---|---|
| Women | $B_2$ Loma Bonita | Poor | 50% |
| Adolescents | $B_1$ Cuauhtemoc | Good | 80% |
| School children | $A_2$ Charco Redondo | Excellent | 100% |
| Women | C2 La Luz | Fair | 70% |
| Women | C1 Chacalapa | Good | 80% |

**Table 7:** Evaluation of the videotape, poster and comic

## Discussion and conclusions

One aspect that has to be taken into account when interpreting the quantitative evaluations applied is that 70% of the participating women referred to be illiterate, and even among those who were not, there is a great difficulty in obtaining a fluid and correct reading, as well as to express ideas in writing among the three population groups. Therefore, the use of a qualitative evaluation complemented the quantitative interpretation of the results.

According to the **qualitative evaluation at a global level** there was an expected positive change as far as the level of knowledge before and after the workshops among all groups and in most of the communities, in particular the school age children from community $B_1$, who showed the highest level of acquired knowledge (Table 3).

In contrast the groups of adolescents from communities $A_1$ y $A_2$ (3 years of usage of Eco-San) did not modify the level of knowledge, as may have been expected. In all cases there was a higher level of acquired knowledge in relation to Eco-San years of use, specifically the construction, use and maintenance knowledge, as may have been expected (Table 3).

According to the acquired knowledge by population groups, school children got the highest records followed by women, and in the last place, by adolescents (Table 3)

Focusing on the **quantitative** results, there were two important results that were consistent with the qualitative ones: The school children obtained the highest number of correct answers (86.6) followed by women (76.6%) and adolescents (58%). Community $B_1$ obtained the highest percentage (93.3%) (Tables 4 to 7).

These consistencies may be explained by the fact that children have a higher level of schooling than adults, who have a greater "educational lag". On the other hand, the school children represent a group that has the greatest capacity to learn in recreational conditions such as the ones the workshops were designed after.

The low values showed by the adolescent groups reflected the low participation they had throughout the project, including one group that never showed up at the workshop. This may probably be related to the nature of the adolescents psycho-biological conditions. Some of them felt shy during the workshops dynamics or were very reluctant to participate (Table 3, 4, 5, 6).

The women's group even when they had more potential disadvantages (i.e. older, illiterate, broken-spanish speaking, etc). Were capable to overcome these limitations and showed motivation and participation during the whole intervention.

In relation to the best didactic material used, the videotape had the highest percentage of correct answers. In fact, we expected this result, based on the fact that the video offers more communication possibilities in predominantly illiterate populations.

Lastly, I want to highlight the importance of including in this paper the social component according to the ecosystem approach components (nature, society, process and device), that was present through the production, dissemination and evaluation of the educational materials presented. In other Eco-San projects, these materials are practically non-existing, and their successful implementation and encouraging results point out to the importance of considering the use of the four of them together (Esrey, et. al. 1998)

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# Cost comparison of conventional and modern sanitation solutions*

**Markus Lechner**[1], **Günter Langergraber**[2,1]

[1] EcoSan Club
Neulerchenfelderstrasse 9/32, A-1160 Vienna, Austria
internet: www.ecosan.at
e-mail: ecosanclub@gmx.at

[2] IWGA-SIG - Department for Sanitary Engineering and Water Pollution Control
BOKU - University of Natural Resources and Applied Life Sciences, Vienna
Muthgasse 18, A-1190 Vienna, Austria
e-mail: guenter.langergraber@boku.ac.at



## Keywords

Comparative study, cost efficiency, investment costs, operational costs, ecosan concepts

## Abstract

The objective of the study is to investigate the cost effectiveness of Ecosan-solutions for rural villages in Austria. Three different scenarios have been compared, ranging from conventional to modern, reuse-oriented, solutions. For comparison a precondition for all solutions was the compliance with the applicable legislation. In the comparison a “model village”, resembling a typical village in rural areas was used. Based on legal requirements due to small recipients – typical for these areas – higher then normal standards for effluents were assumed.

Three scenarios were compared, scenario A representing a conventional solution comprising sewer and treatment plant, scenario B considering urine diversion, separate storage and discharge to the treatment plant for reuse, and scenario C assuming in house measures for quantity reduction, storage and reuse respectively dry toilets and decentralised grey water treatment followed by infiltration. The cost estimations are based on actual costs of comparable systems and offers of suppliers. Necessary changes in the houses have been considered.

The results demonstrate clearly that, both with regard to construction and operation and maintenance, conventional systems for rural areas are the most expensive option but still encouraged through subsidising systems. It becomes clear that in addition to their sustainability reuse oriented systems are also definitely economically advantageous.

## Introduction

The existence and enforcement of strict environmental legislation in Austria achieved significant improvements of the environmental situation; at least as far as the water compartment is concerned. Approximately 85 % of the population are connected to public sewers and consequently treated in biological treatment plants (BMLFUW, 2003a) with, depending on the size, advanced biological nutrient removal. Transferring this high tech end of pipe approach to less densely populated settlements resulted in the past in exorbitant increases both in investment and operational costs. Future trends regarding the possible developments of the water/wastewater industry (PWC, 2001) all focus on economic efficiency, mostly neglecting

*This paper has been peer reviewed by the symposium scientific committee

presently un-served regions for cost reasons (BMLFUW, 2003b). All of these arguments assume the traditional non-prevention oriented strategy to be the only possible option to tackle the existing problems and could possibly result in a reduction of environmental standards for economic reasons.

For this study it is assumed that modern sanitation solutions, which focus on reduction of energy and material flows can assure the high environmental standards of Austria at acceptable cost for the population. The objective of this study therefore was to compare investment and operational costs for different solutions taking into account varying degrees of preventive measures in order to prove that applying different models of technical solutions for different settlement structures can be the option to achieve the requested environmental standards for rural and more remote locations at acceptable costs.

In addition such solutions are better suited to fulfil the legal requirements of Austria according to which reduction, prevention and recycling of wastewater and its compounds are prioritised against treatment of wastewater.

## Frame conditions and problem description

The background of the study was the discussion in three rural villages on the solution of their immediate problems concerning wastewater. For the purpose of the study a “model-village” was created in order to objectify the discussion. The “model-village” is app. the average of the three villages in question and resembles a typical village of this region. It consists of 25 houses with a total of 100 inhabitants. The share of agriculture is still 30% meaning that 8 houses out of the total are active farms. Presently wastewater produced in these households is collected in septic tanks. Theoretically this would mean that wastewater is stored and reused in agriculture due to the fact that these septic tanks normally have an illegal overflow - in order to reduce the emptying frequency - mechanically treated wastewater (sedimentation only) is discharged either by an existing rainwater sewer or by means of drain pipes directly to the recipient.

The particular region is additionally marked by small receiving streams. Under certain circumstances this requires a significantly higher reduction of an emitted pollution load compared to the general standards. Therefore it is assumed that the pollution load of any water discharged from the households has to be less then 15mg/l $BOD_5$ and less then 5mg/l $NH_4$-N at an effluent temperature of 10°C.

## Proposed scenarios

Three scenarios were considered only having one basic principle to fulfil was the legal compliance. This means that each technical solution has to fulfil the legal standards presently in force. Other criteria like for example whether one scenario would result in higher environmental benefits then requested were neglected.

Scenario A solves the problem in a conventional way by constructing a separate sewer system and a conventional biological treatment plant (Figure 1). Due to the strict standards a tertiary treatment step, e.g. a constructed wetland, is required.

Scenario B (Figure 2) assumes a conventional separate sewer system and treatment plant but toilets with urine separation and decentralised storage in each household. Automatically urine is collected separately by using the sewer system during night times with near to zero wastewater flow, stored separately and used as a fertilizer in agriculture (e.g. Lens *et al*., 2001). A tertiary treatment step is not necessary since no access of nitrogen has to be removed. The reason for including this scenario was that compared to Scenario C, which is presented below, still most of the responsibility for operation and maintenance of the whole system lies with the community and not the single households.

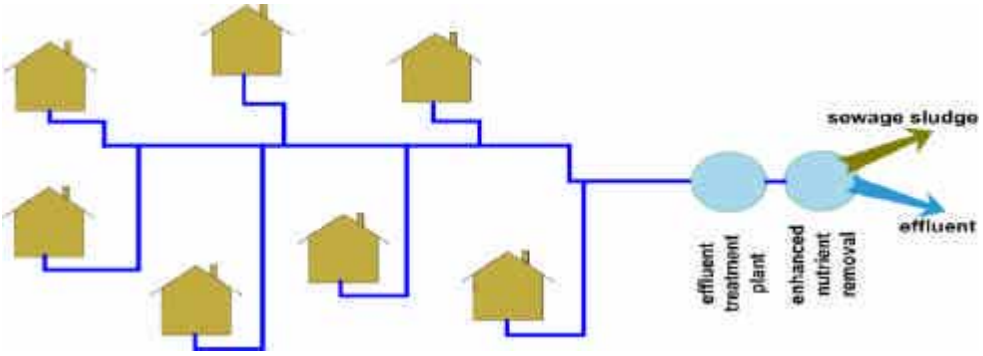


**Figure 1:** Schematic sketch of Scenario A.

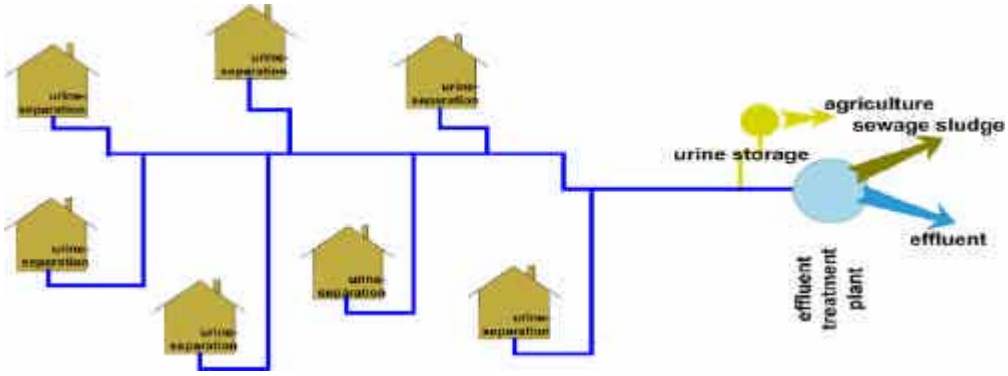


**Figure 2:** Schematic sketch of Scenario B.

Scenario C is assumed to be the option which fulfils the requirements of Ecosan-solutions best under the given conditions, i.e. to further sustainable development by closing nutrient and water cycles with as little loss of material (nutrients) and energy as possible. For those households which are active farms, in house measures for quantity reduction are assumed (i.e. low flush toilets), followed by storage in order to bridge those periods when use in agriculture is not allowed, e.g. during periods of frozen ground or snow, and subsequent use in agriculture together with manure.

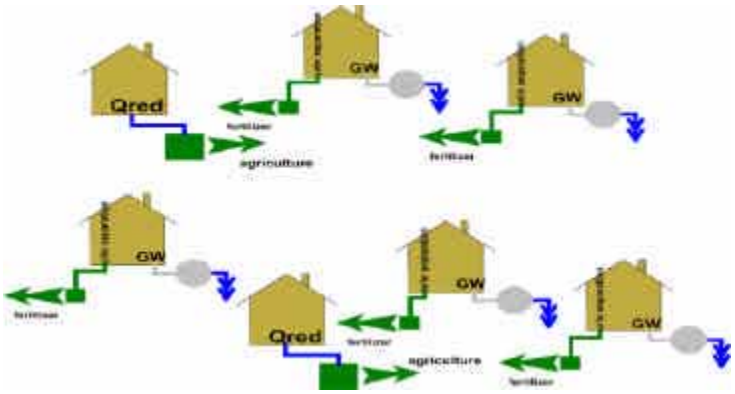


**Figure 3:** Schematic sketch of Scenario C.

For the remaining households reduction in wastewater quantity and quality is proposed by the application of dry toilets was foreseen. For the remaining greywater for each household a constructed wetland for treatment followed by infiltration is considered (Figure 3). It has to be stated that due to the particular situation in Austria regarding groundwater protection infiltration to the ground(water) is not forbidden as such but very strictly regulated. Nevertheless on the

basis of average greywater quality (Laber and Haberl, 1999) after treatme nt no problems are assumed for the sage of this study.

## Investment costs

The investment costs are based on the frame conditions described above, current data published (e.g. BMLFUW 2001, 2003c), information from suppliers (in particular regarding separation toilets, dry toilets, etc.) and own practical experiences from implementation of both conventional and alternative sanitation projects.

For Scenario A cost it is assumed that for the construction of the sewer lines no major hindrances due to underground conditions occur and costs are therefore comparatively low. The same applies for the treatment plant. Nevertheless due to the small size average costs of 1.000€ have been assumed per person equivalent. For tertiary treatment a vertical subsurface flow constructed wetland is assumed with relative cost – including all necessary pumps, structures and pipings – of approximately 125,-€ per person equivalent. The average length of the sewer line per house connection is based on an average length of the network in the village of 30m and a transport line to the nearest receiving stream of app. 1.000m. Table 1 summarises the assumptions and resulting total costs and costs per house connection respectively. The total investment costs are 14.650,-€ for each house connection.

| Unit | Assumptions | Costs | Costs/house |
|---|---|---|---|
| sewer line | 25 houses á 70m at 145 €/m | € 253.750,00 | € 10.150,00 |
| treatment plant | 100pe at 1000€/pe | € 100.000,00 | € 4.000,00 |
| 3rd step | 100pe at 125€/pe | € 12.500,00 | € 500,00 |
| **Total Scenario A** | | **€ 366.250,00** | **€ 14.650,00** |

**Table 1:** Investment costs for Scenario A

Costs for the sewer line in Scenario B naturally have to be same as in scenario A while the cost of the treatment plant is assumed to be reduced significantly since enhanced nitrogen elimination is not required due to separate collection and storage of the urine. Operational problems of the treatment plant caused by a lack of nutrients could be solved by controlled dosage of urine from the storage tank. The storage tank was designed for a storage period sufficient to bridge the period during which no agricultural application of fertilizer is allowed. In addition to these costs also costs for the urine diversion toilet which is vital for the system to function are considered. It was assumed that on average two new toilets were required for each household.

Table 2 summarises the assumptions and the resulting total costs and costs per house connection respectively. The total investment costs of Scenario B (14.694,-€) are basically the same as for Scenario A. The advantage of reduced cost for the treatment plant is consumed by the urine storage tank and the urine diversion toilets.

| Unit | Assumptions | Costs | Costs/house |
|---|---|---|---|
| sewer line | 25 houses á 70m at 145€/m | € 253.750,00 | € 10.150,00 |
| treatment plant | 100 pe at 500€/pe | € 50.000,00 | € 2.000,00 |
| urine diversion toilets | 25x2 at 1.200€ | € 60.000,00 | € 2.400,00 |
| urine storage | 18m³ at 100€/m³ | € 3.600,00 | € 144,00 |
| **Total Scenario B** | | **€ 367.350,00** | **€ 14.694,00** |

**Table 2:** Investment costs for Scenario B

Costs for Scenario C (Table 3), being the most "decentralised" solution, consider the different solutions for farmers and other households respectively. Cost for dry toilets for quantitative and qualitative prevention are calculated for 2/3 of all houses including cost not only for the toilet seat but also the required changes within the houses. For these houses treatment of greywater in constructed wetland systems followed by infiltration is calculated.

It is assumed that by application of vertical flow constructed wetland system a surface area of 2m² per person equivalent is sufficient at relative cost of 250,-€/m². For the remaining 1/3 of households use of the total wastewater in agriculture is assumed. Due to the unsatisfying state of most of the existing septic tanks costs for renovation (50% of new septic tanks) were considered. Since the required size of the tanks depends directly on the wastewater production reduction by installation of low flush toilets is included (2 new toilets per house). Thus a size of 58m³ for each tank is sufficient to achieve a six months storage period. The total investment costs for Scenario C per house connection is only app. 4.450,-€. The main difference compared to the other scenarios is the non-existence of a sewer line.

| Unit | Assumptions | Costs | Costs/house |
|---|---|---|---|
| greywater treatment | 17 houses at 500€/pe | € 34.000,00 | € 1.360,00 |
| dry toilets | 17x2 at 1.500€ | € 51.000,00 | € 2.040,00 |
| low flush toilets | 8x2 at 600€ | € 9.600,00 | € 384,00 |
| renovation septic tanks | 50% of 58m³ per house | € 16.240,00 | € 649,60 |
| **Total Scenario C** | | **€ 110.840,00** | **€ 4.433,60** |

**Table 3:** Investment costs for Scenario C

## Operational costs

The operational costs are based on the frame conditions described above, current data published (e.g. BMLFUW 2001, 2003c and own practical experiences from implementation of both conventional and alternative sanitation projects.

Operational costs can only be assumed with a higher degree of uncertainty compared to the investment costs. One main reason is that only insufficient information on actual operational costs of sewer lines are available. In addition costs depend on the strategy applied in operation and maintenance of sewer lines, whether it is prevention or cure oriented. For the purpose of this study costs for a proper operation of sewer lines is assumed to be 1% of the investment costs annually. Another source of uncertainty is the cost for disposal of sewage sludge produced in Scenarios A and B and in a lesser extent in Scenario C. Depending on the chosen path of reuse respectively disposal the costs vary significantly. It was assumed that the quality of sewage sludge allows application in agriculture. In addition the idealistic value of work by all households in Scenario C regarding the emptying of the dry toilets and operation of the grey water treatment plants was neglected as well.

Depreciation of investment is considered on the bases of a fixed interest rate of 5% annually. The average life span of the mechanical equipment is assumed with 10 years while the average life span of all other investment is calculated with 50 years. Inflation is considered with 2% per year. For the purpose of this study a constant repayment rate was assumed. These assumptions are the same for all scenarios.

Table 4 shows the operational costs for Scenario A. For the treatment plant the costs comprise mainly costs for energy, material, personal and external supervision. Annual cost in Scenario A calculates to 1.300,-€ per house connection.

| Unit | Assumptions | Costs | Costs/house |
|---|---|---|---|
| sewer line | 1 % of investment annually | € 2.500,00 | € 100,00 |
| treatment plant | energy, material, personal, supervision | € 10.000,00 | € 400,00 |
| | sewage sludge (not considered) | € 0,00 | € 0,00 |
| depreciation | 5 % over 10-50 a | € 20.000,00 | € 800,00 |
| **Total operational costs Scenario A** | | **€ 32.500,00** | **€ 1.300,00** |

**Table 4:** Operational costs for Scenario A

For Scenario B (Table 5) operational costs are nearly the same. A slight reduction in treatment plant operational costs – since the highest share in the cost is the personal – is compensated by the slightly higher investment costs of this option. The value of approximately 360kg of collected nitrogen per year is not calculated.

| Unit | Assumptions | Costs | Costs/house |
|---|---|---|---|
| sewer line | 1% | € 2.500,00 | € 100,00 |
| treatment plant | energy, material, personal, supervision | € 9.000,00 | € 360,00 |
| | sewage sludge (not considered) | € 0,00 | € 0,00 |
| depreciation | 5 % over 10-50 a | € 21.000,00 | € 840,00 |
| **Total operational costs Scenario B** | | **€ 32.500,00** | **€ 1.300,00** |

**Table 5:** Operational costs for Scenario B

Operational costs for Scenario C are summarised in Table 6. In addition to the general assumptions the lifespan for dry toilets and low flush toilets was assumed to be 25 years in average. Therefore depreciation costs are high compared to the investment. As mentioned above both the idealistic value of work carried out by the households for operation of the units as well as the fertilizer value of the separately collected material are not included in the calculation. The total cost per household is with app. 410,-€ annually less then one third of the operation and maintenance cost of the first two scenarios.

| Unit | Assumptions | Costs | Costs/house |
|---|---|---|---|
| grey water treatment | 17x energy, supervision, etc. | € 3.000,00 | € 120,00 |
| | sewage sludge (not considered) | € 0,00 | € 0,00 |
| depreciation | 5 % over 10-50 a | € 7.293,17 | € 291,73 |
| **Total operational costs Scenario B** | | **€ 10.293,17** | **€ 411,73** |

**Table 6:** Operational costs for Scenario C

## Cost comparison

As mentioned above the main underlying principle of all scenarios presented was their compliance with the present legal situation with regard to discharge of wastewater to the environment. This means that the three solutions are comparable with regard to their performance in this sense.

In Figure 4 (left) the investment costs of the three options are compared. While the investment costs for Scenario A and B are similar, costs for Scenario C are significantly lower (app. 30%). The difference is mainly caused by the high costs of the sewer system.

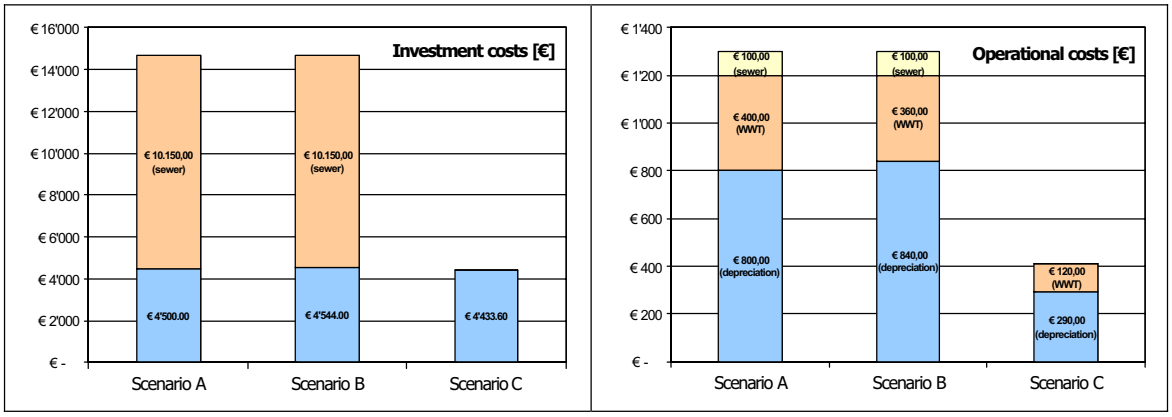


**Figure 4:** Comparison of investment costs (left) and operational costs (right) (wwt wastewater treatment).

Figure 4 (right) shows basically the same picture for the operational costs. In addition to the high depreciation costs, caused mainly by the high investment for the sewer lines also the operation of the wastewater treatment plants in Scenarios A and B is higher. The latter has to be qualified since, as mentioned above, the value of work carried out by the households themselves in Scenario C was not included. Nevertheless it is again obvious that both options with sewers cause approximately 3 times higher costs for operation and maintenance. Although if additionally the value of the nitrogen collected in Scenario B were considered still the level of costs achieved by Scenario C – were the same value is recovered – could not be reached.

Figure 4 compares absolute costs, not taking into account the present system of subsidising wastewater infrastructure in Austria. Generally all installations on private property (with the exception of long connecting sewers and main sewer lines) can not be subsidised. Taking into account average subsidy rates the pictures looks differently.

Figure 5 summarise both investment and operational costs taking into account present subsidising practices. Due to the nature of the subsidising system – normally only the minor part is a direct contribution to the investment but the rest contributes to the repayment of a loan – the effect becomes most obvious for the operation and maintenance costs which have to be financed by the households directly. Scenario B becomes the most expensive since the investment costs are nearly the same as for Scenario A but partly, since in house installations, not supported. Although Scenario A is still 50% more expensive then Scenario C it is obvious that an important incentive for alternative solutions is lost.

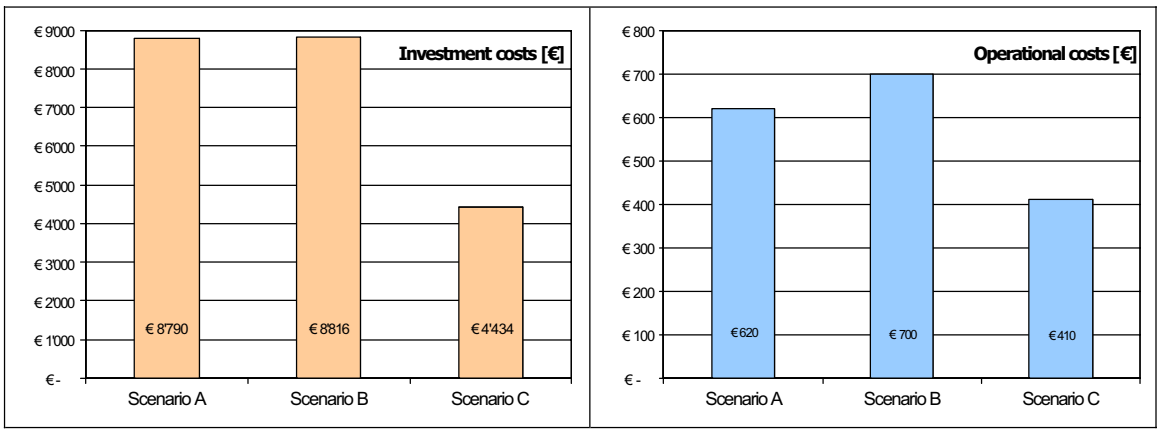


**Figure 5:** Investment costs (left) and operational costs (right) without subsidy.

## Conclusions

The comparison of investment and operational costs of three different scenarios clearly shows that conventional systems for rural areas are the most expensive option (mainly due to the sewer lines needed) but still encouraged through the subsidising system. Neglecting subsidising issues the advantage of alternative sanitation solutions under the frame conditions described above becomes obvious. In addition to their sustainability reuse oriented systems are therefore also definitely economically advantageous.

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# Application of ecosan principles through public private partnership projects-prospects and limitations

**Hartlieb Euler,**
**Pedro Aibéo**

TBW GmbH, Frankfurt
Baumweg 10, 60316 Frankfurt, Germany
e-mail: tbw@tbw-frankfurt.com



## Keywords

Appropriate technology transfer, public-private partnership, sanitation concepts, framework

## Abstract

Inadequate or even lack of sanitation is a key social, health and environmental problem in the majority of countries. Public programs are insufficient and do not reach the majority of the population. Private initiative alone often only serves a few, who then however mostly remain affected by those without suitable sanitation and do not get their co-operation. Lack of finance for investment and operation, lack of integration into dwelling and economic activity, resulting often in unsuitable technical and environmental approaches, and a lack of participation can sometimes be overcome if public and private actors manage to co-operate and agree upon a suitable division of labour and framework of responsibilities and thus turn sanitation into a joint development priority, which can then help as well to save and reuse valuable water, nutrient and energy resources.

## Introduction

Traditional central sanitation and waste disposal, as dominant in industrialised countries, used to be and still is rather publicly planned and supervised by responsible and specialised Government agencies, traditionally built and mostly operated publicly or through public supervision and public financing.

These central systems involve a full sewer system or leading to a waste water treatment plant, or a collection and transport chain to a landfill out of town, with petrol for solid wastes or water being the means of transport, for toilets, grey water, often for rainwater and industrial effluents as well. Here resulting garbage and treated sewage sludge becomes a costly problem, since it is mixed with toxic substances and heavy metals and thus the organic substance and nutrients need to be disposed of instead of being reused in agriculture; the treated water is going into a river or polluting ground water as seapage, instead of contributing to plant growth and water table refilling. These concepts as well fully separate sanitation issues from solid waste management, agricultural and energy production. But they do not separate the waste streams, which would be so much more important for a future reuse.

More recent and sometimes fiercely debated, by some just considered as modern and up-to-date concepts, involve a larger private involvement, sometimes even a full private responsibility and ownership of urban water supply, waste and waste water disposal and treatment. However, for a long time these more private sector oriented approaches followed the same technical planning and underlying principles.

**Figure 1:** Appropriate decentral waste water treatment through a UASB-System in Lima.

**Figure 2:** Canal and treatment for distribution of nutrients and treated waste water, Lesotho.

Regardless of the technical concept of sanitation, there is a common understanding that publicly owned and operated systems, mixed ownership and/or operation as well as private models can all the same be efficient and satisfactory models for all stakeholders involved in sanitation, as long as adequate public control, supervision and regulation for this basic needs requirement can be fully and sustainably secured. However, mostly an appropriate mix of different public and private responsibilities have proven to be the more efficient organisation model to secure appropriate and sustainable sanitation.

Increasingly, central systems are refinanced through consumer or household fees, on waste, water and waste water treatment, sometimes based on actual consumption, sometimes only on a per capita or household basis, which often further increases spoilage, in particular of water. In most developing countries central waste disposal, water supply, sewer and waste water treatment systems are not or only partially in place due to the high investment and operation costs needed and lower household and tax incomes. Development strategies for a long time were mostly copied concepts from industrialised countries, with water supply installations being the first priority. Planning of sanitation took place quite often in a second step often regardless of climatic and economic differences in these countries, with blue prints and equipment from industrialised countries sometimes being transferred regardless of climate and economic potential in a one to one pattern.

**Figure 3:** Vacuum-system reduces water use for Toilet Flushing in apartment building; before anaerobic treatment, Freiburg, Germany.

**Figure 4:** Recycling and energy optimisation sometimes ask for sophisticated control panels even in Ecosan projects.

A direct transfer of the “European” or “industrialised” type of sanitation approach, regardless whether privately or publicly organised or financed to developing countries can create the following problems:

1. The systems developed and applied in industrialised countries are proving to be only sometimes sustainable, here in particular in terms of long-term water and energy balance
2. The need for capital investment and operation requirements are too high for many developing countries
3. Public administrations are mostly less well organised and equipped in developing countries than in industrialised countries, with countless standstills of these systems as a result
4. Clean water is even more scarce in many developing country environments than in industrialised countries
5. Nutrients and their balanced mix as available in organic sludge and waste have a higher economic value and are more needed for sustainable agricultural production and soil conservation
6. Higher temperatures lead to higher evaporation and activity (in landfill, sewer, canals, ponds and other treatment plants), thus changing the optimal waste and water management pattern
7. they lead to a faster biological activity, decomposition and green-house gas production and thus different treatment, transport and storage behaviour and needs for sewage and sanitation
8. Higher temperatures increase the production of biogas as a potential decentral energy supply, which is often crucial, where firewood, dung and charcoal use are a main reason for ecological damage and poverty; here as well climatic issues need to be considered
9. Labour is often abundantly available in developing countries, asking for labour intensive sanitation, recycling and reuse approaches
10. There is often a shortage of qualified labour, management capacities and funds for operation, maintenance and repair of sophisticated installations under public control and responsibility, thus leaving a majority of installations idle after a short period
11. The organic share of municipal and industrial solid waste is larger asking for a different approach to their management; for example their joint treatment with industrial or agricultural waste or municipal sludge
12. High transport cost (roads, vehicles, fuel) for solid waste disposal at far-out centralised dumps and related ground water pollution problems ask for a different approach
13. Soil conservation, the water balance, biomass, forestry, agricultural and nutrient production and related energy and hygienic issues are considerably more important within the overall economy and environmental balance of developing countries
14. Overall public and private economic and financial parameters, costs and benefits and their distribution in most developing countries are considerably different and need to be respected as a base for planning, participation and implementation
15. This transfer approach is even less suitable for city outskirts, rural settings and smaller towns, where the contradictions and restrictions of central sanitation become more obvious

**Figure 5:** Nutrient recycling wants suitable marketing of waste compost Talcuahano, Chile.

**Figure 6:** Recycling of municipal solid waste through composting , Addis Ababa, Ethiopia.

## Public private partnership in eco-sanitation

Actual discussion on Public Private Partnership Projects within the German Development Co-operation focus the dominant public character of Development Co-operation, which is financed from Public funds (Ministry of Co-operation – BMZ) and channelled for implementation through state-owned organisations like GTZ for technical co-operation, KFW for public loan financing, DEG for private loan financing or for example InWent for financing of training issues.

The overall goal is to have the German Private Sector, so far mainly used as a subcontractor, stronger and earlier integrated into development co-operation, to use its know-how and capital and to help these companies to enter the markets of developing countries. As well to reduce the financial burden of public development co-operation and to use efficiencies and experiences of the private sector through these “partnerships”. Commonly in these co-operations the private portion is meant to be focusing and used for private business interests and a public portion is added to secure the development goals. PPP-Projects can either be separate projects or they become increasingly an early and integrated part in the planning and implementation of development co-operation projects.

**Figure 7:** TBW-InWaSia-System for water, nutrients, energy production, recycling and reuse from industrial waste water in Cuba.

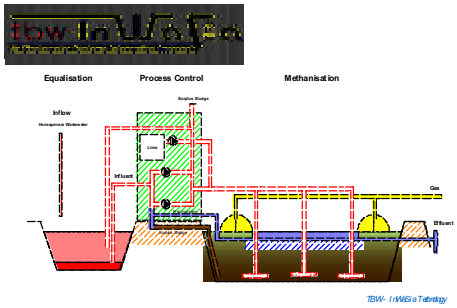


**Figure 8:** UASB-Recycling scheme; waste water treatment plant at sugar cane factory in Jamaica

Ecological sanitation and thus development co-operation focussing ecological sanitation anyhow has to secure a broader involvement of households, the private sector, and different government and non-governmental actors. Ecological sanitation thus is likely to need a major private share involved in implementation from “developing” and “industrial” countries for a number of reasons, for example:

1. The public sector is rather designed and dimensioned to oversee central issues, installations and projects, which involve long-term planning, budgets and personnel
2. Ecological sanitation asks for a larger share of individual varieties of sanitation concepts for different types of situations and thus a larger individual involvement and flexibility
3. Since ecological sanitation tries to reverse the somewhat unconscient “private disposal – public responsibility and care” concept, it asks for broader sens ibilisation and responsibility of private and decentral actors
4. The public sector has less experience and capacities to operate the benefit and reuse side of ecological sanitation in gardening, horticulture, pesciculture and agriculture
5. Ecological sanitation tries to mobilise private interest and investment through more decentral or individual benefits from water, nutrients and energy within reach and touch of the population
6. Ecological sanitation builds on technical concepts which are easier to plan, build, copy and manage for local technicians, households and decentral organisational units

Since larger public co-operation projects of industrialised countries are – at least used to be - often rather designed to support central sanitation structures and their administration in developing countries, an increase of private involvement through the PPP approach in ecosan projects seems to some extent only logical and consequent to allow major elements of ecoson to materialise.

**Figure 9:** Waste-reuse research for simultaneous treatment of liquid, sludge and solid waste from municipalities and industries; in transportable containers, Hanau, Germany.

**Figure 10:** Agro-industrial wastes contain a large nutrient and energy potential; central-decentral treatment plant for municipal and industrial wastes in Rothenburg, Germany.

**Figure 11:** After washing and shredding different plastic fractions can be reused; Lima.

**Figure 12:** Digesters; treatment plant for municipal, agricultural and industrial wastes.

On the other hand, sanitation and waste management are not per se a profitable business for the private sector, and will not become profitable in the near future; if funds are not mobilised for related services, this applies, even if some costs can be reduced, just as well for ecosan projects.

However, the private sector involvement will help to increase focussing the monetary side of sanitation, like water reuse, nutrient reuse, replenishing soils, energy production, climatic issues, other recycling materials and their productive use in urban construction, horticulture, agriculture and other areas.

As well the private sector involvement helps to identify or develop appropriate individual solutions with the optimal cost-benefit relation, a prime driving force of private sector activity.

**Figure 13:** eco-san seminar in the municipality of Yang Song near Beijing, China; here the water table drops 1 m per year.

**Figure 14:** Integrated waste treatment and fertilizer distribution plant, use of toilet and green biomass energy, Thomassin, Haiti.

**Figure 15:** Anaerob-aerob waste separation, treatment and recycling plant in Canete, Peru.

**Figure 16:** Compost preparation from municipal solid waste in Canete, Peru.



Quite obviously there are some risks involved in privatising eco-sanitation and turn them into "PPP Projects":

1. public administrations want to get rid of the overall responsibility for waste and waste water disposal by giving it to privately owned companies without a clear framework of duties, control or without providing or allowing to raise the necessary investment and operational funds;
2. this is occurring for example in some states in the solid waste sector in India at present, where the Government, by focussing recycling and energy values of solid wastes, tries to hand over collection and disposal duties to private companies without securing adequate income with the consequence of poor disposal and treatment practices
3. the private sector might want to "pick the raisins", the valuable portion, out of the sanitation and disposal business (for example only affluent quarters), thus leaving the public sector with the most expensive and least attractive portions of this obligation
4. the private sector, by taking over public sewer and treatment installations and even water sources, can get out of control; as a result, installations and operation sometimes deteriorate; cost increases become unacceptable for households; qualification of the public sector to supervise activities get lost

A good and comprehensive contractual framework, with a long-term sustainability and investment plan, with cheques and balances and constant independent controls is thus crucial for a fruitful co-operation between private and public sector in this field.

More decentralised eco-sanitation leaves more room for local planners, builders, contractors, operators, since the level of investment and securities needed is more within the reach of these companies. Since eco-sanitation concepts are meant to be more close to sight and interest of the households and local community and to existing local know-how levels, a more direct control and intervention can be expected for eco-sanitation approaches; on the other hand, eco-sanitation with a major private involvement can be even more demanding for a public municipal control and supervision.

**Figure 17:** Engineers and supervision team of municipality discuss progress of integrated waste treatment plant in Chonburi, Thailand.

**Figure 18:** Bottom sealing for 6 ha landfill of integrated waste recycling and disposal plant in Chonburi, Thailand.

Just like private and public partner will have to balance their interest through a good framework and communication within a PPP-approach of a development project, this applies as well for the whole sanitation sector in the developing country. So PPP-projects in eco-sanitation mirror perhaps better a sustainable implementation model in a given urban setting. However, no prime concept has been developed yet that secures an optimum organisational structure for all parties and interests involved;

A good mix and co-operation of the different private and public stakeholders and the establishment of clear frameworks is undoubtedly the direction to be taken: and this applies even more for eco-sanitation approaches.

**Figure 19:** Most important is the attitude of the young people towards eco-sanitation; here is an example of sensitisation for sustainable waste management in Imperial, Peru.

**Figure 20:** Even the black and yellow water from train toilets is a valuable nutrient for plant growth and soil improvement if treated sufficiently.

## Conclusions

There are uncountable hindrances of Public-Private Partnerships for truly cost-efficient sanitation. However there is little alternative. TBW has, within a number of projects, made some substantial progress on that rocky road to combine private initiative and public responsibility and participation with more sustainable sanitation and recycling strategies. Just like private and public partner will have to balance their interest through a good framework.

# Human urine from city to field - towards sustainable co-operation?

**Susanna Degaardt**

Kretsloppskontoret (Recycling Office)
Box 11192, 404 24 Göteborg, Sweden
e-mail: a7susdeg@ulmo.stud.slu.se



## Keywords

Fertilizer, nutrients, urine, recycling, resources

## Abstract

Possibilities and problems connected with the establishment of a well-functioning recycling system for source separated human urine from a Swedish city to productive land were investigated. Via literature and interviews with people with experience of similar recycling, potential urine users and other stakeholders, the current position was determined. The results show that a potential market exists for source separated human urine as a fertiliser around cities, especially in agriculture. However certain critical issues must be resolved for the desired degree of consumer confidence and knowledge to be achieved regarding human urine and its recycling system within the entire recycling chain. This is possible with good information and quality-assurance measures. There is urgent need for a risk assessment of pharmaceutical residues in the product, not least to enhance end-user and public confidence. Quality assurance systems have been developed for segments of the chain but an overall approach is lacking. One party, e.g. the urban authority or its contractors, must be appointed to a coordinating role. Society should have the final responsibility for the development and function of the recycling system and should be the driving and supporting force when necessary in the development of these new systems.

## Source separation of human urine – why and how?

The conventional sewage treatment systems of Swedish cities today do not allow a high level of nutrient recycling back to agriculture. Only a small percentage of the total amount of nutrients is captured in the sludge of the sewage treatment plant, still polluted by compounds not wanted in agricultural fields. Many of the nutrients are instead discharged to recipient waters, causing eutrophication and nitrate poisoning of the groundwater. The Swedish Environmental Protection Agency has recently proposed as a national goal that in 2015 at least 60 % of the phosphorus in sewage must be recycled to productive land, of which at least 50 % should be agricultural land (Naturvårdsverket, 2002).

In recent years, research on source separation of human urine has been carried out on a broad front. The results show that this system opens up for a high level of nutrient recirculation in an environmentally advantageous way, where the hygiene risks can be minimized to an insignificant level (Jönsson et.al., 2000). Although urine represents only 1 % of the volume flow in household wastewater, it contributes 80% of the nitrogen, >50 % of the phosphorus and 80-90 % of the potassium (Vinnerås, 2002). By separating the urine at source, a large proportion of the nutrients can be captured in a small and very clean fraction, which functions well as a fertiliser. A urine separating toilet has a special bowl for urine at the front and another for faeces and paper at the back. The urine and a small amount of flushwater flow separately into a collecting tank in the housing area, from where they are later emptied and transported by a

tanker to a storage tank. It is common that the urine is stored in an unused slurry tank at the farm before application. During storage, the urine is sanitised and after this, it is used as a fertiliser for cereals or other crops.

Increased knowledge of the system has prompted a growing political interest in Sweden for source separation of urine, as one of many ways to achieve a greater recycling of plant nutrients. While in the beginning mainly installed in eco-villages, source separation systems are becoming more frequent in villas, blocks of flats, schools and other institutions. About 2-3000 urine separating porcelain toilets have been sold in Sweden, and in addition to that a large number of plastic ones for summer cottages (Johansson et.al., 1998). According to Swedish law, local municipalities must provide for appropriate collection and treatment, e.g. recirculation, of source separated urine and other sewage fractions kept in a closed tank. There is a need to investigate forms for a well-functioning retrieval system all the way from city buildings to the field. To achieve the political vision of recirculation of nutrients, local planning authorities have to pay attention to the kinds of products and recycling management required by the end-consumers for fertilisers, for example farmers. There are also many other stakeholders along the nutrient recycling path and it is important to investigate how they view co-operation.

## Source separation of human urine in the city of Gothenburg and the aim of the study

In Gothenburg, the second largest city in Sweden, there are currently four larger buildings with urine diverting systems installed, together producing some 300 cubic metres of urine-flushwater mixture per year. The city of Gothenburg wishes to create a co-operation with fertiliser consumers for recirculation of this and for an expected increased fraction in future. To achieve this, a feasibility study was initiated, performed as an MSc thesis at the Swedish University of Agricultural Sciences (SLU). The overall questions at issue were:

What are the possibilities and problems in finding an outlet in agriculture or other productive land; and

How can we solve the problems?

## Problems and possibilities – views of different stakeholders

Literature studies and conversation with a great number of actors and scientists were performed to explore issues like urine as a plant nutrient; economic and technical aspects of the retrieval system; legal issues of importance; health- and environmental risks; and actor acceptance. Below follows a brief compilation of the information gained from some of the most important stakeholders.

*Present and potential urine users in agriculture*

Some of the farmers interviewed were interested in using human urine. This interest mainly arose from the need for fertiliser on the farm, the crops grown, the equipment available and the environmental awareness of the farmer. If suitable equipment was not available it could be hired from a contractor but large amounts of urine were required for this to be economically viable. There appeared to be a great need for readily available N fertiliser in organic farming, so if the use of human urine were approved within EU subsidised organic farming, the demand would increase. The international associations for organic farming (IFOAM) can permit human urine that on crops for human consumption, if the urine is sufficiently sanitised. Most farmers are demanding that the nutrient content be assured by analyses etc. Many are sceptical to that the fertilising effect will be as good as stated and potential participants wanted to test the product before agreeing to co-operation. One urine-using farmer questioned was considering stopping because of the poor nutrient concentration in the product when it reaches his farm. There was a fear of being sanctioned by consumers if confidence in urine were to be lost in the future. This

has already happened to farmers fertilising with sewage sludge in 1999, when the mass media raised concerns about the presence of brominated flame-retardants in the sludge. End-users wanted a guarantee that this would not happen and were very interested in the position taken by branch organisations and consumers.

*Potential uses in municipal parks and sports fields*

It was shown that there is a certain need for fertilisers, which could theoretically be replaced by human urine on e.g. lawns and flowerbeds. Application of human urine by an injection technique in combination with soil spiking has been shown to work well on golf areas (compared to conventional spraying). This method should in principle also work on a park or football pitch but it was not known whether the injection equipment required was available. Acceptance issues are very important for all these areas. What would be the reaction of visitors and of grounds staff? Would there be an undesirable smell? A desire was expressed for much more information and for precise details of the urine composition. Staff and sports players would be exposed to the fertilised soil – is there a risk of infection in cuts etc.? Football attracts the mass media, so a massive information campaign would be needed to prevent scandal stories at a later date. If directives came from above and a good level of co-operation was established, most interviewees would be willing to test the system. Small-scale testing would be an accessible route. There is a pedagogic potential in using urine in parks and at the same time informing the public, provided negative effects can be eliminated. One park was discussing using urine in its compost instead of artificial urea.

*The food industry, the Union of Swedish Farmers (LRF) and consumer organisations*

Most of the large food and feed companies policies encourage recycling of plant nutrients from town to country. However, during questioning it became clear that the feed industry and the mills will not permit fertilisation with human urine until more tests are carried out on pharmaceutical residues and until there is quality assurance of the product. There is a fear of negative press coverage being associated with brand names. The general opinion was that the Government should devote more funding to this issue, as it is a social problem. The meat industry currently permits the use of human urine, as does the leading dairy in the area under certain circumstances. The target of the LRF is for the majority of all nutrients to be recycled from town to country within a generation. They permit both urine and blackwater but not sewage sludge. Leading food companies, national organisations for the environment and sewage and urban councils are working together within the ReVAQ project, which allows monitoring of e.g. heavy metals, organic poisons and salmonella in recycling. Consumer organisations are generally positive to source separated toilet waste as opposed to sludge.

*Urban authorities and housing companies*

In many areas there is a lack of procedures to ensure that urine separation systems are correctly installed in buildings and then maintained. This has led to nutrient losses in the form of ammonia, and to rain and soil water leaking in. It is the responsibility of the urban council to supervise when granting permits for such systems and to collect the urine. Today, there is in practice inadequate or non-existent supervision of such systems.

*Recycling companies for organic waste*

One company that had the business concept of recycling urine for urban councils claimed that the amounts recycled were far too small to create a financial incentive for recycling. A lot of money has been invested in conventional systems, which have been developed over 50 years. If urine separation is allowed an equally long period of development, it will probably function and be financially viable. Initial funding was often readily available, as politicians wanted to improve their environmental profile, but there was a perception that difficulties arose in transferring recycling to general practice while trying to cut costs. It is not good for society to go in and pay all the recycling costs because of the high degree of unreliability in the initial phase. It is often

hard to withdraw this support at a later stage. It would be better to find a buyer who valued the nutrients. A computer system has been developed that allows traceability of every batch from the production source, to the storage sites, to the field on which it is applied and the time of application, to the crop grown etc.

## Conclusions



There are users who are very positive to the use of human urine but one condition for this is that the quality of the urine as regards concentrations of plant nutrients and its freedom from harmful substances must be assured.

A well-functioning quality assurance system must be coordinated across the entire chain. Urban authorities bear the main responsibility for such coordination. The work in ReVAQ could perhaps act as an example.

The health and environmental risks of pharmaceutical residues have not been investigated. An analysis of the health and environmental risks of pharmaceutical residues in relation to recycling of human urine needs to be carried out.

The benefits of nutrient recirculation mainly belong to society as a whole and society should therefore support the development of these systems to the extent necessary. E.g. agreements regarding compensation for any losses suffered by individual farmers could be introduced.

Farmers and their customers within the food and feed industries are not very knowledgeable about human urine as a product and many believe the risks are as great as for sewage sludge. Since the general public has little information about the issues involved, press stories can have a great impact. We must provide extensive and accurate information to the market and change opinions. A public debate about the importance of recycling nutrients would be ideal. It might then transpire that the public will want us to await the results of testing for pharmaceutical residues, despite many believing that both the health and environmental risks in this regard are greater with the conventional waste systems of today.

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# Complexity of basic needs and the role of ecological sanitation in the rural region of Lake Victoria, Tanzania

**M. Grottker,**
**D. Grottker,**
**D. Karrasch,**
**V. Kleineidam**

Fachhochschule Lübeck
Stephensonstr. 3, D-23562 Lübeck, Germany
e-mail: grottker@fh-luebeck.de



## Keywords

Basic needs, ecological sanitation, cybernetics, health and hygiene, education, infrastructure

## Abstract

Living condition and standard in the rural region of Lake Victoria, Tanzania, is very poor compared to central Europe. Deficits in basic needs are obvious and development is slow due to a high population growth rate and difficult due to the complexity of basic needs. In this paper the interactions of basic needs and the role of ecological sanitation shall be described in a cybernetic approach. By this the technology of ecological sanitation is less described in particular, but the complexity of interactions which make the implementation of a technology successful or not, is discussed.

## Introduction

During a more than ten-year partnership between a Tanzanian (Mwanza, Lake Victoria) and a German NGO (Lübeck) the basic needs in the rural region of Lake Victoria were investigated. Several visits of members of both NGO's took place in order to learn and understand living conditions in the different countries. However, rapprochement of both NGO's was slow due to the different sociological, cultural and technological background in the two countries. But both NGO's stated: The slower the cooperation was growing, the more stable development took place. On this background the complexity of basic needs and the role of ecological sanitation is discussed in the NGO's and reported in this paper.

## Basic needs

The investigations of the paper's authors during the last 3 years were focussing on the basic needs in Tanzania, defined and roughly explained below. They are dominant regarding the development of rural areas by technical measures in order to improve living conditions in the villages and small towns in Tanzania. The interactions among these basic needs are very complex which makes a non-linear, cybernetic thinking in improving living conditions necessary. Each of the following basic needs is influencing all the others significantly; all measures of development have to be taken into account in parallel. The relevant basic needs, requirements on it and its state in Lake Victoria region can be very brief summarized as follows (Karrasch et al., 2002; Grottker, T., 1989):

Health prevention is very poor in the Lake Victoria region, since all 5 dominant infectious diseases as Malaria, Pneumonia, diarrhoea, tuberculosis and HIV were among the top 10 diseases in the investigated hospitals and dispensaries. Poor hygienic living condition, water supply, wastewater drainage / treatment, waste management as well as very little knowledge

about the interaction of hygiene and health are reasons for this state.

Medical treatment of diseases is fairly good in big cities like Mwanza, where many hospitals and dispensaries are located. In rural regions few dispensaries with little medical and pharmaceutically resources are available. Long walking-distances, treatment-fees and opening hours make the medical treatment very difficult. Basic medical service is required in each village.

Drinking water supply is mainly basing on shallow wells, which can fall dry during summer season and a few deep wells, which belong for example to private schools. Clean drinking water supply with more than 10 l/(P•d) and less than 2 hours to walk is required in every village.

Ecological sanitation could be easily implemented in the rural region, because in general no drainage and/or treatment system is in use. Safe wastewater collection and storm water drainage is necessary in order to dam infectious diseases and limit energy and material resources.

No waste management exists in rural villages. Since only few wastes are produced in rural regions, it looks uncritical. Nevertheless, consumer goods like batteries, electronic devices or chemicals might cause a high risk for the villagers. Organic material should be reused and inorganic or toxic wastes should be dumped at a “safe” location.

The nutritional conditions are specific to the topographic, climatic and agricultural conditions in the Lake Victoria region. Although the annual precipitation is about 1500 mm/a nutritional supply during dry seasons is sometimes very serious. Consequently starchy nutrients, which are resistant to long dry periods, are dominant in the nourishment. Diversity in agricultural production is required in order to sufficiently supply villagers with carbohydrates, proteins, vitamins and minerals. Further, conservation techniques are required, using a minimum of energy and material resources.

Housing conditions are adequate to rural village structures. Nevertheless infrastructure and hygiene is poor (see above/below), but most serious is the lack of mosquito nets, too little space in the houses and poor water / wastewater conditions, which increase the risk of infectious diseases.

Traffic system is typical to the east African communities. Villagers are walking on foot or riding by bike. Public (mini-) buses are available, but very expansive and in case of heavy illness or pregnancy people will often not be transported to hospital. Rural development is necessary to make people more independent of the traffic system.

Communication takes place at local markets and/or social meeting points. During dry seasons trade is far less than during rainy seasons. Consequently less communication and less information exchange is possible.

Electric power supply is available only along the main traffic roads. It is necessary for public (and private) services as medical services, water supply, sanitation and conservation of nutrients.

Firewood supply is necessary for cooking and preparation of hygienic drinking water if no water supply is available. In savannah around Lake Victoria some regions are seriously lacking in firewood. Reforestation is necessary immediately in order to protect from dramatically firewood shortage in the next decades.

The Tanzanian government offers basic school education. However, many families have no money for school fees and children have to work for the family income. This problem increases if parents died by HIV or other infectious diseases or inadequate medical services. The understanding of the interactions with all other basic needs increases step by step the longer children go to school. Because many children start primary school not before the age of 9 years, about 10% finish primary school (reach the 6th class) only.

Continuing education is offered by private (church) or public services. Mainly women take part in the education programmes, which are focussing on health prevention, hygiene and environmental problems. The role of women in Africa differs significantly from the role of European women. Development in technology has to take this requirement into account if education programmes are carried out in order to improve basic needs.

## Complexity of interactions among basic needs and role of ecological sanitation

The complexity of interactions among basic needs is very high. The improvement of living conditions by changing only one or the other basic need will fail, except development takes place very slow. A more efficient and quick way to find a developed and stable system needs a cybernetic approach (introduced e.g. by Vester, 1990), which is carried out as follows.

In table 1 all thirteen basic needs mentioned above are listed on the x- and y-axis of the table. For each basic need the effect on every other basic need is evaluated and reverse. Each basic need is once observed in its active role and on the other hand in its reactive (passive) role. The evaluation is basing on the intensity but not on the kind of the interactions. Values from 0 to 3 are weighing this intensity.

| **Effects of ⇩ on ⇨** | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | AS | Q | P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| health prevention | 1 | | 3 | 2 | 3 | 3 | 2 | 1 | | 2 | | 1 | 2 | 3 | 22 | 76 | 638 |
| medical treatment | 2 | 3 | | 2 | 2 | 2 | 3 | 1 | | 2 | | | 3 | 3 | 21 | 78 | 567 |
| drinking water supply | 3 | 3 | 3 | | 3 | | 2 | 1 | | 3 | | 2 | 1 | 1 | 19 | 83 | 437 |
| ecological sanitation | 4 | 3 | 2 | 3 | | 1 | 2 | 3 | | | | | 1 | | 15 | 71 | 315 |
| waste management | 5 | 3 | 2 | 2 | 1 | | 1 | 3 | 1 | | | 1 | 1 | 1 | 16 | 67 | 384 |
| nutritional conditions | 6 | 3 | 2 | | | 2 | | | | 3 | | | 3 | 3 | 16 | 57 | 448 |
| housing conditions | 7 | 2 | 2 | 1 | 3 | 3 | 2 | | 1 | 2 | | | 2 | 1 | 19 | 106 | 342 |
| traffic system | 8 | | 3 | 2 | 1 | 3 | 3 | 1 | | 3 | 2 | 2 | 1 | 1 | 22 | 440 | 110 |
| communication | 9 | 3 | 2 | 2 | 2 | 3 | 3 | 1 | 1 | | | 1 | 2 | 2 | 22 | 110 | 440 |
| electric power supply | 10 | 2 | 3 | 1 | 1 | | 1 | 2 | | 1 | | | 1 | | 12 | 400 | 36 |
| fire wood supply | 11 | 1 | 1 | 2 | | 1 | 3 | 2 | 1 | | | | | | 11 | 100 | 121 |
| basic school education | 12 | 3 | 2 | 3 | 2 | 3 | 3 | 1 | | 2 | | 2 | | 3 | 24 | 120 | 480 |
| continuing education | 13 | 3 | 2 | 3 | 3 | 3 | 3 | 2 | 1 | 2 | 1 | 2 | 3 | | 28 | 156 | 504 |
| | PS | 29 | 27 | 23 | 21 | 24 | 28 | 18 | 5 | 20 | 3 | 11 | 20 | 18 | 247 | | |

**Table 1:** Evaluation of interactions and their effects among basic needs and interpretation of the role of each basic need: Either active or reactive, either sensitive or buffering.
0 = no interaction, 1 = small interaction, 2 = medium interaction, 3 = high interaction
AS = sum of active effects, PS = sum of passive effects
Quotient Q = AS / PS x 100, Product P = AS x PS

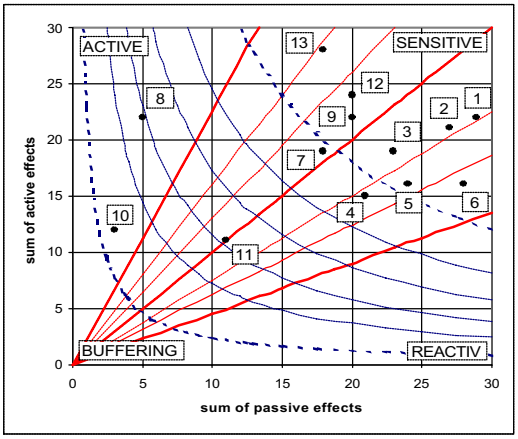
The results of this evaluation are shown in figure 1 and can be interpreted as follows. Basic needs as *traffic system* (8) and *electric power supply* (10) are highly active on other basic needs, but on the other hand buffering, because their reactive role is marginal. They play a minor role in the development of living condition in the Lake Victoria region, as well as the *firewood supply* (11), which is neutral in both dimensions.

Living conditions in the region of Lake Victoria are very instable, because 8 of 13 basic needs are highly sensitive and two more are sensitive. They are effecting other basic needs as well as they are effected by them on a high to very high level. This graph make obvious, how serious development in this region is. A wrong, a too intensive or extensive, a too fast or slow development may cause dramatically changes in other basic needs and loss of living condition may be the consequence.

Development without the slightly active to neutral, but highly sensitive basic needs as *continuing education* (13) or *basic school education* (12) and *communication* (9) no stable living conditions are possible. *Housing conditions* (7) play a minor role, because they are neutral and less sensitive. On the other hand basic needs as *health prevention* (1), *medical treatment* (2) and

*drinking water supply* (3) are highly sensitive but more or less neutral. *Ecological sanitation* (4), *waste management* (5) and *nutritional conditions* (6) are slightly reactive to reactive, but *ecological sanitation* (4) is less sensitive.

## Interpretation and Conclusions




1. Health prevention
2. Medical treatment
3. Drinking water supply
4. Ecological sanitation
5. Waste management
6. Nutritional conditions
7. Housing conditions
8. Traffic system
9. Communication
10. Electric power supply
11. Firewood supply
12. Basic school education
13. Continuing education

**Figure 1:** Evaluation of interactions and their effects among basic needs and interpretation of the role of each basic need: Either active or reactive, either sensitive or buffering

The implementation of ecological sanitation technology is significantly improving living conditions in the Lake Victoria region, Tanzania. But no stability in living conditions can be reached if changes go too fast or interactions among basic needs are ignored. Consequently the following concept to improve living conditions by ecological sanitation systems is suggested.

1. Preparation. Ecological sanitation projects should be prepared by continuing education (adults/women), basic school education (children) and communication (markets/seminars/ meetings). Information exchange and education on the interactions among basic needs and between technology, environment and society with respect to ecological sanitation systems is necessary. Without education no success in the long term can be expected.

2. Implementation of technology. The implementation of ecological sanitation technology shall follow after specific education step by step. Interactions where either basic needs are highly or medium affected by ecological sanitation (No. 1,2,3,6,7 of table 1) or ecological sanitation is highly or medium affected by other basic needs (No. 1,2,3,7,9,12,13 of table 1) have to be observed carefully and control procedures have to carried out, if necessary. Sometimes other basic needs have to be improved in parallel (e.g. drinking water supply) to guarantee the systems functioning in the long term.

3. Operation concept. Stable operation of ecological sanitation systems is guaranteed only, if an operation concept is developed during step 1 and 2. Therefore operation committees have to be established by the community, mainly composed of the users of the system. Further, the continuing interaction between the different committees of the concerned basic needs has to be established.

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# Preliminary survey based on community need leading to sustainable sanitation - an Indonesian case study

**Suriptono**

Institute for Environmental Management and Technology, Merdeka University
Jl Terusan Raya Dieng 62- 64,Malang, East-Java, Indonesia
e-mail: suripton@indo.net.id



## Keywords

Community participation, preliminary survey, small-scale community technology, small-scale technology, sustainable sanitation.

## Abstract

The preliminary survey based on local community need as a preparation of a project is essential in order to build 'sustainable sanitation' in the local community level. The 'Small-Scale Community Technology concept' that is produced by the survey, and the small-scale sustainable sanitation technology: the Ecomax, have been a significant part of the success of the Embong Brantas Project – the small-scale based sanitation technology project.

## Introduction

Most community development projects have a strong social dimension that is critical to its success. It is a matter of fact that many community development projects including sanitation projects in Indonesia funded by World Bank and others have failed tragically due to ignoring social aspects in their project's preparation. As a result most people remain disposing of human waste directly into rivers and canals. Considering the importance of social dimension in community development projects, the Embong Brantas Project in the squatter area in Malang Municipality, East Java, Indonesia, as a small-scale community sanitation project, has carried out a preliminary survey before implementing its sanitation programs.

## The preliminary survey

The survey was intended to answer questions such as: what were the expectations of the community?; how was the community prepared for the project?; how has the community been organized to manage the technology and does this work?; and how can it be improved from community perspective? The survey was conducted in Embong Brantas area, involving professionals from Malang Municipality, Surabaya (the capital city of East Java), and Jakarta (the capital city of Indonesia), in order to assess the attitude of the community towards the project proposal. The preliminary survey aims not only to stimulate and encourage the local community at Embong Brantas to be aware of the need of sustainable sanitation for their benefit towards healthy living, but also to design an integrated programme which is culturally acceptable, and to study how to approach the local community and how to effectively implement the project. Further, the survey is also used to unite local community will to fully participate in this project in order to create a sense of ownership. Moreover, the survey is an excellent opportunity to obtain information directly from all stakeholders who have ever been involved in the delivery of sanitation services in the past. Their inputs that have come from real experience would provide invaluable information to prepare and secure the sustainability of the project.

## The survey's questionnaires

The questionnaires of the survey are as follows:

1. What is your occupation?
2. Have you heard about the Embong Brantas Project?
3. How important is it to clean up the Brantas River?
4. How important is it to have sewage treated? Why?
5. How important is it to have clean water supply in/near every house?
6. Sewerage can be done with a large pipe that takes it all away (at great cost) or it can be done with small pipes and managed locally.
   a. Is it important enough to do the treatment locally despite the extra work for local people?
   b. Is it an opportunity for local people to be more involved in their *Kampung*?
   c. Will there be resentment at having to help manage the treatment?
   d. Is it likely to be seen as second-best technology?
7. What kind of management system would be required to establish an effective local wastewater management system?
8. Would women be involved in this process?
9. What kind of problems do you envisage? Can they be managed?
10. In your opinion, does the local community need a 'public environmental education programme' (PEEP) before they begin to operate and maintaining the project? Is it 'essential' or just 'important'?
11. What is the best way of performing PEEP to the local community in the project?
12. What kind of education system would best be performed so that the local community has a sense of belonging to the project?
13. Who should deliver PEEP to the local community on the project?
14. Who should fund this PEEP?
15. Does the local community need 'technical training' for operation & maintenance of the project?
16. Who should give the 'technical training' for the local community involved in the project?
17. Who should fund this training programme?
18. Do you agree that *PKK* will have an important role in disseminating information on domestic wastewater disposal issues?
19. What is your opinion on the efforts of the head of *RT/RW* in encouraging the local community to maintain a healthy environment especially in domestic wastewater area?
20. How should 'CEMT' perform their role in order to achieve their goal?
21. How should 'CEMT' perform their role in order to be a good partner of the local government in improving the environment?
22. How should 'CEMT' perform their role in order to be a good partner of the local community in improving our environment?

Note/Abbreviation:

PEEP : Public Environmental Education Programme
*PKK* : *Pendidikan Kesejahteraan Keluarga* – Literally means: Family Welfare Education. PKK is women's association.
*RT / RW* : *Rukun Tetangga* (harmonious neighbourhood) / *Rukun Warga* (harmonious community).
CEMT : Centre for Environmental Management and Technology. Merdeka University, Malang, East Java, Indonesia.

## The survey's respondents

The people interviewed who have had an experience in carrying out or being involved in sanitation projects previously are listed below, showing their occupation.

| | |
|---|---|
| Ministry of Public Works, Directorate General Cipta Karya | : 4 respondents |
| The Jakarta Wastewater Management Enterprise (*P.D. PAL JAYA*) | : 2 respondents |
| Jakarta City and Environmental Planning | : 2 respondents |
| National Research Council | : 1 respondent |
| Provincial Government in Surabaya | : 4 respondents |
| Regional Planning Board in Malang | : 2 respondents |
| Environmental Agency | : 2 respondents |
| Department Public Works in Malang | : 3 respondents |
| Malang Water Supply Management Enterprise | : 1 respondent |
| The Sanitation & Waste Agency of Malang | : 2 respondent |
| The Public Health Agency of Malang | : 5 respondents |
| Jasa Tirta Public Corporation | : 1 respondent |
| Head of Blimbing Borough in Malang | : 1 respondent |
| Head of Precincts in Malang | : 4 respondents |
| The Institution of Family Welfare | : 4 respondents |
| NGO's | : 6 respondents |

## The survey's results

1. Although there is very little experience in small scale sewerage technology and domestic wastewater management, the government and community representatives can see immediately that it would be important to do this project.
2. Although there are competing priorities, people can see that the project will improve health, give a greater sense of human dignity, and improve the appearance of the area.
3. Cleaning up water is fundamental to people not only for health reasons but also for cultural and religious reasons.
4. The small scale technology approach has immediate appeal to everyone as it is seen to be a part of the community and it can help build the community.
5. To manage a small scale 'village' system' such as the one proposed should involve the community and the lowest level of the local government (*Kelurahan*/Precint), *i.e.* a 'bottom-up' management approach will work best.
6. Women should centrally be involved in this process as they are the most closely affected and can influence families.
7. The key problems envisaged are mostly to do with the maintenance of the technology.
8. A 'Public Environmental Education Programme' (PEEP) is needed before the project begins and should be conducted through the community organizations (*RT/RW and PKK*) by way of regular meetings and should be run by the local government and Centre for Environmental Management and Technology (CEMT). Funding for this program should come from a combination of the government, CEMT and the community.
9. Technical training for operating and maintaining the system will be required and needs to be conducted by CEMT (with the local government's help); and funds for this should be from the government, CEMT and the community.
10. The involvement of CEMT with the government and the community provides many opportunities for developing a model project.

The survey's results are then analysed to produce an innovative 'sanitation development concept' that contains social, environmental and economic aspects of sustainable development principles which is called 'small scale community technology' (**SSCT**). Socially, the SSCT fits with the traditional Indonesian community principle of *'Gotong Royong'* and enables the local community to own and manage the technology by themselves. Environmentally, the SSCT will treat domestic wastewater more effectively and has more potential for water reuse. Economically, the SSCT will be cost-effective because, unlike large-systems, small-scale systems require proportionally smaller on-going maintenance budgets. Moreover, the SSCT will not cause major disruption to the densely populated cities. The large saving is very important for developing countries like Indonesia where funds are scarce and tend to be used to meet priority needs. SSCT is a system designed to help develop 'small-scale technology' and build 'community participation.

## The Ecomax technology – small-scale technology

AusAID/Australian Aid, through the Pollution Control Implementation (PCI) project, funded a small-scale Australian technology – Ecomax – for testing the benefits of small-scale technology in the Indonesian context. Ecomax is an innovative, high-performance sewage treatment system developed in Western Australia. A typical household system is generally positioned adjacent to the house and grassed over to blend into the garden landscape and requires about 100 square meters of leaching space. The system has the following notable features: very high phosphorus and nitrogen removal, high removal of BOD and suspended solids, disinfection without chemical addition, heavy metal removal, gravity driven process, very long life, negligible maintenance, and there is no moving parts (Bowman, 1997). The technology is able to reach the 20:30 BOD:SS requirements set by PCI. More importantly, it is small enough to fit in to a site in the community and it is not too complex for the local community to manage.

## Conclusion

The preliminary survey based on community need that has produced 'Small-scale community technology' system has shown that the delivery of sustainability is always going to involve technical and social dimensions. The fact that sustainability is not being delivered is not because of the lack of the technical innovation but the lack of social innovation.

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# Rural sanitation in Ghana

**Michael Tsiagbey**

Council for Scientific and Industrial Research
P. O. Box M.32, Accra, Ghana
e-mail: m.tsiagbey@eudoramail.com



## Introduction

Rural water and sanitation in Ghana is considered and seen as a social issue and not merely a technical or financial one. Sanitation, in general has always been an afterthought in past water and sanitation programmes in Ghana until the launch of the country's Community Water and Sanitation Programme (CWSP) in 1994 when situation reversed. Sanitation programmes in the country could be described as ambitious since they involve fundamental behavioural and attitudinal changes at the household level.

The decade of 1970-80 may be described as the lost decade for sanitation in Ghana since there was no mention of sanitation in water and sanitation programmes. In the ensuing decade of 1980-90, water and sanitation projects were considered but not seriously and this decade may be described as the decade of awareness to start recognizing sanitation in its own right within water and sanitation programmes. The national communal Ventilated Improved Pit (VIP) latrines programme implemented from 1980 to1987 on the initiatives of the Ministry of Local Government and Rural Development was unsustainable due to constraints in funding. Except for a UNDP assisted project in two regions (Volta and Central) of the country in 1984-87 and a project implemented under a Programme of Actions to Mitigate the Social Cost of Adjustment (PAMSCAD) which made the building of five (5) demonstration latrines for each hand dug well provided in a community, sanitation programmes in rural Ghana in the past was almost nonexistent. Most water and sanitation projects in the past considered and assumed that sanitation is part of hygiene education on water component.

The situation changed considerably in the early part of 1990. Local experiences and lessons from re-designed UNDP pilot water and sanitation projects in two regions (Volta and Eastern) and successful sanitation programmes from other parts of the world paved the way for what is today the rural sanitation of Ghana. In deed, the national community water and sanitation policy and strategy for sanitation promotion was formulated in 1994.

## National community water and sanitation programme

The Community Water and Sanitation Agency (CWSA) was established by an act of Parliament in December 1998 as Act 564. This Agency is mandated to be responsible for the coordination and management of the country's rural water and sanitation programme. The objectives, policies and strategies of the CWSP have been defined through a long process of dialogue between government, funding agencies, service providers and users and other stakeholder representatives.

The vision of the CWSA is the development of capacity in District Assemblies to be able to plan and facilitate water and sanitation services using the private sector and community management groups to ensure sustainability of facilities. This requires the transfer of high quality skills to District Assembly staff, community management group members, associations and private sector firms.

It is envisaged that by the creation of this capacity, it will become possible to achieve the provision of sustainable community water and household sanitation facilities in 83% of

communities and small towns by year 2008 and in all communities and small towns in the country by year 2020.

The mission of CWSA is to manage Ghana's Community Water and Sanitation Program (CWSP) for accelerated and equitable delivery of potable water and sanitation facilities as well as promote hygiene education benefits to rural communities and small towns in Ghana.

The objectives of the CWSP are summarized as:



- Provide the basic water and sanitation services to communities that will contribute towards the capital cost and pay the normal operations, maintenance and repair costs of their facilities;
- Ensure sustainability of these facilities through community ownership and management, community decision-making in their design and active involvement of women at all stages of individual projects;
- Promote efficient, cost effective and sustainable delivery of improved water supply and sanitation facilities through private sector promotion and support;
- Maximize health benefits by integrating water, sanitation and hygiene education interventions, including the establishment of hygiene education and latrine construction capabilities at village level.

The strategy of the rural water and sanitation launched in 1994, assigns to the public sector, the role of facilitation and the private sector the role of implementation. District Assemblies are the centres for the application of the strategy whilst Community Water and Sanitation Agency (CWSA) offers technical assistance and overall monitoring of the strategy. The strategy for rural water and sanitation delivery has changed from the former supply driven approach to a de mand driven approach with emphasis on sustainability.

The strategies of the programme include the following key elements:

- Demand responsive approach to delivery of facilities;
- Public sector facilitation, with CWSP as the lead government agency;
- Private sector provision of goods and services;
- Community ownership and management;
- Integration of hygiene education with the provision of water and sanitation facilities;
- Gender mainstreaming at all levels of sector activities.

*Demand responsive approach to delivery of facilities*

The national strategy stipulates that development interventions are directed at communities that actually desire to own and manage the water and sanitation facilities. Experience has shown that supply driven approach to water delivery has not ensured sustainability of the systems, which were put in place. Consequently, the demand responsive approach is being applied with the implementation of the strategy. However, the strategy also provides some degree of flexibility to enable the CWSA address or respond to emergency situations.

*Public sector facilitation*

The strategy provides for the public sector institutions to create the enabling environment for the private sector and other stakeholders to operate. The CWSA is expected also to ensure capacity building for key sector players, especially the District Assemblies by providing technical assistance and specialist support in the implementation of NCWSP. Furthermore, CWSA ensures equity and widespread coverage of safe water and improved sanitation facilities through subsidies.

*Private sector provision of goods and services*

In line with Ghana's development goal of using the private sector as the engine of growth, private sector institutions are to provide goods and services required for the effective implementation of the NCWSP. Direct and actual implementation activities are contracted to private sector or NGO organizations to carry out.

*Community ownership and management*

It has been observed that sustainability of facilities is higher where communities perceive the facilities to be their own. Hence, ownership and management of the water and sanitation facilities are key elements in the national strategy. The community ownership element of the strategy is facilitated and rationalized by requesting the communities to contribute towards the capital cost of construction of the facilities.

Integration of Hygiene Education with the Provision of Water and Sanitation Facilities

The intended health benefits from the provision of the water and sanitation facilities can only be realised through the integration of hygiene education into all rural community water and sanitation projects. The hygiene education is of importance in ensuring the acquisition of knowledge and skills in the proper use and maintenance of water and sanitation facilities. The promotion of hygiene education creates the necessary awareness and change in attitudes and behaviours at the levels of individual, household and community towards the use of water and sanitation facilities.

*Gender mainstreaming at all levels of sector activities*

The national community water and sanitation strategy advocates awareness creation of the roles of men and women with respect to the delivery of water and sanitation facilities. It is believed that such measures enhance the sustainability of the facilities, especially as women are more affected by the availability and non-availability of water and sanitation services.

**Status of implementation of community water and sanitation programme**

| Regior | Population | | | Communit es | Rural Household with Sanitatic n Facility | Sanitati on Covera e % |
|---|---|---|---|---|---|---|
| | Total | Rural | Urban | | | |
| **Ashanti** | 3,187,601 | 2,273,953 | 913,648 | 2,387 | 23230 | 8.16 |
| **B. Ahafo** | 1,824,822 | 1,665,821 | 159,001 | 2,435 | 32,870 | 15.76 |
| **Central** | 1,580,047 | 1,475,783 | 104,264 | 2,586 | 74,430 | 40.32 |
| **Eastern** | 2,108,852 | 1,440,155 | 668,697 | 3,972 | 26,500 | 14.72 |
| **G. Accra** | 2,909,643 | 393,244 | 2,516,399 | 714 | - | 0.00 |
| **Northern** | 1,854,994 | 1,602,028 | 252,966 | 3,727 | 7,000 | 3.52 |
| **U. East** | 917,251 | 870,394 | 46,875 | 2,165 | - | 0.00 |
| **U. West** | 642,223 | 575,579 | 66,644 | 1,018 | - | 0.00 |
| **Volta** | 1,612,299 | 1,302,093 | 310,206 | 2,643 | 39,040 | 24.00 |
| **Western** | 1,842,878 | 1,550,169 | 292,709 | 1,815 | 8,410 | 4.32 |
| **TOTAL** | 18,480,610 | 13,149,219 | 5,331,391 | 23,462 | 211,480 | 12.87 |

**Source**: Community Water and Sanitation Agency, Coverage data on potable water and sanitation facilities in rural communities and small towns in Ghana, December 2001. A household sanitation facility serves 8 people.

**Table 1:** Distribution and percentage coverage of household latrines provided under CWSP

The limitation of the data in Table 1 is that the sanitation component of the CWSP was implemented mainly on pilot basis and was geared towards sensitizing households to use

latrines. This accounts for the low count of sanitation facilities.

However, there exist sanitation facilities, which were provided by other agencies but the data on the coverage of sanitation facilities by these other agencies are not immediately available. Therefore, the data shown in the table represent only households served with sanitation facilities by the support of Community Water and Sanitation Agency. The water and sanitation sector assessment carried out in the African Region revealed that the overall rural sanitation coverage status for Ghana in 1999 was 64% (WHO, 2000)

At the community level, the involvement of the private sector in the provision of sanitation facilities has mainly been through project-trained latrine artisans. The community-based artisans have been trained in the construction of various types of improved sanitation facilities suitable and affordable to rural communities. The trained artisans are then relied upon to construct new sanitation facilities for consumers on demand, some with project assistance.

The use of locally trained artisans as providers of sanitation facilities has been quite successful in the promotion of sustainable sanitation (Doku, 1996). Communities have resident artisans who are well trained in the construction of various types of Ventilated Improved Pit (VIP) latrines and some are promoting latrine construction through direct marketing. Latrines are now being built in some communities without project subsidies and once this catches up, the country is bound to attain the primary goal of sustainability.

## Key-lessons

- The prevailing poverty in the rural areas and the low priority consideration of sanitation does not encourage household ownership of latrines;
- Any low-cost sanitation project that did not promote a technically, socially acceptable or generally affordable sanitation facilities, was likely to fail;
- Low cost intervention for provision of latrines is difficult to implement in unstable soils;
- User education related to cleanliness, disposal of cleansing materials and use of latrine by all members of the family including children needs to be intensified;
- The private sector lacks the entrepreneurial skills, marketing techniques and the promotional tools to be able to sell their product to potential consumers;
- Too much emphasis on the promotion of household latrines with the total neglect of communal facilities even in areas where they are more feasible.

## The way forward

Constraints such as difficult ground conditions, high groundwater table, limited availability of space due to dense settlement patterns and high poverty levels in the rural areas point to the fact that Ecological Sanitation (Ecosan) latrines will be a better option and must be promoted in Ghana. There should be adequate experimentation and pilot studies for the selection of options of Ecosan latrines for the communities in Ghana.

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