FINAL REPORT
SanRes 1992-2001

25 May 2002
Uno Winblad

CONTENTS

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ACRONYMS, ABBREVIATIONS & GLOSSARY

Cemat	Centro Mesoamericano de Estudios Sobre Tecnologia Apropriada, Guat
ECATU	Eastern Cape Appropriate Technology Unit, Umtata, South Africa
Ecosan	sanitation approaches based on recycling human excreta
EcoSanRes	Phase 2 of the Sida-funded SanRes programme
faecophilic	persons/cultures with no taboos against handling and talking about human faeces
faecophobic	persons/cultures with strong taboos against handling and talking about human faeces
flushsan	sanitation approaches based on flushing away human excreta
pitsan	sanitation approaches based on storing human excreta in deep pits
R&D	research & development
RMB	Chinese currency unit (RMB 1 = USD 8.2)
SanRes	Phase 1 of the Sida-funded sanitation research programme 1992-2001
SEI	Stockholm Environment Institute, i/c the EcoSanRes programme
SEK	Swedish currency unit (SEK 1 = USD 0.1)
Sida	Swedish International Development Cooperation Agency, Stockholm
SMI	Swedish Institute for Infectious Disease Control, Stockholm
TATU	Transkei Appropriate Technology Unit, Umtata, South Africa
USD	US dollar VIP toilet Ventilated Improved Pit toilet
washer	a person who uses water for anal cleaning
wiper	a person who uses paper or some solid material for anal cleaning
WKAB	Winblad Konsult AB, Stockholm, i/c the SanRes programme
WSSCC	Water Supply & Sanitation Collaborative Council

1. INTRODUCTION

This is the final report of the SanRes programme, a Sida-funded international research and development undertaking. The purpose of the report is to document nine years of empirical research, discuss the results and formulate conclusions and lessons learned.

For administrative and fiscal reasons, the SanRes programme has a beginning and an end. It is, however, based on earlier work by a number of people around the world. The task of developing and promoting ecological sanitation will continue through the Sida-funded EcoSanRes programme, aswell as many other local, national and international activities.

In this report the word sanitation refers to systems for the management of human excreta. The approach to sanitation explored in the SanRes programme is called ecological sanitation (ecosan for short). It is based on three fundamental precepts: preventing pollution rather than attempting to control it afterwards, rendering human excreta safe, and recycling the safe products for agricultural purposes.

Documents illustrating the development of the SanRes programme have been deposited in the Library of the Stockholm Environment Institute in boxes marked “SanRes Final Report - Document File”. A list of these documents is attached (Annex 1).

1.1 Background

In the early 1990s it was clear that development in sanitation had reached an impasse. The number of households in the world without access to safe and adequate sanitation was growing (UN 1990), and the sanitation approaches advocated by development aid agencies were neither sustainable nor replicable (Winblad 1974, pp 296-303). Only a minority of people in the third world had what was considered an acceptable toilet. The available options (pit toilet, VIP toilet, pour-flush toilet or WC connected to septic tank or sewers) each had their own problems. In many areas none of them could be used due to high water table, seasonal flooding, unpickable soil, lack of space, lack of water for flushing or, for the more expensive solutions, lack of money. From an environmental point of view, none of the available options was sustainable.

In an attempt to break the impasse, Sida’s Infrastructure division in 1991 asked Uno Winblad, an urban planner and international consultant in the field of environment and health, to draft a proposal on what Sida could do. Sida approved his proposal for a 3-year project with a budget of SEK 2.5 million in August 1992 (WKAB 1992). This is the origin of what was to become the SanRes Programme 1993-2001. Winblad Konsult AB, WKAB, has managed the programme. (From 2002 and onwards a much larger Sida-funded programme will take over. The new programme is called EcoSanRes and is managed by the Stockholm Environment Institute, SEI.)

Sida’s reason for selecting Uno Winblad for this task was presumably that for many years he had been a persistent critic of conventional approaches to sanitation. The ideas developed and tested in the SanRes programme were originally put forward in his competition entry awarded 1st prize in the Nordic idea competition “Housing in Developing Countries” in 1970 (Scandinavian Consulting Group 1970), see fig 1 and 2 overleaf.

Fig 1 and 2

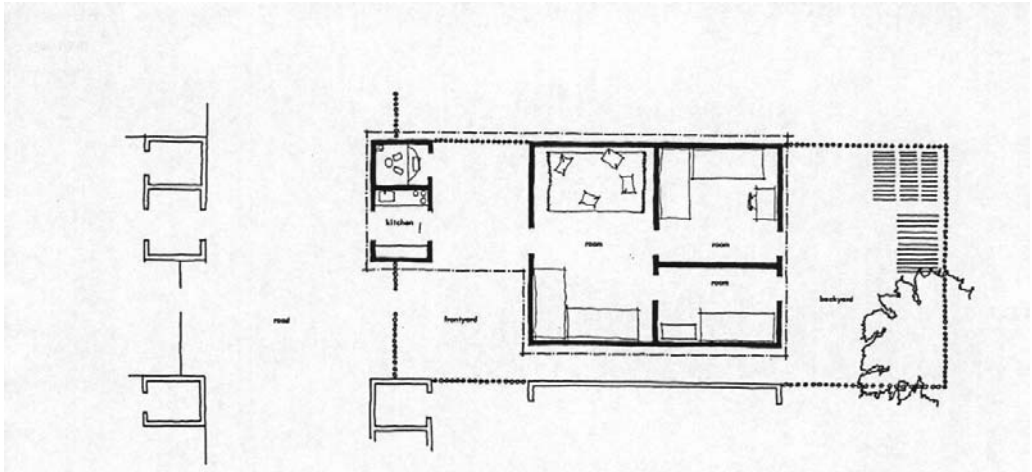
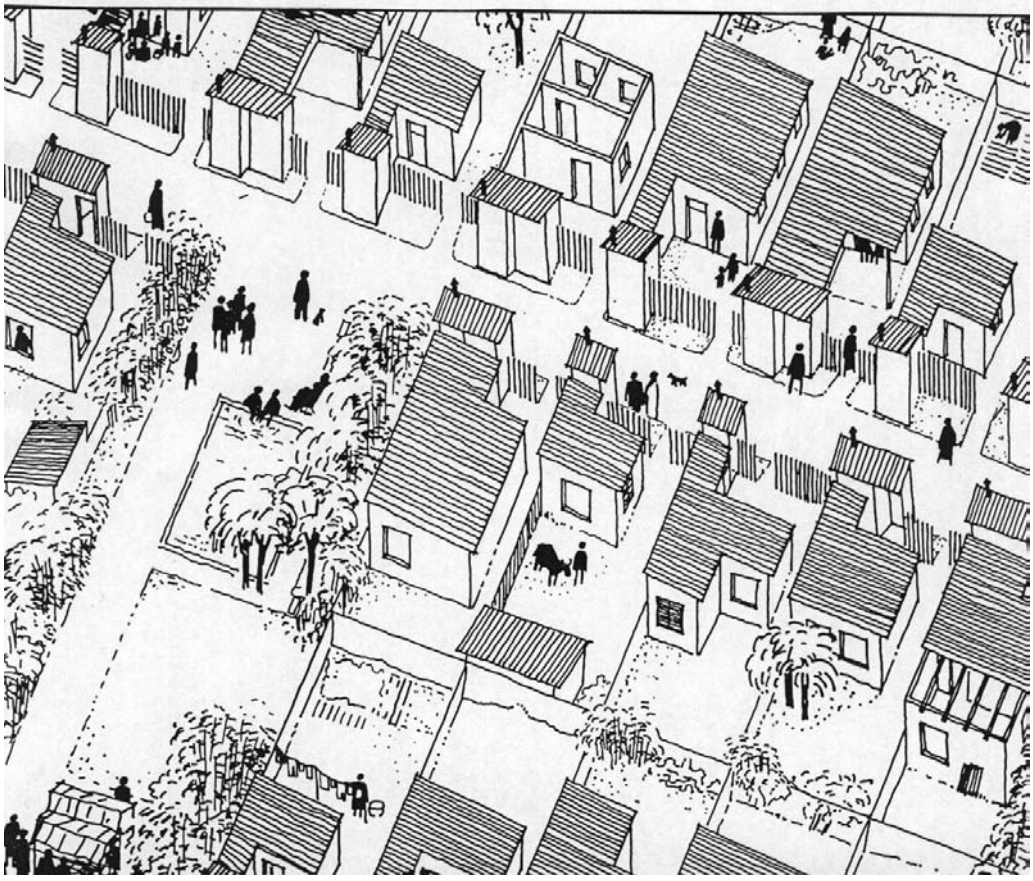


Fig 1 and 2: Plan and bird's eye view illustrating the proposal awarded the 1st prize in the Nordic idea competition "Housing in Developing Countries"



1.2 Aims and issues

- The specific **aims** of the the original project (1993-1995) as well as the total programme (1993-2001) were:

- To promote the development of affordable and replicable sanitation systems for the poorest quarter of urban and rural households in the third world.

- To establish, in selected countries, a local capacity for research and development on sanitation for low-income groups.

- To facilitate South-South collaboration in the field of applied sanitation research.

- The SanRes programme was to address the following **issues**:

- The lack of affordable, replicable sanitation alternatives for a majority of rural and urban households in the third world.

- Toilet construction under difficult conditions (high groundwater table, difficult soil conditions, limited availability of building materials and extreme poverty).

- On-site sanitation at high population density.

- Protection of the environment against pollution, particularly the protection of groundwater and other water resources.

- Prevention of vector breeding.

- The use of human excreta as a resource.

- Mobilization of community participation for large-scale implementation.

- Health education focusing on women and school children.

1.3 Method and approach

SanRes is a programme of empirical research. It was conceived as a means to initiate and encourage efforts to solve a number of issues related to sanitation without water. The hypothesis behind the programme is that safe, environment-friendly and cost-effective solutions can be found if we follow the simple precept “Don’t mix!”:

- By keeping urine and faeces apart, problems of odours and fly-breeding are reduced or even eliminated, and storage, transport and sanitization are made easier. The dry output from the toilet can be transported to a neighbourhood composting station or an eco-station (Simpson-Hébert 2002) for secondary and tertiary treatment.

- By not mixing human excreta and flushing water, the sanitation problem is limited to managing a comparatively small volume of urine and faeces. As a result, water is saved, the environment preserved and investments in infrastructure reduced.

- By not mixing greywater and blackwater relatively simple on-site treatment methods can be used for the greywater.

- Implicit in this precept is that industrial wastewater is taken care of at source, by the industry generating it.

In theory this hypothesis makes a lot of sense. But does it work in practice? On a large scale? Under a variety of natural and cultural conditions? - To test this hypothesis in vivo the SanRes programme had to develop toilets that could be used in modern, multi-storey housing.

A secretariat located at WKAB in Stockholm has been responsible for coordination, links with Sida and appraisals. The R&D activities have primarily been the responsibility of the national/local parties involved, with backstopping from the secretariat and members of an informal, international network of ecosan professionals.

The sequence of events has normally been: selection of country, introductory seminar, selection of cooperating institution, establishment of pilot project, networking, training courses, initiation of special studies, appraisal, and dissemination.

Countries for SanRes activities were selected using the following **criteria:**

- an obvious need for a radically new approach to sanitation;
- existing ecosan projects or an expressed interest in trying new methods;
- a variety of natural, cultural and economic conditions;
- feasibility of implementation (political stability, existing contacts)

In each country a counterpart institution was appointed after consultation with the participants of the introductory seminar.

Networking, training, special studies, and dissemination have been centered on the pilot projects. Professionals from the region, without any previous involvement in the projects, have carried out the final appraisals.

In its dissemination of findings, SanRes has used a variety of media: printed publications in several languages, newspaper articles, lectures, exhibitions, demonstrations, radio and TV programmes and the internet.

2. ACTIVITIES

2.1 Pilot projects

The core activity of SanRes is empirical research in the form of pilot projects. The purpose of the projects is to develop and test ecosan designs for individual households, to provide a setting for training and special studies and to provide a focus for dissemination.

In selecting venues for SanRes activities three parts of the world were of particular interest:

- **China**, where recycling of human excreta for agricultural production has been practised for centuries.
- **Vietnam**, where the double-vault, urine-diverting toilet was developed already in the 1950s and was still used by hundreds of thousands of rural households.

- **Central America** and **Mexico** where a number of individuals and NGOs had been working on dehydrating and composting toilets since the early 80s, including in urban and peri-urban areas.

Altogether six pilot projects have been completed, each including 21-90 households: three projects in China, one in Vietnam, one in Mexico and one in El Salvador. SanRes has also funded two small training/demonstration projects in South Africa and Bolivia, each for 10 households.

Projects with direct SanRes involvement:

- The **Barrón** area, a peri-urban settlement in the Municipality of Nicolás Romero on the outskirts of Mexico City. Project covering 24 households. Funded by SanRes and implemented by Grupo de Tecnologia Alternativa S.C 1994. Results presented at the SanRes workshop in Mexico City, November 1994.

- **Tecpán**, a semi-rural community of 200 households in La Libertad Department, 40 km west of San Salvador, the capital city of El Salvador. Project covering 36 households. Initiated by SanRes, funded by Unicef, implemented by Ministry of Health 1994-97. Appraisal report by Jorge Vargas in June 2000.

- **Cam Duc** Commune - a semi-rural community of 1,800 households in Cam Ranh District, 30 km south of Nha Trang in Khanh Hoa Province, Vietnam. Project covering 62 households. Initiated and funded by SanRes, implemented by the Nha Trang Pasteur Institute 1997-98. Appraisal report by Paul Calvert and Pham Si Nghien in October 2000.

- **Wangqing** County, Jilin Province, northeastern China. Project covering 90 households in two Korean minority villages (Dongxing and Antian). Initiated and funded by SanRes in cooperation with Unicef, implemented by the Institute of Environmental Health and Engineering in Beijing on behalf of NPHCCO (Ministry of Health) 1997-98. Project report by Wang Junqi in June 2000. Appraisal report by Wang Rusong and Tang Hongshou in February 2002.

- **Qingxu** County in Shanxi Province, central China. Project covering 21 households in a new residential area in Wu village, 6 km from from the county town. Initiated and funded by SanRes in cooperation with Unicef, implemented by the Institute of Environmental Health and Engineering in Beijing on behalf of NPHCCO (Ministry of Health) 1997-98. Project report by Wang Junqi in June 2000. Appraisal report by Wang Rusong and Tang Hongshou in February 2002.

- **Tianyang** County, Guangxi Province, southern China. Project covering 90 households and a school/public toilet in Dalu village, Wucun Town, 190 km from the provincial capital of Nanning. Initiated and funded by SanRes in cooperation with Unicef, implemented by the Health Bureau in Guangxi on behalf of NPHCCO (Ministry of Health) 1999-2000. Project report by Wang Junqi in June 2000. Appraisal report by Wang Rusong and Tang Hongshou in February 2002.

- **Payne Farm**, a village near Umtata, Eastern Cape (formerly Transkei), South Africa. Project covering 10 households. Funded by SanRes as a training/demonstration project, implemented by Transkei Appropriate Technology Unit, TATU, in 1995. Project report presented at the SanRes

  Workshop in San Salvador 1996. Project taken over and continued in two other villages, 30 households added, by CSIR/ECATU in 1997.

- **Arco Iris**, a peri-urban community of 200 households in El Alto close to the capital city of La Paz in Bolivia. Project covering 9 households initiated and funded by SanRes as a training/ demonstration project, implemented by a group of local women 1997-99 with the assistance of a local SanRes consultant. Project used for demonstrations during the World Bank-Unicef-SanRes training course in La Paz in April 1999. Project report by Petra Forsström de Léon 1999.

In addition to these wholly or partly Sida-funded projects, the SanRes programme has generated locally financed follow up projects in China, Vietnam, South Africa, El Salvador, Mexico and Bolivia. These follow up projects are much larger than the original pilot projects: In Guangxi province (China) consisting of more than 25,000 units (Black 2001, p 27), in Jilin province (China) about 1,000 (Wang 2001, p 31), in Vietnam about 1,500 (Duong 2002a, p 4, and Duong 2002b), in South Africa more than 2,000 (Austin 2002) and in Bolivia 3,000 (Johansson 2002). These projects are directly related to SanRes activities. In a number of other cases the relation may be less direct but is clearly discernible: Peter Morgan's work in Zimbabwe (Morgan 2001), WaterAid's projects in Mozambique (Breslin 2001), the SWTWS projects in Uganda (Nalubega 2001) and CETAL projects in Chile (Gallardo 2000).

For project-related documents see Annex 1.

2.2 Special studies

SanRes has commissioned a number of special studies of particular constituents of ecosan systems. As ecosan systems are complex, we have concentrated on a few of components covering such diverse areas as design, microbiology, dissemination methods and legal aspects.

Studies funded by SanRes:

- **Design and production** of urine-diverting seat-risers with particular reference to female anatomy (1993-94). Consultant: Josefina Mena, Grupo de Tecnologia Alternativa S.C., Mexico. Results presented at the SanRes workshop in Mexico City, November 1994.

- **Design and production** of urine-diverting squatting pans and a potty with urine diversion (1997). Consultants: Hans Mårtensson, Kalmar, and Karl Rydberg, Stockholm. The squatting pans tested in the pilot project in Vietnam 1998.

- **Economic implications** of ecosan versus conventional sanitation in urban areas - a theoretical model (1994-95). Consultant: Jorge Vargas, Costa Rica. Preliminary results presented and discussed at the SanRes workshops in Mexico City, November 1994, and in Kalmar, Sweden, May 1996.

- **Community sanitation** - investigating methods of ecosan promotion in 5 regions in Mexico (1998-2001). Consultant: George Anna Clark, Espacio de Salud AC, Mexico. Final report in August 2001. Appraisal report by Ron Sawyer in September 2001.

- **Environmental Regulation Study** - a comparative evaluation of ecological sanitation and sewerage in the metropolitan area of Cuernavaca, Mexico (1998-1999). Consultants: Cesar Añorve and Ron Sawyer. A "Summary Report" and various documents submitted in December 1999.

- **Microbiological testing** of ecosan toilets Cam Duc Commune, Vietnam, 1998-99. Consultants: SMI and Nha Trang Pasteur Institute. MFS Report in December 1999. Report presented at the Nanning conference November 2001.

- **Microbiological testing** of ecosan toilets in Yongning County, China, 2001. Consultants: Lin Jiang and Li Lingling, Nanning, China. Draft report April 2002.

For documentation of special studies see Annex 1.

2.3 Capacity building

Capacity building is the second major activity. SanRes has conducted or participated in a large number of lectures, seminars and training courses linked to the pilot projects. Many of those have been local events and are not included in the list below. The list includes capacity building activities with international participation.

Major capacity building activities:

- "National Seminar on Low-cost Sanitation", **Addis Ababa**, Ethiopia: A 1-day seminar (15 participants) 8 January 1993 resulting in the establishment of a national network for ecological sanitation. Six of the Ethiopian participants invited to participate in the SanRes Workshop
- on Dry latrines for Rural Areas, San Salvador, November 1993.

- "Dry Latrines for Urban Areas", SanRes workshop in **San Salvador** (24 participants), November 1993.

- "Dry Latrines for Urban Areas", Sanres workshop in **Mexico City** (21 participants), November 1994.

- "SanRes Working Group on Design Innovations", **San Salvador** (4 participants), January 1995. Findings reported at the workshop in San Salvador in January 1996.

- "Rethinking Sanitation", SanRes workshop in **San Salvador** (20 participants), January 1996.

- Drafting the book "Ecological Sanitation", SanRes workshop in **Kalmar,** Sweden (9 participants), March 1996.

- "Ecological Alternatives in Sanitation", SanRes international workshop in Balingsholm, **Stockholm** (48 participants), August 1997.

- Production of prefabricated seat-risers in **San Salvador**. Training course conducted by Cesar Añorve from Mexico. (20 participants), November 1997.

- Drafting the book "Ecological Sanitation", SanRes workshop in **New York** (8 participants), January 1998.

- Testing ecosan toilets for pathogen survival. SanRes training course in **Nha Trang**, Vietnam, (15 participants from Vietnam, China and Sweden), April-May 1998.

- Ecosan exhibition - panels, models, prototypes. Displayed at **Stockholm** Water Symposium in August 1998 and at the China-Sweden Week exhibition in **Shanghai** (with Chinese texts) in March 1999. A mini-version of the original exhibition shown at the WSSCC conference in **Abidjan**, Ivory Coast, in November 1998, the WHO conference in **Bad Elster**, Germany, November 1998, the National Seminar on Ecological Sanitation in **Nha Trang**, December 1998, and the 2nd Global Forum in **The Hague** in March 2000.

- Ecosan training course and seminar, **La Paz**, Bolivia (24 and 18 participants), April 1999 (in cooperation with the World Bank).

- Ecosan seminar, **Jinja**, Uganda (24 participants), May 1999 (in cooperation with AustrianAid).

- "Ecological Sanitation Notes" - the SanRes **website** (www.wkab.se) June 1999-May 2002. (During 2001 an average of 260 visits per month.)

- SanRes seminar on ecological sanitation, Stockholm (20 participants),August 1999.

- Ecosan training course, **Butuan City**, Philippines (32 participants), January-February 2000 (in cooperation with UNDP and the Philippine Center for Water and Sanitation).

- Ecosan training course, **Kabale**, Uganda (24 participants), March 2000 (in cooperation with AustrianAid).

- "Ecological Sanitation in a Recycling Society". Sida/UNDP seminar in connection with **Stockholm** Water, August 2000.

- National workshop on ecological sanitation, **Nha Trang**, Vietnam (40 participants), January 2001.

- Seminar on sanitation, (an event related to the publication of the Japanese edition of the book "Ecological Sanitation"), Tokyo (79 participants), January 2001. (Organized by the Japan Toilet
- Association.)

- "Promotion of Ecological Sanitation", workshops in **Mukono** and **Masaka**, Uganda (46+51 participants), July 2001.

- "First International Conference on Ecological Sanitation", **Nanning**, China (320 participants from 27 countries), November 2001.

- **Internet** Discussion following the Nanning conference, (259 participants from 43 countries), November-December 2001.

For documentation of courses, conferences and exhibitions see Annex 1.

3. DISCUSSION

This chapter is an attempt to analyse and discuss the big questions in ecological sanitation: -Does it work? - Is it safe? - Do people, men as well as women, want it? - How do we implement ecological sanitation? - How much does it cost?

Other aspects of the SanRes programme are discussed under the subheadings - Network and promotion, and - What remains to be done?

3.1 Does ecological sanitation work?

Do the projects and studies carried out by the SanRes programme confirm our hypothesis?

The projects listed under 2.1 above clearly show that ecological sanitation can work under a variety of climatic conditions: in warm, humid climate (Guangxi and Cam Duc), in temperate, extremely dry climate (Bolivia) and in areas with extremely cold winters (Jilin). It works not only where the users are 'wipers' (China, Vietnam), but also, where they are 'washers' (Kerala). Not only in faecophilic cultures (China, Vietnam) but also in faecophobic (Mozambique, Zimbabwe).

In Guangxi thousands of families have installed urine diverting, ventilated, double-vault toilets inside their houses. All family members use the toilets. They are easy to keep clean (tiled floor is standard), they are odour-free and there is no fly-breeding. Similar results have been reported from the other projects. Microbiological studies indicate that it is possible to achieve a considerable reduction in pathogenic organisms during on-site primary processing. We have positive reports of recycling, although in this area SanRes has not had the capacity and time to undertake systematic studies and make controlled experiments.

This does not mean that success can always be guaranteed. There are many pitfalls and, without good preparations and sufficient follow up, a project is likely to fail.

The partly negative outcomes of three of the SanRes-funded projects (Tecpán in El Salvador, Transkei in South Africa and Shanxi in China) have been due to external factors rather than to the ecosan concept.

- Tecpán is an example of a project where continuity was lacking: The original, competent and highly motivated team of four local health inspectors who initiated the project was replaced by one person with little knowledge of ecological sanitation and neither the time nor interest to follow up and carry on the experiments. This intervention by the Salvadorean Ministry of Public Health had a disastrous result for a very promising project (Vargas 2000, p 17).

- In Transkei the implementing organization (TATU) was closed down and consequently there was no direct follow up of the small SanRes-funded project. However, after reorganization (TATU was replaced by ECATU), a new start was made with the help of CSIR (Austin 2002).

- The pilot project in Shanxi is a special case: A government imposed edict in 1998 resulted in widespread unemployment in Wu Village, the site of the pilot project. Many families were therefore unable to complete the construction of their new houses. At the time of the appraisal in May 2001 only 16 ecosan toilets were in use (Wang 2001, p 18).

Studies of all the SanRes projects on the whole confirm the hypothesis: ecological sanitation does work well under diverse natural and cultural conditions.

3.2 Is ecological sanitation safe?

Ecological sanitation is based on sanitizing human excreta to render them safe for recycling. The SanRes approach has been that of stepwise pathogen destruction: excreta are first processed on site and then, if necessary, off site, until they are inoffensive and safe enough to be returned to the soil (Winblad ed 1998, pp 13-14).

A common misconception in the ongoing debate about ecological sanitation is that the output from the on-site processing chamber must be sterile or totally free from pathogens. This can be achieved but would require incineration (Winblad 1974, p 298; Liu 2001, pp 91-93) or a very long retention time. *The purpose of the primary treatment (dehydration-decomposition, pH increase, retention time) in the on-site processing chamber is not to sterilize completely but to reduce volume, weight, odours and pathogens to facilitate storage, transport and further treatment* (Winblad 1998, pp 208-209). This may result in a product that can be recycled directly, but normally we would require secondary treatment (for example, high temperature composting together with household refuse) at a neighbourhood eco-station (Simpson-Hébert 2001, pp 131-132). In extreme cases, when a sterile product is required, a tertiary treatment (for example, incineration) is possible.

It should be noted that all studies of pathogen die-off in ecological sanitation presented at the Nanning conference in November 2001 (Black 2001, pp 15-18) were on primary treatment only. In the future, when our main concern will be the safety of large, city-wide ecological sanitation systems, we need studies of faecal pathogen die-off after total (primary and secondary) treatment. An important argument for secondary treatment at eco-stations is that this would make it possible to standardize and control the final quality of the product.

Studies carried out during the past few years (Black 2001, pp 15-17) confirm the conclusions from studies in Tanzania in the 70s, that a number of elements in the processing chamber

contribute to the destruction of pathogens: time, temperature, unfavourable pH, competition for nutrients, antibiotic action, and toxic by-products of decomposing organisms (Winblad 1978, pp 20-21).

Human urine does not generally contain pathogens that will be transmitted through the environment (Schönning 2001, p 30). Urine can therefore be infiltrated in an evapo-transpiration bed (Calvert 1997, pp 30-32) or applied to crop land with mechanized equipment (Winblad ed 1998, p 14). Schönning (2001, p 31) states that when urine is used on crops that are to be commercially processed, for example cereals, the risk for infection through food consumption is negligible. For food crops that are to be consumed raw, she recommends that urine be applied not later than one month before harvesting.

The pertinent question about the safety of ecological sanitation is not the plain “How safe is it?” but rather “How do we process human excreta so that their recycling to soil is safe considering acceptable risks.” - To find the answers microbiologists must study pathogen destruction after full primary plus secondary treatment.

3.3 Do people, men as well as women, want ecological sanitation?

When we introduced the concept of ecological sanitation we were often met with disbelief and scepticism (Lin Jiang 2001b, p 26). People considered no-flush sanitation as a solution for the poor, for those who had no alternative. To break down this psychological barrier, SanRes has encouraged the development of neat, prefabricated toilet devices and the use of easy-to-clean, tiled floors. We have also tried to improve the primary processing and increase the operational safety margins by redesigning chambers and modifying management procedures.

Squatting pans

> An effect of the SanRes pilot projects in China is that private entrepreneurs in different parts of the country now produce several models of urine diverting squatting pans. The pans are made of plastic,
> fibreglass or porcelain and range in price from USD 5 to 10. Urine diverting squatting pans have also been developed in Vietnam (Duong 2000). The three pilot projects in China and the project in Vietnam used porcelain pans made in Hebei province. (Figure 2.4 in our book “Ecological Sanitation” shows the current model, Prototype No 3). The follow up projects are using the fibreglass or plastic models made in Guangxi (Figure 7 on the back cover of the Nanning Conference Report). Porcelain looks more solid and is easy to keep clean even after years of use but must be transported and handled with care. Fibreglass and plastic models are tougher and easier to transport but may be discoloured after some
> years. Both types function well though. In China fibreglass and plastic models are already in mass production and are even exported to other countries.

Seat-risers

> The seat-riser specifically designed by women for women (Dudley 1994, p 7-10) was developed after a request by Sida. It does not actually differ much from other urine diverting seat-risers produced in Mexico. The fibreglass model tested at the Barrón project in Mexico City worked well but is not, as far as we know, in regular production. Most ecosan projects in Mexico are using the equally well-functioning, uni-sex seat-risers designed by Cesar Añorve (Añorve 2000). Similar models are now produced also in South Africa (Austin 2002).

Processing chamber(s)

> The most common ecosan designs are based on the Vietnamese double-vault, urine-diverting toilet. With proper operation this simple and effective device works well - particularly in dry

climates. In some projects we have tested a modified design incorporating an elongated processing chamber
covered with a solar heater (Winblad ed 1998, pp 27-30, 37-38). The main purpose of this design is to improve the evaporation from the chamber. (Increased rate of evaporation will reduce the possibility of malfunction due to careless use of the toilet.) Tests in Vietnam (Bui Trong Chien 2001) show that it does function that way and that the survival time of pathogenic organisms is shorter in processing chambers with functioning solar heaters. Our own observations in several countries over a number of
years indicate that the toilets with solar heaters fully exposed to the sun work better than toilets without solar heaters: dehydration is quicker and the processing chamber is better able to cope with moderate misuse. Many of the toilets with solar heaters in those of our pilot projects where they were tested (Tecpán, Cam Duc, Shanxi and Jilin) are unfortunately designed or located in such a way that they do not receive much sun. The toilets may still function satisfactorily but are not really solar heated and should not be used in comparative studies.

Potty

A potty with urine-diversion was developed for use by households who have no toilet at home but have to use a public toilet (very common in China), for people who have problems moving to the toilet, and for use during emergencies. The prototype has been tested in Sweden but is not yet in
production.

Ash-dispenser

Our team in Guangxi province has developed a pedal operated ash-dispenser for use in school toilets (Lin Jiang 2001a, p 16). It is a simple device made of easily available standard components. It is currently tested at a number of school toilets in Guangxi.

Technical management procedures

The Cam Duc project in Vietnam has tested a number of design-management variations (Calvert 2000, Appendix 9). A general conclusion is that operation, particularly the regular addition of ash and keeping urine and water out of the processing chamber(s), is more important than any particular design feature. Some of the designs using removable buckets may, however, be more suitable when a system of communal collection is introduced.

Women have been quick to realize the advantages of the sanitation solution we have provided in our projects (Calvert 2000, p 36; Wang Rusong 2001, pp 15, 21, 27, 28). The fact that the toilets can be placed close to or inside the house means an enormous improvement in privacy and safety for women. The urine diverting squatting pans and seat-risers used in our projects are well adapted to female anatomy. (The problem, if any, is rather for men who prefer to urinate from a standing position. The best solution for them is to have a special urinal next to the pan/seat or to urinate in a hand-held small bucket. This would eliminate the splashing that is a common accompaniment of male urination practice.) As there is no need for water for flushing, there is less water for women to carry home. Our insistence on high finishing standards means that the ecosan toilets are easy to keep clean (and toilet cleaning is a job that usually falls to women). Diverted urine can be used to increase the productivity of the vegetable garden.

SanRes has been criticized for placing “Too much emphasis on toilets compared to closing the loop .....” (Stockholm Environment Institute 2001). - The emphasis on toilets is in accordance with the stated purpose of the SanRes programme (see 1.2 above). Closing the loop is not part of the stated aims. The programme’s emphasis on the most visible parts of the sanitation system is the secret behind its success. Acceptance by the users is a key issue in sanitation promotion. Urban users will only accept a new sanitation concept if they

see it as attractive and having status value. The crude concrete contraptions used in Vietnam and Central America for toilets placed at the back of the garden may function well, but will simply not be accepted by urban households. Without widespread acceptance there will be no loop to close. Now when SanRes has given ecological sanitation an attractive face it is possible for its continuation, the EcoSanRes programme, to follow with similarly careful attention to other parts of the ecological sanitation system.

3.4 How do we implement ecological sanitation?

A complete ecological sanitation system for an urban area consists of receiving devices and operating procedures, primary processing, transfer to eco-station, secondary processing, transfer to end-user, and end-use (return to the soil). Although recycling of human excreta is central to the concept of ecological sanitation, the SanRes programme has not had the resources to do systematic work in this area. In the pilot projects, households have been encouraged to recycle urine and sanitized faeces in their own gardens and many have reportedly done so (Gough 1996, pp 52-53; Calvert 2001, p 34). In China there is an immense potential for using diverted urine for vegetable production in greenhouses (Winblad ed 1998, p 75; Wang Rusong 2001, p 26).

A full-scale testing of the total system would require a project covering several thousand households in a continuous area. This has been outside the scope of the SanRes programme. What SanRes has done is to develop and test some components of the system in smaller communities.

Our experience is that the single most important factor in implementing ecological sanitation is the availability of a competent local team. Once ecological sanitation has been successfully introduced and is being used by a significantly large number of households (as in Guangxi province in China), there will be a spontaneous expansion. However, in the pioneering stages of ecosan development, the team is all important and must be available for a sufficient length of time - years rather than months.

Lin Jiang (2001b, p 26) points out the importance of finding a family that will agree to have the toilet built inside the house. If this is done, other families are likely to follow. If the first few toilets in a project are located outside the house, that pattern is likely to prevail.

Political will is important for large scale implementation. A way of creating political will is to demonstrate success and popular acceptance of ecological sanitation through a high profile pilot project. In the corrupt environments where SanRes has been active, political will is, however, not a straightforward issue.

Things are bound to go wrong if users do not understand how the system is supposed to work. Until ecological sanitation becomes part of the local culture, any project must be preceded and accompanied by demonstration and training. There must also be a follow up of the use of each installed unit for at least a year. The instances of improper use and maintenance that we have come across have been closely linked to non-existent or deficient instruction and follow up (Vargas 2000, p 11).

Methodologies for mobilization, training and follow up in relation to ecological sanitation were developed and tested by Unicef and the Ministry of Public Health in El Salvador in 1995-96. Manuals and other educational tools were published (Gough 1996a&b). (The availability of this excellent material did not prevent the decline of the ecosan pilot project in El Salvador basically because there was no follow up. See 3.1 above: “Does ecological sanitation work?”)

The most common problem with an ecological sanitation system is too much moisture in the processing chamber resulting in odours and fly-breeding. This might happen if too much liquid (rainwater, urine and/or water used for anal cleaning) comes into the chamber or if too little absorbent material is added. If rainwater comes in, there is a design or construction fault. Urine might leak into the chamber from the urine collector or go there directly due to careless use of the toilet or lack of knowledge about the why and how of urine diversion. If people use water for anal cleaning, they need a squatting pan or bathroom of a different design plus knowledge about how to use it (Winblad 1978, pp 44-46; Calvert 1997, pp 30-32). Absorbent material (ash, husks, dry soil, sawdust, lime, sweepings) must be added daily. Weekly application of hot ash and embers directly from a stove has proved effective in controlling fly-breeding.

Our experience is unequivocal*: Without a major input of mobilization, information, instruction and follow up, implementation is bound to fail*. Users must understand how ecological sanitation works, what can go wrong, how to interpret danger signals (odours, fly-breeding) and how to manage daily operations and periodic maintenance.

3.5 Is ecological sanitation cost-effective?

At the household level the actual construction costs for ecological sanitation are easy to calculate and can be remarkably low. The total cost of materials for a typical ecosan toilet in Guangxi province was RMB 284 (= USD 35) in 2001 (Lin Jiang 2001a, p 9). This is only 1/3 of the cost of a 3-chamber septic tank or a biogas toilet (Lin Jiang 2001b, p 27).

The main reason for the comparatively low investment cost of ecological sanitation is the low volume of material to be transported and processed. The volume of a processing chamber is only 0.5-1.0 m3, much less than the volume required for a pit toilet or a septic tank. Another reason is that, as ecosan toilets are placed above ground, they require no excavation. Ecosan does not depend on water so there is no need for sewers. The eco-station for secondary treatment is likely to cost much less and require less land than a sewage treatment plant.

As long as ecological sanitation remains a relatively unknown concept, its introduction requires substantial investments in mobilization, information, instruction and follow up. And,

as we have no fully built up urban ecological sanitation systems to study, we have no data on some of the running costs, such as the cost of collecting and transporting urine and primary processed faeces from households to eco-station, and the costs of establishing and running an eco-station. A fair cost comparison between ecological sanitation and conventional sewage should, however, consider the fact that whereas a sewage treatment plant has to dispose of toxic sludge, an eco-station will sell useful products. Reports from our pilot project in Jilin province, China, state that the farmers of Dongxing village by using urine from ecosan toilets have saved the equivalent of USD 900 per hectare per year in their greenhouse vegetable production (Wang Rusong 2001, pp 26).

To calculate the cost of building and operating a total ecological sanitation system and make a fair comparison of these costs with those of a conventional sewage system is a complex task. We did make an attempt in 1995 using a computer simulation model (Vargas 1995). Lack of reliable input data (the World Bank refused to provide us with detailed cost information on its water and sewage projects) as well as budgetary constraints prevented us from continuing this study.

On the basis of the information we have, our conclusion is that the introduction of ecological sanitation is bound to lower the total cost of urban sanitation.

3.6 Network and promotion

SanRes has been working through an informal network of individuals and institutions willing and able to play an active role in promoting R&D on ecological sanitation. The active network has included about 50 individuals around the world. The total number of participants in SanRes seminars, conferences and training courses exceeds 1,000. Many more have participated in local training courses in China, Vietnam, the Philippines, South Africa, Mexico, El Salvador and Bolivia.

SanRes publications printed and/or published on the internet have reached a much larger number of people. The book “Ecological Sanitation” was published in English in 1998 and in Chinese, Vietnamese, Japanese, French and Spanish during the two following years. The total print run of all the editions is 12,000. The book is also available on the internet (www.ecosanres.org).

Many thousands of people have seen the SanRes exhibition originally prepared for the Stockholm Water Symposium in 1998. Special versions of this exhibition have been shown at conferences in Africa, Europe and China.

The website ‘Ecological Sanitation Notes’ (available on the internet from June 1999 to May 2002) had during 2001 an average of 260 visits per month. A Google search on the internet on 19 May 2002 gave 41,700 hits for ‘ecological sanitation’ and 8,700 for ‘urine diversion’.

South-South cooperation has been encouraged throughout the SanRes programme and culminated at the Nanning conference in November 2001.

It is no longer possible to keep track of the expansion of ecological sanitation activities around the world. Major international organizations like Unicef, UNDP, the World Bank and the Development Directorate of the EU are now promoting ecological sanitation within their regular programmes and so are a number of bilateral donors and NGOs.

A result of SanRes’ networking and promotion activities during the past nine years is that the concept of ecological sanitation is now firmly established.

3.7 What remains to be done?

In SanRes we have followed the old adage that it is always best to under-promise and over-deliver. We have more or less done what we set out to do in 1992 and in some respects we have indeed over-delivered. Still much remains to be done and, together with Sida, we have therefore initiated a sequel to the SanRes programme: a Phase 2, to be managed by the Stockholm Environment Institute.

In its strategy document, the Stockholm Environment Institute (2001a, pp 4-5) claims that Phase 1 of the SanRes programme has suffered a number of weaknesses to be addressed in Phase 2. Another document (Stockholm Environment Institute 2001b, p 5) states that “Planning of ecosan projects has thus far been carried out on an ad-hoc basis” and advocates the need for a planning tool that involves everyone and everything everywhere.

A full understanding of the intentions, successes, failures and shortfalls of Phase 1 (SanRes) is a prerequisite for a good outcome of Phase 2 (EcoSanRes). The statements from the two SEI documents are therefore disquieting as they indicate ignorance and misinterpretation of the purpose and scope (see 1.2 above) as well as the achievements (see 2.1-2.3

above) of Phase 1.

The planning of SanRes has definitely not been “ad-hoc”. It has been systematic, remarkably consistent and firmly geared towards what we can now see as a not-too-distant possibility: the breakthrough of ecosan on an urban scale.

The six “weaknesses” of Phase 1 are, according to the other SEI document:

> 1. “No human health impact ...” - Health impact studies in the field of sanitation are notoriously difficult to carry out and in this case it would have been futile to measure the health impact of ecosan in scattered households. Such studies were therefore not included in the terms of reference for Phase 1.
>
> 2. “No development and/or measure of ecosystem changes ...” - Measuring ecosystem changes were not included for the same reason as stated above.
>
> 3. “Little economic analysis, particularly comparisons ...” - We have shown that at the household level ecosan toilets are extremely cost effective. However, here is a need for comparative studies of the economic implications of ecosan versus flushsan systems for urban areas, and this should be one of the important tasks for Phase 2.
>
> 4. “Little guidance for engaging policy makers or gaining political will.” - The opposite is true. In each country we have included central as well as local policy makers in our projects from the outset. Our book “Ecological Sanitation” is directed at policy makers. Our success in generating large follow up projects (unusual in international development assistance) would not have happened without the involvement of policy makers and political will.
>
> 5. “Too much emphasis on toilets compared to closing the loop ...” - This “weakness” is actually the very basis for our success - see the last paragraph of 3.4 above.
>
> 6. “Too little dissemination ... and too few peer reviewed articles ...” - A surprising statement considering the way “ecological sanitation” has become known and accepted all over the world over the past few years. - As for “peer reviewed articles” it must be understood that SanRes was conceived as an empirical research project. Its purpose was to produce real projects on the ground rather than papers for academic journals.

The lack of hard data on the overall costs of ecosan versus flushsan (point 3 above) can be considered a weakness of Phase 1. But the other points mentioned in the SEI documents are not weaknesses. The impact issues (points 1 and 2) were, for good scientific reasons, not part of our task. The policy maker, hardware and dissemination issues (points 4, 5 and 6) are not weaknesses but indicate the strength and success of the SanRes programme.

The main weakness of Phase 1 has rather been insufficient support and follow up of field projects and studies. The initial budget was only SEK 833,000 per year for three years and the project management was dimensioned accordingly. With hindsight it is clear that the budget was too tight and that more management resources should have been allocated.

With Sida’s offer of initially SEK 15 million over two years for the further development of ecological sanitation there is a golden opportunity for Phase 2 to do something really important. The main task for Phase 2 over the next few years should be to bring into being a large-scale urban application of a comprehensive ecological sanitation system. The project ought to include some 5,000-10,000 households in one continuous location. There should be adequate institutional support, communal collection and support services (see for example the interesting “chimney sweeper analogy” in Knapp 2001, pp 190-191), eco-stations for secondary treatment (Simpson-Hébert 2002), greywater and solid waste management, and recycling.

Phase 1 has built the foundation for such a comprehensive urban project. China would be a suitable location. When the first project is well under way, a second project could be started in another part of the world - possibly in Mexico.

4. LESSONS LEARNED

Lessons learned can be summarized as follows:

- Ecological sanitation systems work well in many climates, in various cultures, in difficult locations and in urban as well as rural areas.
- By applying the principles of stepwise pathogen destruction the risk for disease transmission via sanitized faeces is far less than with conventional sewage.
- Ecological sanitation requires no water.
- In an ecological sanitation system there is no pollution of the environment as the total output is recycled.
- The high status of ecological sanitation and its widespread acceptance in our project areas have to a large extent been due to attractive design of toilet rooms and fixtures.
- The possibility to place the odour-free ecosan toilet inside the home has been greatly appreciated by women, children and old people.
- The location of the toilet in the first few pilot households will set a pattern that is difficult to break in subsequent expansion of the project.
- Investment and operational costs of an ecological sanitation system are, at the household level, lower than those of conventional sanitation.
- Political will comes after popular acceptance.
- An important condition for project success is the availability of a competent and dedicated local staff for a sufficient length of time.
- Careful management - keeping urine and water out of the processing chamber and after each use adding ash or other dry material - is more important for good functioning than specific design features.
- The total success of ecological sanitation in Guangxi has paved the way for full-scale implementation in urban areas in China.
- The main task for the next few years should be to bring into being a large scale (5,000-10,000 households) urban application of a total ecological sanitation system in one continuous location.

5. CONCLUSIONS

The overall conclusion is that the SanRes programme has been a success - in some ways it has even exceeded expectations. Ecosan is now established as a credible alternative to pitsan and flushsan. The cost effectiveness of the program is evident: a total budget of SEK 11 million over 9 years has produced significant changes in the sector, other agencies are entering the arena, the network is expanding, and projects are proliferating all over the world.

Phase 2 was launched in January 2002 with a budget of SEK 15 million for the first 2 years. By continuing the purposeful, empirical approach of SanRes, Phase 2 could create the world's first comprehensive urban ecological sanitation project and make it a success. With the resources now available and the leverage created by SanRes, Phase 2 should be able to make an even greater impact.

There is, however, a manifest risk that Phase 2 turns into a mere research funding structure, frittering away its resources on a large number of small, unrelated academic studies of limited relevance. Such studies will come about even without Sida funds, initiated by universities in search of topics for papers and theses. A comprehensive urban project on the other hand, is such a big step forward that no municipality could or would dare to make the investment without substantial backing from donors. Phase 2 should therefore allocate a major part of its resources to the establishment of the urban project. All Phase 2 experiments and studies should focus on and be integrated into this project.

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APPENDIX 1:

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