

Title: **ecosan – Introduction of closed-loop approaches in wastewater management and sanitation – a new supra-regional GTZ - project**

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1. The problem with conventional wastewater management

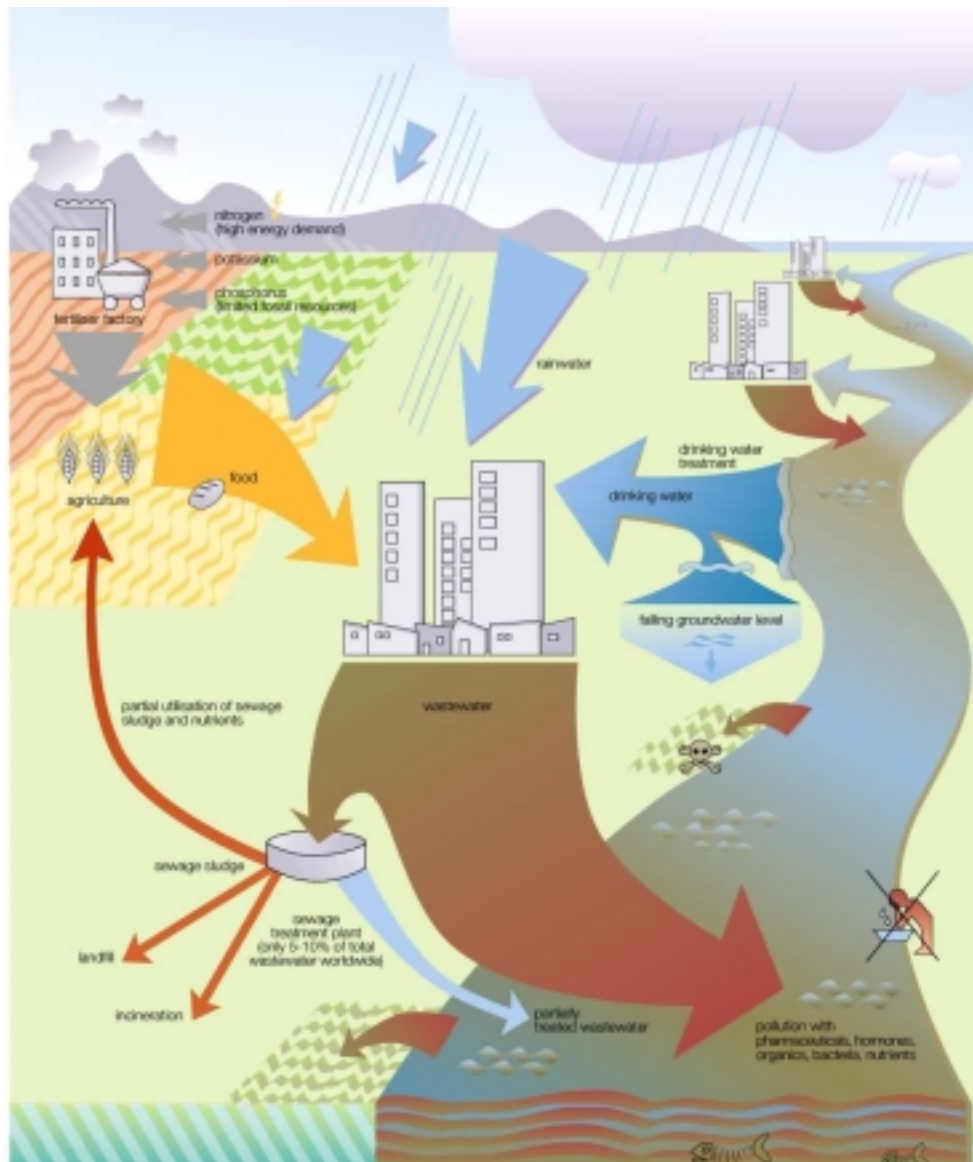


Figure 1: Drawbacks of conventional wastewater management systems

- Unsatisfactory purification or uncontrolled discharge of more than 90 % of wastewater worldwide
- Precedence of central combined systems in organized disposal
- Consumption of precious water for transport
- High investment, energy, operating and maintenance costs
- Frequent subsidization of prosperous areas, neglect of poor settlements
- Pollution of waters by nutrients, hazardous substances, pathogens, pharmaceutical residues, hormones, etc.
- Loss of nutrients and trace elements contained in excrement through discharge into waters
- Impoverishment of agricultural soils, dependence on fertilizers
- **Linear end-of-pipe technology**



Conventional forms of central wastewater management, i.e. a combined system with post-connected multistage wastewater treatment facilities, are still standard in developed industrialized nations today. Increasing criticism has, however, been levelled at these methods for ecological and economic reasons. Increasing investment costs, high operating and maintenance costs and high water consumption as a result of misusing valuable drinking water just for transport give grounds to question such methods in rich nations, let alone their widespread application in developing countries.

Particularly for arid and semiarid zones, the search for appropriate solutions has become a pressing problem. With increasing population density and the resultant groundwater pollution, conventional decentralized disposal systems such as latrines and seepage pits are not a viable alternative either. Despite great efforts by many international and local organizations to improve water management in developing countries, 2.2 million people a year die in these regions, mostly children, as a result of illnesses caused by contaminated drinking water and lack of sanitation and hygiene.

In addition to this, conventional wastewater disposal systems directly impair soil fertility as the valuable nutrients and trace elements contained in human excrement are not usually rechanneled 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. 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 commercial/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.

2. 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 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.

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 a year and that needed to produce his food (7.5 kg nitrate, phosphorous and potassium and for 250 kg grain¹). Ideally, ecosan systems enable almost complete recovery of all nutrients and trace elements in household wastewater and their reuse in agriculture - after appropriate treatment. 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, economy/small-enterprise promotion, administration, etc. in system development.

¹ (after Wolgast, 1993, Recycling System, WM Ek ologen AB, Stockholm)



Figure 2: Advantages of ecological sanitation

- **Re-utilization**
(hygienically safe extraction and use of nutrients, trace elements, water and energy)
- **Resource conservation**
(less water consumption, substitution of fertilizer, minimization of water pollution)
- Preference for modular, decentralized partial-flow systems
- Appropriate, economical solutions
- Preservation of soil fertility
- Food security
- Integral, interdisciplinary approach (household water management, resource conservation, environmental protection, town planning, (urban) agriculture, irrigation, food security, small-enterprise promotion, hygiene)
- **Material-flow cycle instead of disposal**

In practice, the ecosan strategies of the separation and separate treatment of faeces, urine and greywater for example minimizes the consumption of valuable drinking water and treats the separate wastewaters at low cost for subsequent use for soil amelioration, as fertilizer or as service or irrigation water.

Diverse technologies can be used, from simple low-tech to sophisticated high-tech systems. 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.

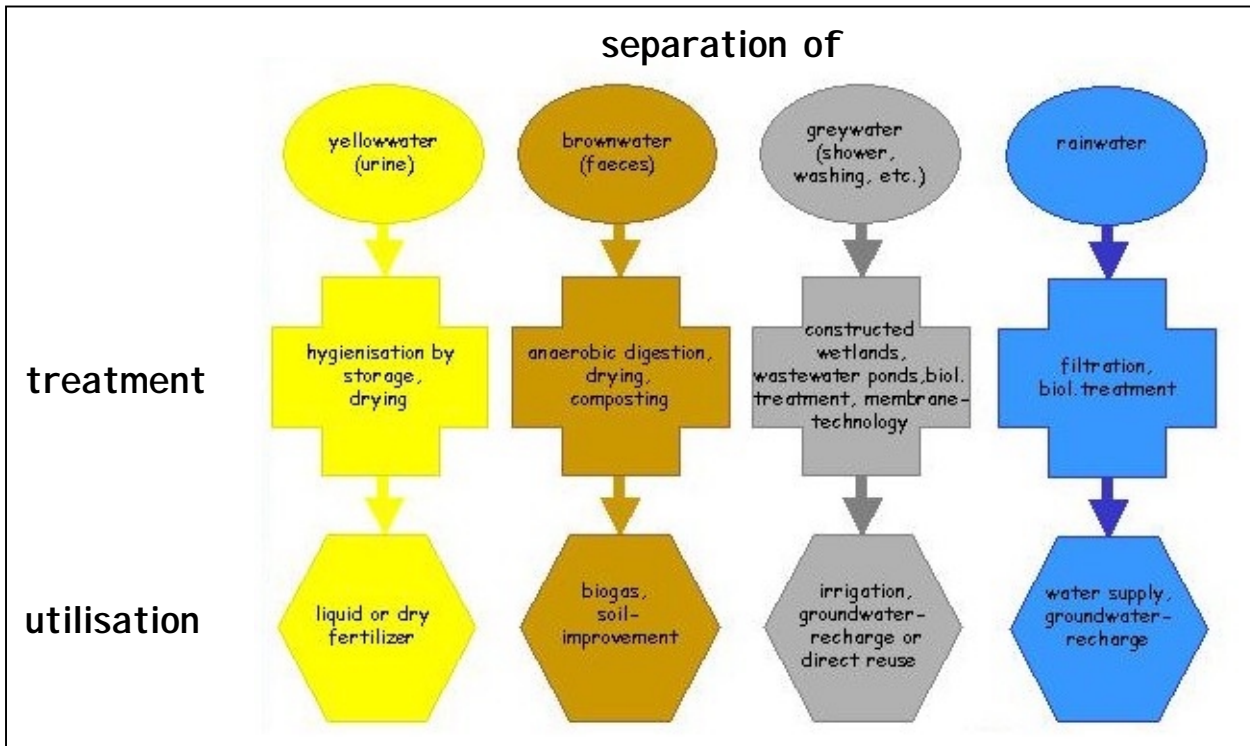


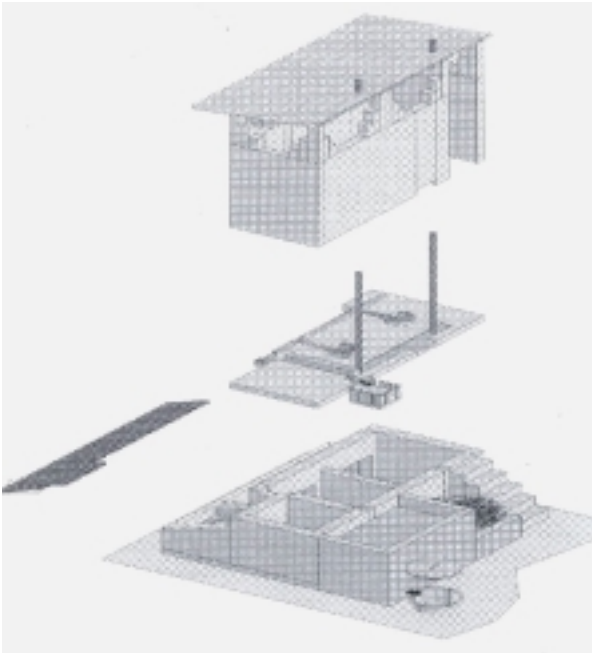
Figure 3: Examples of ecosan facility systems

Of key importance particularly here are also 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.

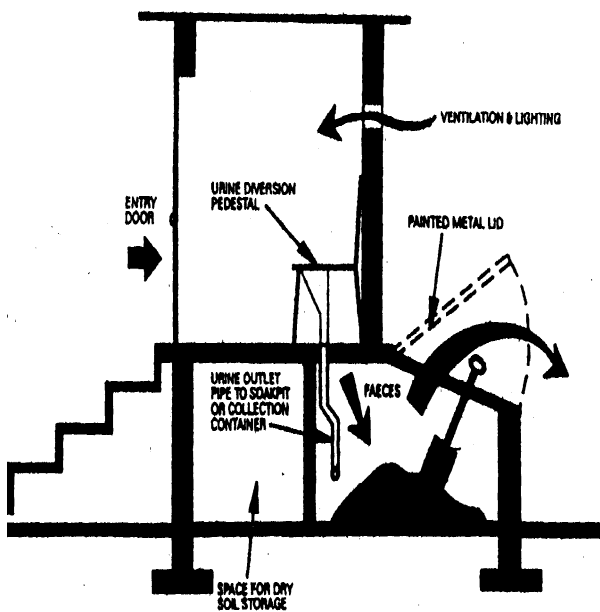
Closing local nutrient cycles by retrieving and using nitrogen, phosphorus, potassium, trace elements and organic components contained in excrement is even more important considering some of the disadvantages of fertilizers. For one thing, they are too expensive in many parts of the world or are unavailable to local farmers, and their effects on soil and food quality are in dispute. For another, 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. In this connection too 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, and a number of very experienced experts are working in this field, 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, whereas experience with urban and periurban areas is still quite inadequate. Faced with rapid urbanization worldwide there is a pressing need for solutions in conurbations.

Figure 4: Examples of elements in possible ecosan technologies:



Exploded drawing - Separating dry toilet with shower facility and greywater filtration, Preliminary project West Africa, GTZ ecosan



System sketch of a separating dry toilet based on Austin, van Vuuren, Case study, urine separation technology, 1999



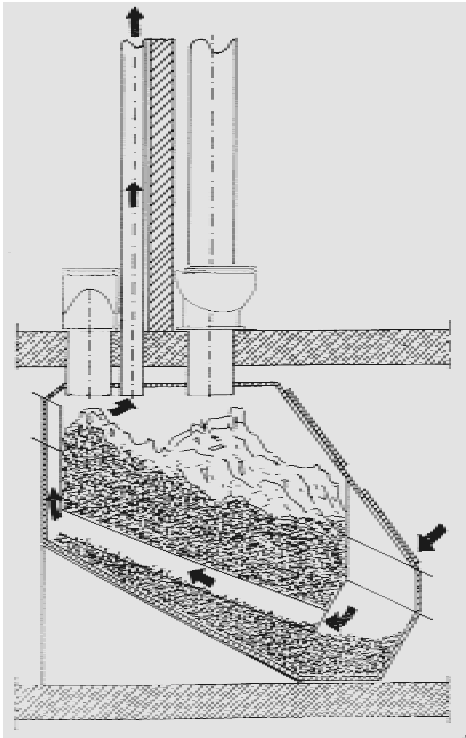
Separating dry toilet in Mexico,
(Source: S. Esrey, Unicef, New York,)



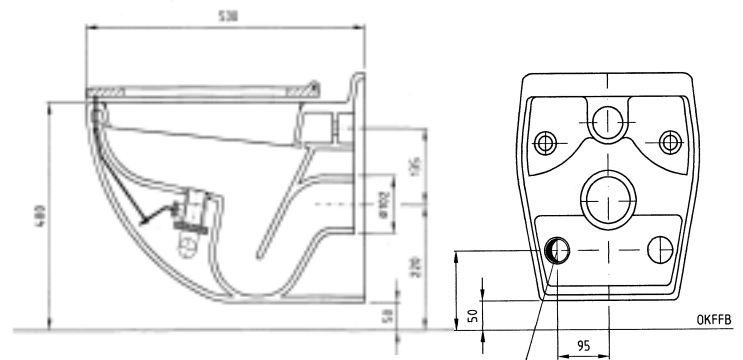
Separating squatting toilet in China,
Design Lin Jiang
(Source: U. Winblad, Schweden)



Separating dry installation in residential building in Mexico,
(Source: S. Esrey, Unicef, New York)



Compost toilet in Hamburg,
Berger Biotechnik, Hamburg, 2001



Urine-separating toilet for vacuum sewage systems
Roediger Vakuum- und Haustechnik Hanau, 2001



3. New GTZ R&D project - ecological sanitation

In May 2001, GTZ started a new supra-regional research and development project, ecosan, financed by the Federal Ministry for Economic Cooperation and Development (BMZ). This aims at promoting the development and pilot application of integral ecologically, economically and socially sustainable recycling-based wastewater and sanitation concepts in developing countries. Ultimately it is intended to contribute to the global dissemination and application of ecosan approaches and establish these internationally as state-of-the-art techniques – also in industrialized countries.



International ecosan Symposium

In preparation for the project, the international symposium entitled *ecosan - closing the loop in wastewater management and sanitation*, was held in Bonn in October 2000. Nearly 200 experts and interested parties from all over the world and diverse professional fields presented and discussed the current state of ecosan activities in practice, research and policymaking as well as future action to mainstream and propagate recycling-based wastewater management schemes.

(The symposium documentation is available as a download from <http://www.gtz.de/ecosan/pubs.html>

or can be ordered free of charge under Order Nr. H – 215 – e from
Universum Verlagsanstalt GmbH KG ; 65175 Wiesbaden, Tel: ++49 - 611 - 9030252 (Mr Herda)
Fax. ++49 - 611 - 9030556 , e-mail: horst-dieter.herda@universum.de)

The results of this symposium also provided the basis for defining the task of the GTZ ecosan project under discussion here. This includes:

Knowledge management

To succeed in redirecting present wastewater management towards ecosan strategies on a world scale there is a need for coordination and cooperation. A major task of the GTZ project therefore is to mobilize the expertise already available in cooperation with interested international and local partners. This will help put the experience gained to use, promote further development, and keep overlapping activities to a minimum. Support for ongoing international knowledge transfer focuses on publications, as well as on practical user and expert know-how regarding existing and new ecosan-related developments, experience, problems, successful projects, research findings etc.

Networking

This entails building up a global sectoral network of individuals, institutions and projects for exchanging current experience and to act as a platform for developing new ways of more sustainable recycling in urban and periurban areas. The network is open to experts, prospective users and decision-makers who are seeking information, have special questions or are preparing to take decisions. The GTZ ecosan project helps support this network with the following services:

- **e-newsletter**

Beginning June 2001, publication of a multilingual electronic ecosan newsletter (at present in German, English, Spanish and French). It provides information on interesting new developments in this field, downloading facilities for the latest publications, an events calendar, contacts and interesting links and a forum for specialist exchange distributed to several thousand readers. As the service is aimed at an interested specialist public, the future shape of the newsletter will also depend on the interaction between readers and editors.



Information and download of the latest issues from:

<http://www.gtz.de/ecosan/newsletter.html>

Registration:

When you register for subscription, please send an e-mail from the e-mail-account on which you wish to receive the newsletter with the text 'subscribe ecosan' to majordomo@mailserv.gtz.de

- **ecosan website**

Permanently updated information, links, events, publications, pilot projects, etc. on closed-loop approaches in wastewater management and sanitation

www.gtz.de/ecosan (still being developed)

- **Conferences and workshops**

Organization, design and attendance of events in cooperation with other partners

- **Ecosanet**

Foundation of a EU-financed international ecosan network with a total of over 20 organizations from European and non-European partner countries. It facilitates joint knowledge and information management on ecosan, the joint preparation of analyses, studies and evaluations of ongoing projects, the cooperative drafting of recommendations and guidelines as well as to support dissemination strategies and improve market opportunities for new eco-sanitation systems.

- **International working groups**

Initiation and coordination of expert working groups to prepare basic material and develop model ecosan strategies

Pilot projects

The second major pillar of the GTZ ecosan project is the joint development and implementation of – largely urban - pilot projects with other international and local partners in developing countries. 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, of course 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 that contain nutrients rather than waste loads or pollutants. (Hazardous substances such as heavy metals or toxic organic compounds are of course still undesirable and must be kept out of the water and the nutrient cycle.)

In addition to addressing technological issues in wastewater disposal, the development work still needed to underpin new integral wastewater and sanitation strategies tailored to various framework conditions by way of pilot projects includes 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 just as necessary to make economic comparisons with conventional systems as to develop training modules for users, service enterprises and farmers as well as measures in health and hygiene education.

Various pilot projects have been and are being initiated and monitored together with different partners in the ecosan project. At present, various project designs are being prepared for the new research programme on decentralized water management systems financed by the German Federal Ministry of Research (BMBF) aimed at enabling the transfer of developments to various settings.

<p style="text-align: center;">Senegal</p> <p>Sustainable wastewater management and sanitation as part of the rehabilitation of periurban areas of Dakar</p> <ul style="list-style-type: none"> • Small scale, sustainable water supply and sanitation systems for Dakar suburbs • Separate collection and treatment of urine, faeces and greywater • Rainwater collection and use • Agricultural or horticultural use of greywater, sludges and urine • Marketing of the products through small scale enterprises 	<p style="text-align: center;">Algeria</p> <p>Implementing ecosan strategies as part of rehabilitating panel constructions</p> <ul style="list-style-type: none"> • Decentralised treatment of faeces, urine and greywater of multi-storey buildings in suburbs • Rainwater collection and use • Greywater reuse for upgrading the local environment through creation and irrigation of gardens and parks • Constructed wetlands, membrane filtration, treatment of faeces and organic waste in biogas plants • Development of marketing strategies and logistic plans for agricultural use of sludges and urine
<p style="text-align: center;">Brazil</p> <p>Sustainable wastewater management at the University of Blumenau</p> <ul style="list-style-type: none"> • Local, sustainable water supply and sanitation for university buildings • Separate urine, faeces and greywater treatment • Rainwater collection and use • Treatment of organic waste and faeces in biogas plants • Agricultural use of greywater, sludges and urine 	<p style="text-align: center;">China</p> <p>Urban, closed-loop-type wastewater management in Changsha</p> <ul style="list-style-type: none"> • Local, sustainable wastewater management in new urban areas • Separate collection and treatment of urine, faeces and greywater • Vacuum sewer systems for water saving • Rainwater collection and usage • Treatment of organic wastes and faeces in biogas plants • Membrane filtration • Agricultural use of greywater, sludges and urine
<p style="text-align: center;">Ghana</p> <p>Ecological development of the Valley View University campus</p> <ul style="list-style-type: none"> • Sustainable small scale solutions for waste and wastewater management as part of an overall programme for an ecological development of the VVU • Separate collection and treatment of urine, faeces and greywater • Rainwater collection and use • Treatment of organic wastes and faeces in biogas plants • Agricultural use of greywater, sludges and urine on the campus and the neighbouring village 	<p style="text-align: center;">Cuba</p> <p>Practical comparison of decentralized strategies for municipal wastewater and waste disposal using the end products in four provinces in Cuba</p> <ul style="list-style-type: none"> • Rationalization, demonstration and scientific comparison of different types of facility • Preparation of a dissemination plan • Application of different anaerobic sanitary and household waste treatment facilities prefabricated in Cuba • Implementation and comparison of different water-saving or waterless toilet systems • Implementation and comparison of different gas utilization facilities in households • Study on treated wastewater and the recovered fertilizer for germ contamination and identification of a suitable post-treatment for hygienization and possible use in periurban agriculture, for example



<p style="text-align: center;">Indonesia</p> <p style="text-align: center;">Decentralized public sanitary facility in densely populated poor urban areas in Tangerang</p> <ul style="list-style-type: none"> • Development and implementation of decentralized, sustainable water management strategies as part an ongoing sanitation programme for building public sanitary facilities in densely populated poor areas • Various schemes for decentralized wastewater or separate urine, faeces and greywater collection and treatment • Treatment of faeces and organic waste in biogas facilities for power generation • Agricultural use of greywater, sludge and urine 	<p style="text-align: center;">Mali</p> <p style="text-align: center;">Ecosan feasibility study for on-plot-systems for separate treatment of urine, faeces and greywater and implementation of a pilot installation</p>
	<p style="text-align: center;">Egypt</p> <p style="text-align: center;">Large-scale test on sewage sludge decomposition</p>
	<p style="text-align: center;">Botswana</p> <p style="text-align: center;">Integration of ecosan systems into a program for community- based natural resource management</p>

Figure 6: Examples of ongoing or planned ecosan pilot measures by GTZ

The requisite interdisciplinary cooperation of all actors described above, which is unfortunately still not a matter of course, can be tried out and consolidated on a pilot scale. When developing material-flow sanitation techniques - whose main aims are the prevention of water pollution, the destruction of pathogens and the recovery of important nutrients – it is possible to integrate not only sanitation technology developments, but also urban-development, agricultural and irrigation, sociological, health-promotion, and economic and employment-promotion aspects into planning and implementation geared to local conditions. The implementation of a whole array of international demonstration projects in various economic/geographical, sociocultural, urban development and climatic regions, as well as the testing and optimization of selected conceptual designs through mutual information exchange and comparison affords a unique opportunity to arrive at sound transferable solutions for broad application, which are essential for a sustainable future.

Contact

If you wish to cooperate with the GTZ ecosan project or require information, etc. you are also welcome to contact us at:

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