ECOSAN PROJECT EXPERIENCES IN GERMAN DEVELOPMENT COOPERATION – EXAMPLES, OBSTACLES AND OPPORTUNITIES

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1 INTRODUCTION

On behalf of the German Federal Ministry for Economic Cooperation and Development (BMZ), the GTZ started in 2001 its supra-regional research and development programme in ecological sanitation (ecosan). With this programme, the ministry was reacting to the increasing international demand for holistic wastewater management concepts based on the idea of a consequent consideration of a safe and sustainable closed-loop material flow cycle.

German development cooperation has chosen the concept of Integrated Water Resources Management (IWRM) as the reference framework for all its interventions in the field of water and sanitation. The ecosan approach represents the concrete implementation of IWRM with regard to basic sanitation supply and to the sustainable management of water and related resources such as nutrients, organics and energy contained in the human excreta and wastewater and the soil. Experience shows that the aims and purpose of the IWRM approach can be made tangible through the implementation of ecosan projects. The projects do not only result in sustainable sanitation systems, but highlight the inter-sectoral dependencies between basic health care, environmental protection, sustainable resources management, food security and income generation, all of which benefit equally from ecosan approaches.

An important discovery made during the work of the sector project has been that new sanitation concepts not only present an enormous potential for the solution of the global water and sanitation crises, but that, with their implementation, brand new markets for technologies and service providers are beginning to develop. The creation of, and demand for modern sanitation and recycling solutions is both a significant challenge and an enormous opportunity for the local public and private sector companies and small scale service providers, but also for international suppliers and export markets.

The following text addresses, from the point of view of the BMZ-GTZ ecosan programme, the impulses given within German development cooperation for using a sustainable ecosan approach in order to make the Millennium Development Goal for sanitation achievable, and what the constraints and potentials are currently seen to be.

2 KEY ACTIVITIES OF THE BMZ-GTZ ECOSAN PROGRAMME

The aim of the German ecosan programme 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 to establish these internationally as state-of-the-art techniques, in both developing and industrial nations, and at mainstreaming ecosan-approaches into German development co-operation.

As shown in Figure 1, the ecosan programme, co-operating with other German, international and local partners, has two key areas of activities, that is firstly the ecosan relevant knowledge management and networking and secondly the support of ecosan implementation projects in developing, emerging economies and transformation countries.

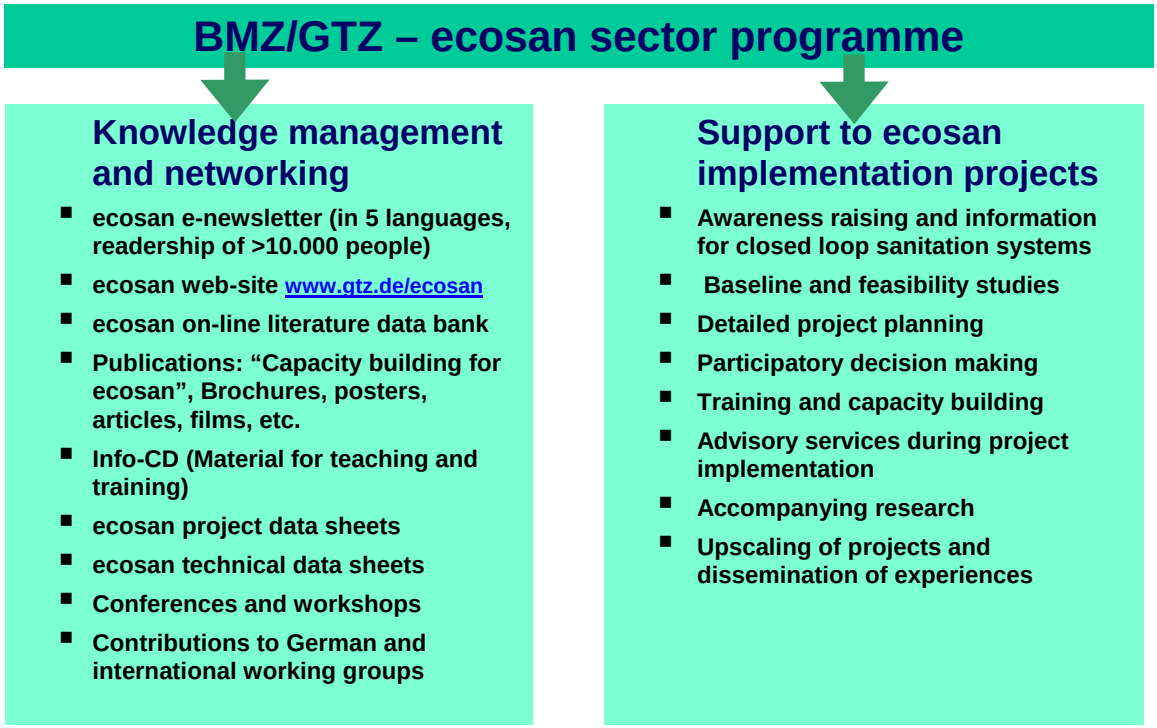

Figure 1: Knowledge management and the support of ecosan implementation projects are the two main pillars of the BMZ-GTZ ecosan programme

In the area of ecosan implementation, the BMZ-GTZ ecosan programme, works with other actors of the German development cooperation (e.g. BMZ-GTZ regional programmes, DED, KFW, CIM, BORDA and Inwent), with other bi- and multilateral donors (e.g. SIDA, DGIS, UNESCO, EuropAid) and with different networks (e.g. EU-NETSSAF, IWA, IWWA, PEN, Syrian Order of Engineers, CREPA). The aim of these ecosan pilot projects is to arrive at cost-effective, user-needs oriented, practical ecosan solutions. 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. Economic aspects are being studied regarding investment, maintenance and operation costs, business opportunities and market analyses as well as suitable marketing strategies for the recovered recyclates. Last but not least trainings for users, service enterprises and farmers, and health education measures are also part of the project implementation activities.

In this way, since its inception in 2001, the programme has supported the preparation, planning and implementation, and advising of over 100 pilot and demonstration projects in more than 40 countries worldwide. An overview of the chronological development of the increasing number of ecosan projects in implementation is given in Figure 2.

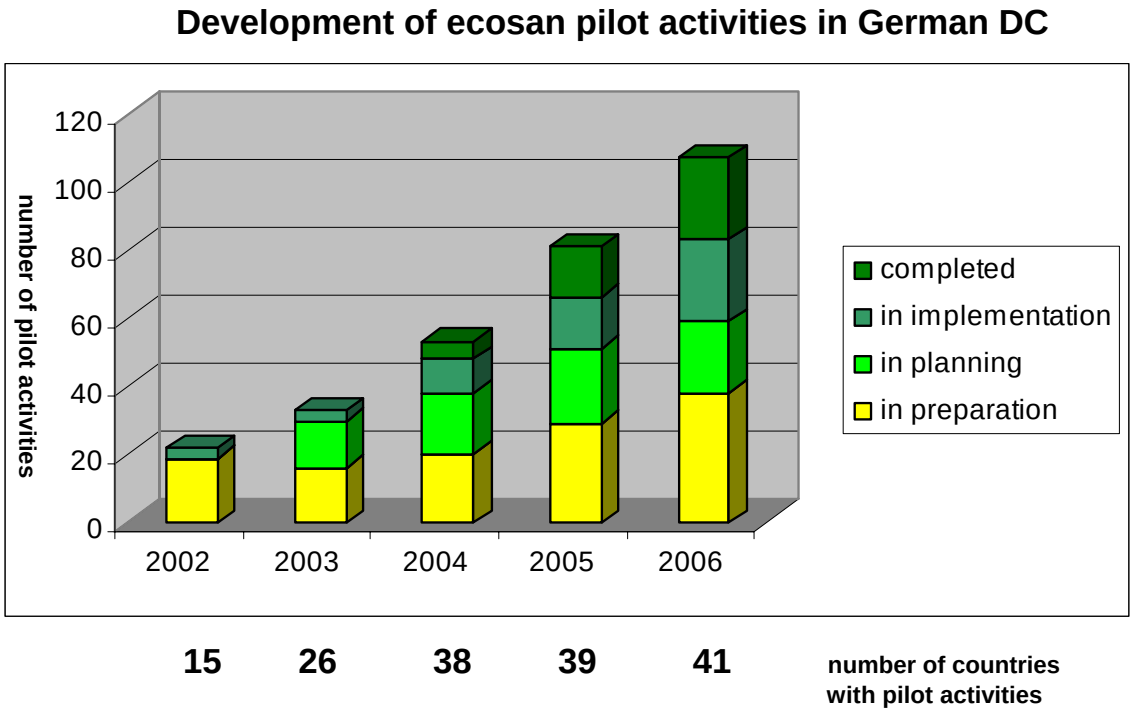

Figure 2: Overview of the development of ecosan pilot and demonstration measures in the framework of German development cooperation.

3 EXAMPLES OF PILOT- AND DEMONSTRATION PROJECTS OF THE GERMAN DEVELOPMENT CO-OPERATION

In order to achieve the aims of the ecosan approach, German development cooperation is implementing different technical and organisational models in different contexts around the world. Also the composition of the involved German development cooperation organisations (e.g. GTZ, KfW, DED) and their partners varies from project to project. The project examples presented here can therefore only give an impression of how multifaceted both the boundary conditions and the appropriate solutions in the projects are.

3.1 Constructed wetlands and wastewater reuse

The use of nutrient rich water discharged from constructed wetlands or wastewater treatment ponds has been successfully implemented in several ecosan projects in different regions around the world. In Peru, for example, within a KfW financed project, the wastewater from the city of Chiclayo (84 000 m^3/a) is lead into a treatment pond before continuing on to irrigate 2 000 ha of rice fields.

In the Philippines, a model constructed wetland is more robust and more performant than conventional models, as it uses a regional plant variety. The wetland treats the wastewater from 715 households in a poor settlement, uses the treated water from the wetland to irrigate green areas in the town and is an integral part of the ambitious environmental programme of the city of Bayawan.

In Syria, another model constructed wetland has adapted the technology to the local climatic conditions, thus requiring a significantly smaller surface of around 0.5 m²/cap, as compared to the usual 3 to 6 m²/cap used in Europe, whilst retaining very good cleaning and disinfection results (Box 1).

Box 1: Model-project for constructed wetlands in Syria

The village of Haran Al-Awamied is located south east of Damascus, Syria. The inhabitants are poor, with farming the main source of income. The use of untreated wastewater from the existing gravity sewers for irrigation was common. The specified purpose of the GTZ supported ecosan project in Haran Al-Awamied was therefore to make the use of wastewater for irrigation hygienically safe and to make best use of its fertilising effect. At the same time this project was intended as a model-project to adapt the technology to local conditions and to allow for the replication of the technology elsewhere in the country.

One result of the project was that the treatment space required per person was drastically reduced in comparison to European standards due the favourable climatic conditions in Syria. The implemented model-plant itself consists of bar screens and a sedimentation tank as a pre-treatment, two reed beds to treat the wastewater, and one reed bed for sludge humification. The treated water is collected in a tank for storage, and is pumped from the collection tank to the fields near the plant when needed, with the distribution being organised by the farmers.

Figure 3: Constructed wetland reed beds (left); sludge reed bed (middle); official inauguration of the pilot project (right). (Source: Mohamed)

The improved availability of irrigation water containing valuable nutrients reduces farmer's expenditure on commercial fertilisers. It contributes to higher yields in crop production, and increases the number of harvests from one to several per year. The reed plants of the constructed wetland are used for wicker and roof materials. The treated sludge is used as soil conditioner.

As the constructed wetland provides the residents with this range of, they provide a great deal of support to ensure its correct functioning. Other motivating factors behind the choice of the reed were its low costs, easy construction and simple operation and maintenance.

Along with supporting the technical implementation of sanitation and irrigation projects in both Syria, and Jordan, German development cooperation is promoting the development of a corresponding legal framework to ensure hygienically safe and economically sustainable operation of the systems. The project in Jordan carried out a comprehensive research of local parameters to enable an optimal fertilisation and irrigation with treated wastewater, and published a series of guidelines for the safe use of reclaimed water which can be transferred for use in other, similar contexts in other countries (Box 2). The project planning foresees an area of up to 10 000 ha of agricultural land being irrigated in the middle term with wastewater treated to the new standards.

Box 2: Model-project for the use of reclaimed water in Jordan

The GTZ supported Reclaimed Water Project aims to encourage the use of treated wastewater (reclaimed water) in the Jordan Valley on about 10 000 ha of agricultural land as a substitute for freshwater and in accordance with environmental and public health regulations.

The project area is characterised by a low annual rainfall with a mild winter allowing the off-season production of vegetables under irrigation. As irrigated agriculture consumes about 70 % of the available fresh water resources, which are also urgently needed as drinking water, the use of marginal water resources, such as brackish and reclaimed water for irrigation, is highly desirable.

In the project region, the main source of reclaimed water for irrigation is the countries largest treatment plant with the effluent being distributed through wadis, reservoirs and canals to agricultural areas. Reclaimed water, diluted with surface and rain water is then used for agricultural irrigation. Drip irrigation is most commonly practiced, in combination with a black plastic covering to reduce evaporation.

Figure 4: Demo plot (left); irrigation and mulching (middle); planting (right). (GTZ)

The Reclaimed Water Project monitors and evaluates agronomic and irrigation practices on 20 selected farm units. Analysis of local practices and comparison with international experience will lead to appropriate and practical guidelines for the use of reclaimed water.

The implementation of crop quality monitoring has so far been difficult as governmental agencies do not yet feel responsible for the sampling and analysis of crops irrigated with reclaimed water. Providing guidelines in this field will help clarify and improve the situation. In the beginning, the majority of farmers in the project were not aware of the nutrient content of the reclaimed water but now they are starting to appreciate its quality.

3.2 Reuse through urine diversion dehydrating or composting toilets

In many African countries including Benin, Botswana, Burkina Faso, Ethiopia, Mali and Namibia, but also in India and the Philippines, German development cooperation, represented by the GTZ, CIM and the DED, with various partners, is engaged in projects in rural and peri-urban areas, to disseminate the success of the urine diverting dry toilet, which has been so successfully introduced in China, with Swedish support. Currently only initial experiences of the systems in these countries have been made, although these now represent an important basis for upscaling, as is now happening for example in Kenya, Benin and Burkina Faso. These three projects are being supported by local partners, German cooperation and the EU-ACP Water Facility (Box 3), and along with upscaling the approach, will also deliver important input for both ecosan related African EU research projects, NETSAFF and ROSA. The challenges in these projects will be in part regionally determined: in West Africa for example anal washing is practiced in many areas (as it is in the Philippines and India) and the systems must therefore be adapted to this practice. A further challenge particularly in Africa is the lack of traditional knowledge of gardening, soil conservation through the use of compost or other organic fertilisers in many regions.

Box 3: ecosan in peripheral neighbourhoods of Ouagadougou, Burkina Faso

German Development Cooperation, in partnership with CREPA (Centre Régional pour l'Eau Potable et Assainissement), and ONEA, and supported by funds from the EU Water Facility, has recently started implementing an ecological sanitation project in disadvantaged neighbourhoods of Ouagadougou, the capital of Burkina Faso, West Africa. The project aims to ease the access of households in peripheral neighbourhoods to sustainable, safe, affordable and ecological sanitation systems which contribute to household food security, the protection of natural resources and the growth of small and medium businesses. To do so, the partners have adopted a three strand approach to the project. Firstly, ecological sanitation systems are being developed with the users of the systems, which respond to their needs and their context. Secondly, lobby work is being carried out at municipal and governmental level in order to create an enabling environment for ecological sanitation and to ensure its inclusion in legislation and future strategic plans for sanitation, with particular attention being paid to the multi-disciplinary approach required for ecosan. This second strand will also serve to create conditions for the third strand, which is to support and promote the involvement of the local private sector in furnishing the infrastructure and if necessary the logistic services required by the system.

Figure 5: Through a broad range of activities the EU-ACP WF project in Burkina Faso aims to reach up to 300 000 people in Ouagadougou. Aerial photograph showing the typical distribution of households in peripheral neighbourhoods (left). Opening workshop for the 3 partner organisations at CREPA Headquarters (right);

The project officially began in July 2006 and will run for a period of three years. In the current phase, preparations are being made for a multi-stakeholder launch of the project which will take place outdoors in one of the neighbourhoods concerned. Through a broad range of activities over the three years the project aims to reach up to 300 000 people in Ouagadougou, informing them of the existence and the possibilities ecosan has to offer, and providing them with safe, appropriate, affordable closed-loop sanitation. This represents one of the largest ecosan projects in an urban area currently on the African continent.

Box 4: ecosan within a natural resources management project in Botswana

In Botswana the village of Paje is affected by strong winds, extreme erosion and soil degradation, whilst the Hanahais settlements are characterised by an extremely dry climate and sandy soil. Water consumption varies between 12 to 340 l/p/d depending on the access to a piped water connection and gardening activities, but mostly waster is used for gardening purposes.

To establish ecosan and other environmentally sound practices in the villages of Paje and east and west Hananhai in Botswana, the GTZ-supported IUCN natural resources management project placed a strong emphasis on participatory approaches and focused on 'learning by seeing'. Raising community and household awareness for the ecosan concept included tangible activities, which were undertaken in all households.

Figure 6: Training workshop (left); traditional hut with ecosan toilet (middle); revised ground structure (right). (IUCN/GTZ)

From pilot trials, it was found that fertilisation with urine and compost led to a 40-50% higher production when compared to unfertilized plots.

3.3 Low-flush toilets, vermicomposting and biogas production

In India, due to the problems associated with the caste system and to protect Dalits from discrimination, "scavenging" (the manual handling of fresh excreta) is prohibited. Here, ecosan solutions are preferred to ensure that workers only come in contact with hygienically safe substances. Possible technologies include double chamber urine diverting dry toilets, worm composting toilets or biogas installations connected to low flush squatting toilet pans. As experience in Nepal has shown, the co-fermentation of human excreta with animal dung not only increases gas production, but also increases acceptance for reuse.

Based on the collected experience of the GTZ-GATE programme for biogas technology, 20 000 biogas digesters for animal dung and household wastewater are being built annually in Nepal with the support of the KfW, producing biogas and liquid fertiliser.

Vermicomposting technology has a similar sanitising and value raising effect. The technique is already recognised in North America as a standard treatment for the eradication of worm eggs and is now being tested in development cooperation projects, for example in India and the Philippines, where accompanying research is examining the efficiency of the treatment under different conditions. Vermicompost is an extremely desirable and easily marketable fertiliser in both the Philippines and in India.

In Lesotho small biogas systems have been developed with the GTZ and DED for the treatment of domestic wastewater in combination with animal dung. In Kenya however, the dissemination of large biogas digesters for the treatment of agricultural organic waste is being promoted by the GTZ. Using public-private-partnerships, several companies should be enabled to furnish the market with all its technical and counselling needs. Through the German Water Programme in Kenya and the EU-ACP Water Facility, these measures are being expanded to include an ecosan component, which should, among other things, disseminate information on the possibility to co-ferment animal dung with domestic waste.

3.4 Integrated ecosan solutions in schools, universities and cities

In different countries ecosan systems for schools and universities are being developed and tested within the framework of German development cooperation. Besides the impressive projects discussed in India and the Philippines during this conference, the GTZ is currently involved in the construction of 15 universities in Ethiopia, all of which will be fitted with ecosan systems.

Whilst the projects in India supported by the GTZ mainly employ on-site solutions with low-flush toilets combined with biogas digesters, grey water gardens or simple UDDTs, or, in the Philippines, with support from German integrated experts (CIM) vermicomposting, rainwater collection and use, and UDDTs combined with urban agricultural projects on the campus of the Xavier University in Cagayan de Oro, in the Ethiopian University Construction project, a combination of decentralised solutions for grey water from the students' halls of residence and a centralised solution for toilet and kitchen water has been developed.

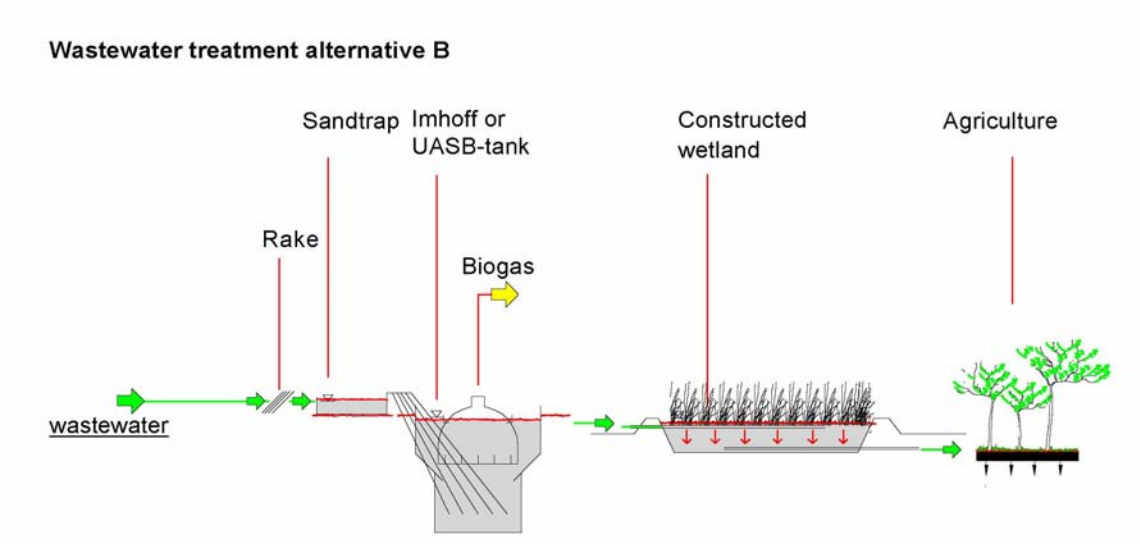

Figure 7: Different concepts are being drawn up for the wastewater management of 15 universities in Ethiopia. The figure shows a combination of a screen, sand trap, UASB biogas reactor, constructed wetland and the reuse of the treated water in agriculture

The grey water will be treated in a decorative reed bed and used to irrigate green areas on the campus. For the centralised treatment of black water and kitchen wastewater a combination of anaerobic wastewater treatment, with a UASB (Upflow Anaerobic Sludge Blanket) reactor and a constructed wetland are planned. Thai experts who worked with the German development cooperation at the start of the 90's in a Thai-German biogas project, and who have developed UASB reactors will work on the introduction of this technology. As an alternative to the constructed wetland, a final treatment using a trickling technique and a subsequent treatment pond is possible. Sufficient biogas will be generated during the anaerobic treatment to completely supply all cooking need and to operate the gas fridges in the university canteen, and an additional portion of the gas can be burnt in a generator to produce electricity. These systems also present the universities with the opportunity to engage in practice oriented research on the new technologies being used, for example with regard to the efficiency and productivity of the facilities, or regarding the optimisation of technical aspects of the installation for its use in the production of food or plant based raw materials.

Schools, universities and the buildings of research and development institutes are very suitable as a launch pad for the dissemination of ecosan approaches. This can be seen for example in the approach developed by the Xavier University with the GTZ for a city wide implementation of

ecosan in Cagayan de Oro, and in the school projects of the Innovative Ecological Sanitation Network India and numerous other examples. The pilot and demonstration projects at the GTZ Headquarters in Eschborn, the KfW Headquarters in Frankfurt, and similarly motivated projects at the Swiss Federal Institute for Environmental Science and Technology (EAWAG) in Dübendorf near Zurich, Switzerland or the UNESCO-IHE in Delft, the Netherlands also underline the special role such institutions can play in dissemination.

Again in Ethiopia, in a public-private-partnership, the GTZ is supporting the development of urine diverting dry toilets for multi-storey buildings, with the project being accompanied by the EU research project ROSA. The experience from a large number of projects has shown that combination of development cooperation and accompanying research is very useful, particularly for the development of complex urban systems.

DEWATS (Decentralised Wastewater Treatment Systems) have been made particularly well known by the Bremer Overseas and Development Agency (BORDA), who have been spreading this approach mainly in China, India and Indonesia, with financial support from the EU and the BMZ. Generally these installations consist of a combination of a biogas digesters with anaerobic baffled reactors (see Figure 8), sometimes with a constructed wetland for polishing. A joint project between GTZ, Borda and the Biogas Research and Training Centre in Chengdu was increasing the reuse options for DEWATS projects using ecosan approaches. From the project variants that were compared with one another, the best performance was achieved by separating the grey water and treating the black water for reuse in a biogas reactor.

Figure 8: 140.000 Decentralised Wastewater Treatments Systems (DEWATS) have been implemented in China together with the Ministry of Agriculture – many of them in an urban context (Source: Borda).

4 OBSTACLES AND OPPORTUNITIES

As result of a joint international effort to promote sustainable sanitation, which has seen a significant contribution from the German development cooperation, ecological sanitation has assumed an increasingly prominent position in the international discourse on sanitary provision

and is now routinely recognised as an innovative approach, which could play an important role in achieving the MDGs when scaled up (e.g. in the recently published UNSGAB - Hashimoto Action Plan, the 2006 WHO Guidelines on excreta reuse, the UNDP PEP-Paper on water and poverty reduction and in the Dakar Statement from the 2004 Global WASH Forum). Much progress has been made, but much more is still needed before ecosan is recognised as the standard approach to sanitation, and the required paradigm shift results in current conventional systems forming the minority of sanitary solutions on the practical implementation level.

In the following sections, the obstacles and opportunities for ecosan with regard to the 10 recommendations for action from the 2003 Lübeck ecosan Symposium will be discussed.

(1) Obstacles and opportunities for ecosan in rural and peri-urban areas

Despite the fact, that ecosan system are now being successfully promoted in a number of countries, several obstacles still remain in the way of it being accepted as the standard for rural and peri-urban areas. On the part of decision makers and planners there remains an information deficit, which limits the range of choices available to them. Even when information is available, it is often insufficient or outdated, leading to wrong assumptions, for example that ecological sanitation systems are more expensive than conventional systems. The lessons learnt from existing systems must therefore be better documented and disseminated. More practical knowledge on system construction, operation and maintenance and on the safe use of the products needs to be developed, and more attention needs to be given to sanitation marketing, community lead initiatives and the evaluation of sanitary system costs. If these obstacles are met, ecosan can have a great potential for large scale application as has been the case with the Chinese UD-toilets and biogas experience or in South Africa.

(2) Obstacles and opportunities for ecosan in urban areas

Urban areas with their rapidly growing populations and high population densities are in particular need of closed-loop sanitation systems, not only to protect human health, but also out of an increasing need to use efficiently the available resources (including water, nutrients, energy and organics) efficiently. There is now quite a number of small to medium-scale ecosan systems either being planned or in implementation in urban areas around the world. However, they are mostly all implemented in relatively homogenous contexts, and complex systems, covering a range of household types, income levels, cultural and geographical conditions within one urban area are still extremely rare. These complex systems are needed to develop a variety of technological, organisational and economically viable solutions for densely populated urban areas and to obtain results concerning the costs and performances of different systems in both industrialised and developing nations. Only a few private investors have shown a readiness to invest in closed loop sanitation systems for urban areas – which is an important pre-condition for these systems being widely applied and accepted as standard.

To date decentralised, split-stream, closed-loop sanitation systems have also been of little importance in the context of industrialised nations. This represents a considerable obstacle to the economy for the development and marketing of new concepts and technologies, as there is little or no incentive for innovation in sanitation on some of the leading international markets for environmental technologies, and there is therefore a resulting lack of reference projects for the successful marketing of such systems.

(3) Obstacles and opportunities for agricultural reuse

The acceptance of the agricultural reuse by farmers of the fertiliser products of ecosan systems has proven to be unproblematic, and the need to carefully manage finite resources, particularly phosphorous, has added an extra impetus to the necessity of nutrient recovery. All around the world farmers are, for the most part, open to the ecosan concept and recognise the nutrient value of urine, excreta and wastewater. In some cases however farmers have been concerned about how consumers or food trade companies would view their products if they were fertilised with treated urine and excreta, and the effect this might have on sales. One part of addressing this issue is to keep the risk of disease transmission to a minimum. This willingness to reuse received significant support with the publication of the series of the three 2006 WHO guidelines on the

safe use of wastewater in agriculture, and in aquaculture and the safe use of excreta and greywater, which will further help promote safe agricultural reuse.

Agricultural reuse has therefore seen a huge amount of progress in recent years. However there is an active ongoing debate, driven mainly by European researchers, on the potential risks of micro-pollutants such as endocrine substances and medical residues in wastewater, particularly urine, which may as a result require specific measures or treatment. Nevertheless, when compared to the risk posed by the current practice of discharging these substances into our water bodies and contaminating our drinking water resources, ecosan practices of applying treated faeces and urine to topsoil can be considered a much safer practice. In the soil the substances are exposed to a greater amount of oxygen und biological activity, and their degradation can be expected to occur much more rapidly than in water – however this remains to be confirmed by practice oriented research. Reuse options for ecosan fertilisers also need further field testing at medium and large scale and appropriate pre-treatment, distribution, marketing strategies and guidelines for the safe handling and use for different local conditions need to be developed or optimised. In many cases, existing legal frameworks also need to be reviewed to enable nutrient recovery, particularly from urine.

(4) Obstacles and opportunities for raising awareness and creating demand

Activities ranging from local pilot and demonstration projects through to UN level strategy papers have served to make ecosan widely known, resulting in a sharply increase demand. However the current shortage of trained and experienced ecosan experts is causing something a bottle neck in responding to this demand, disseminating the concept and up-scaling projects. The success of many ecosan projects still depends very much on the engagement of single institutions or individuals, and is often hindered by decision makers, authorities, construction engineers and systems operators whose ignorance of innovation and fear of possible risks scares them. Additionally they are often frightened by the work involved in new, multi-sectoral concepts that may require decentralised, participatory planning and implementation.

In order to change the course of current wastewater management practices that have been accepted as standard for over 100 years, Herculean efforts in awareness raising and capacity building will be needed for decision makers, administrators, planners, technicians, architects, farmers and the recycling branch to enable them to follow the new intra-sectoral approach.

(5) Obstacles and opportunities for stakeholder participation

Almost all ongoing ecosan projects have used a participatory approach, at least to some degree, which has lead to a great degree of interest and enthusiasm to adopt ecosan, even in areas where initially it was believed there would be a very low degree of acceptance. There is however still a need to gain further field experience on the use of household centred approaches and to develop skills for participatory processes within all relevant institutions and stakeholder groups conducting sanitation projects. The participation of the private sector as a stakeholder needs to be further encouraged in order to create a range of options and services, allowing users to select the services they desire, and gender issues need to be further highlighted, investigated and integrated into processes.

(6) Obstacles and opportunities for making decisions on an informed basis

The increasing number of pilot and demonstration projects, and the steadily developing knowledge base for ecosan have contributed to enhancing the information base on sanitation alternatives for users, planners and decision makers. However, many information deficits still exist, for example on the operation and maintenance requirements for different sanitary systems regarding the collection, the transport, treatment and end use of the excreta and reclaimed water. Economic information and analysis of different sanitation systems is also sorely needed to provide a fair and balanced comparison of the financial implications of different systems (including a consideration of all the externalities that they may incur) and provide a good base for informed decision making.

Obstacles and opportunities for education and training for ecosan

Education has a clear role to play, both in acknowledging the paradigm shift in sanitation and in incorporating the interdisciplinary theme of innovative sustainable sanitation systems into teaching curricula. The acceleration of capacity building for ecological sanitation has become one of the most critical factors for meeting the rapidly increasing demand for sustainable sanitation solutions. Education on ecosan should enable people to develop, plan and implement ecosanitation systems that are hygienically safe, socially acceptable, economically feasible, environmentally sound and technically appropriate.

Educational institutions, universities, and technical schools can contribute to the mainstreaming of the new sanitation paradigm by fully integrating the discourse and criteria for sustainability into their curricula. In response to satisfying especially the health needs of unserved, mostly poor population groups, education and research has to add resource conservation and waste reuse into the taught sanitation paradigm, in order to improve economic conditions and the health of the population served, the quality of the environment and the long term availability of natural resources.

The education system has to prepare students to think about urine and faeces and grey/black water as resources. Emphasis has to shift from the simple disposal to the hygienisation of contaminated flow streams, and to resource conservation and safe reuse. Teaching must make clear that health and a healthy environment is a prerequisite for human productivity, and productivity determines economic well being.

Many proven technical elements are available for ecological sanitation systems and the number of pilot demonstration and research projects, and of large scale applications, is continuously increasing. However, given the broad variety of local framework conditions and the large number of open questions in this complex interdisciplinary field, there is still a great need to further develop technical and operational solutions and to enlarge the knowledge base with respect to public health, risk management, economics, logistics, material-flow-streams, socio-cultural and many other aspects.

(8) Obstacles and opportunities for the adaptation of the regulatory framework

Ecological sanitation is an interdisciplinary approach, which is therefore affected by many different sector strategies, by-laws and regulations in the fields of sanitation, water management, occupational health, environmental protection, agriculture, waste reuse and others. The paradigm shift towards ecosan therefore requires a huge effort to further develop and adapt these framework conditions. Especially in many industrialised countries, thoroughly developed regulations are often lacking the required flexibility and even inhibit the granting of permission for the development and implementation of innovative solutions. Therefore in many ecosan projects a huge commitment, persuasiveness and creativity of individuals is often required to allow for alternative solutions, and additional funds and time are often needed to argue for exceptional project approvals (e.g. as research, pilot or demonstration projects).

However, as international institutions such as UNSGAB, WHO, UNESCO, UNEP, UNDP and IWA have already recognised ecosan as a promising new paradigm for sustainable and affordable sanitation, and as they have integrated recommendations for the promotion of ecosan in their strategies and guidelines, this will hopefully result in the gradually adaptation of national and local laws and regulations. Also of extreme importance is the work of several international and regional networks of professionals who have started to contribute to the knowledge development and the revision of relevant technical standards. This will gradually make the planning and implementation of ecosan a lot easier.

(9) Obstacles and opportunities for ecosan financing

Appropriate financing instruments that help to finance the user's investment for on-site and neighbourhood systems have not yet been developed. There is still a need for financial systems that recognise ecosan systems have a different cost structure from conventional sanitation systems. Innovative financing alternatives including start-up funds, community based finance programmes and cost recovery mechanisms have yet to be widely used. There is also a need to improve the mechanisms for private sector participation in ecosan systems that would open opportunities particularly for small and medium-sized enterprises and lead to job creation. Some

business having recognised the market potential, are investing in the development of innovative systems for the international market, and several private manufacturers of dry toilets based for example in South Africa, China or Sweden have also been selling their products overseas. However these tend to be the exception rather than the rule and there is a need for a market development for ecosan.

Recent calculations have shown that despite initial claims to the contrary, even a relatively expensive ecosan installation in a household can, within a relatively short period of time, cover its constructions costs through the production of agricultural inputs, reclaimed water or energy. Such preliminary investigations are very encouraging, however further studies and research into the economic side of ecosan and comparing it on an even basis with conventional end-of-pipe approaches to sanitation is still sorely needed.

(10) Obstacles and opportunities for the application of ecosan principles to international and national Action Plans and Guidelines

With the recent WHO, UNESCO, UNDP-PEP and UNSGAB guidelines and action plans, ecosan strategies have received a high level international recognition. However, for the most part, their integration in national action plans, guidelines, poverty reduction plans, etc., is still at the beginning.

5 CONCLUSION

German development cooperation is committed to advancing the ecosan approach through both direct project implementation with partners and through the international network of organisations working with ecological sanitation. The demand for ecosan is rising and the BMZ-GTZ ecosan programme is responding to this.

The range of pilot projects illustrates that there is an international interest in ecosan, from all corners of the globe, and that given the right approach it is possible to identify, develop and implement an ecosan system that corresponds to the needs and expectations of the users.

The practical experience of the project has enabled key obstacles and opportunities to be identified for the further dissemination and up-scaling.

Increase the number of pilot- and demonstration measures, assure finances for up-scaling of the successful rural and urban examples, combine pilot-measures with applied research to speed up the adaptation of systems to new contexts, and start a huge capacity building initiative, to meet the increasing demand for ecological sanitation – these are the core messages drawn from the project experiences.