First International Conference on Ecological Sanitati

5-8 November 2001, Nanning, China

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ECOLOGICAL SANITATION CONFERENCE REPORT Nanning, China, 5-8 November 2001

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BACKGROUND

ary crisis affecting nearly half of the world's population represents a mounting disgrace to human dignity and a serious threat to human health. At least 2,400 million people today either have no sanitation facility at all, or are obliged to use one which is unhygienic and foul-smelling. Every year more than 2 million children die of diarrhoeal disease and hundreds of millions of others suffer illness which proper sanitation would have prevented. On health grounds alone, radical approaches to this crisis are required.

A public health revolution:

Ecological sanitation could be the beginning of a new public health revolution. During the 20th century we have witnessed several public health revolutions including universal childhood immunizations, the eradication of smallpox, improved water supplies, the green revolution with its improved food yields and expansion of primary health care. The one public health problem that has proved intractable this past decade has been a lack of sanitation for about half the population of the world.

Mayling Simpson-Hebert, USA

In the 21st century, new thinking on sanitation is also demanded for reasons of environmental sustainability. Up to now, there has been a tendency to see plentiful supplies of water for flushing as the key to effective sanitation. This is no longer realistic. In large parts of the world, supplies of freshwater are scarce. Already, some 80 countries with over 40% of the world's population suffer water shortage at some time of the year. Chronic scarcity threatens the Middle East, northern China, Central America, western USA and elsewhere. Under pressure from population growth, rapid urbanization, and the extra consumption of water which comes with a higher standard of life, the threats to freshwater supplies are growing.

These threats are not confined to volumes. In developing countries, 90% of effluent from towns and cities is discharged untreated into rivers, lakes and the sea. The pollution caused to soils, surface water and groundwater is a threat not only to public health but to the whole environment – in temperate as well as tropical, industrialized as well as developing, zones. Thus during the past decade or so, new reasons for serious sanitary concern have emerged. The capacity of the earth's bio-

system for absorbing the extraordinary volumes of wastewater and pollution produced by humanity has already become seriously overstretched.

Given its extravagant use of water and the pollution it causes to groundwater, lakes and the sea, sewerage is in the long term an unsustainable sanitation model even for rich countries. Its promotion in seriously water-short parts of the world is indefensible. Its elaborate systems of pipes, pumps and treatment plants, and its institutional and managerial requirements are unaffordable in much of Asia, Africa and Latin America. The safe disposal of the output from treatment plants, toxic sludge, is a mounting problem in the rich countries. Yet there has been little formal investment in safe and efficient no-flush sanitation systems, manageable by households and communities.

This was the original impetus for the ecological sanitation idea: the need of millions of households and communities for a sanitation system which was hygienic, congenial to use, affordable, and environmentally safe. But it has another important and revolutionary dimension. From the outset, the approach was based not only on human and environmental health needs, but on respect for human excreta as a natural resource. Instead of designating urine and faeces as 'wastes' and hiding them in tanks and pits or despatching them into pipes, ecological sanitation set out to recycle the nutrients in them for use in plant and animal life-cycles. Ecological sanitation is designed to interact fully with the eco-system and its own processes. It also has a role to play in poverty reduction, especially in releasing resources for use in food production, and in improving living conditions for those degraded and harmed by a polluted environment.

Ecological sanitation defined:

An approach to sanitation which respects ecological integrity, conserves and protects freshwater, promotes dignified and healthy living, and recycles nutrients from human excreta for use in agriculture.

Nanning conference

To maximize efficiency in both pathogen destruction and nutrient re-utilization, ecological sanitation normally favours the separate collection at source of urine and faeces. Urine contains by far the larger share of nutrients within excreta, and is a safe and clean fertilizer. Faeces collected in a separate chamber and covered with ash, lime, or

sawdust to reduce odours, assist drying, and raise pH, do not require a large container and can be left to dehydrate before being composted and recycled as fertilizer and soil conditioner.

In 1993, the Swedish International Development Cooperation Agency (Sida) launched a formal ecological sanitation initiative. The *SanRes* programme was set up under the direction of *Uno Winblad,* a Swedish architect and pioneer of ecological sanitation, to pursue a holistic sanitation approach, combining public health and urban development with environmental and economic concerns. For its first eight-year phase, the objectives of the programme were to promote affordable and replicable ecological sanitation systems; establish pilot projects in a number of countries; help build local capacity for research and development; and facilitate South-South collaboration in the field of applied sanitation research.

Since the establishment of the programme, a number of independent small-scale initiatives in ecological sanitation have been supported in a variety of climatic, geographic, and cultural locations. Exchange between them has been promoted through seminars and visits, and a network on ecological approaches to sanitation has emerged. Progress in developing and operating ecological sanitation systems, and in researching their effectiveness, has been marked. The ecological sanitation concept – now known as 'ecosan' – has been brought to the attention of a wide variety of governments, NGOs, international organizations and external support agencies. It has won followers and gained currency among a range of strategic partners.

Against this background, the First International Conference on Ecological Sanitation was convened in Nanning, China, from 5-8 November 2001. The Conference marked the climax of *SanRes*' work to date. After some years of scientific research, technological development and practical experience on the ground, ecological sanitation had reached the stage of maturity when an international exchange was needed. 320 participants from 27 countries met to share experiences and exchange information and views. An important intended outcome of the Conference was to help bring 'ecosan' to a new threshold of credibility and launch it into mainstream sanitation thinking.

The Conference was convened by the Jiu San Society, with the support of the Government of Guangxi Zhuang Autonomous Region and associated ministries and institutes. It was funded by the Government

of Sweden and Unicef, with some input also from UNDP, GTZ, and the Water and Sanitation Programme (WSP).

This report of the First International Conference on Ecological Sanitation is intended to give a synthesis of the many subjects, themes and debates which took place during the four-day event. It cannot do justice to many of the technical and scientific papers, nor to the richness of many of the presentations which demonstrated ecosan in action. The intention is to provide a snapshot of where the approach known as ecological sanitation has reached, and assist the process of moving it to the next stage of public acceptance and growth. (Most of the papers presented at the conference are available at www.ecosanres.org.)

2. WHY CHINA?

For a number of reasons, China was the natural venue for the First International Conference on Ecological Sanitation.

Since time immemorial the Chinese have faced problems of water and land sustainability. They are justly proud of a long tradition of managing a difficult environment in accordance with nature and making efficient use of all available resources. The use of human excreta as a fertilizer has a history of more than 2,000 years in China. Sanitation systems in cities, whereby nightsoil was collected door to door and sent to surrounding farms for crop fertilization, can be dated as far back or further. In China today, over 90% of human excreta is still used in agriculture.

In spite of the advent of modern lifestyles, Chinese attitudes are therefore already naturally predisposed towards an approach to sanitation which interacts with the eco-system rather than overloads it. Along with those of some other neighbouring countries such as Vietnam, they have helped to inform and inspire the formal articulation of 'ecosan'. Not surprisingly, China has also become the country in which the approach in recent years has been implemented on the largest scale. Official support and popularity among users means that China is likely to remain the pioneering setting for implementation at scale in both rural and urban settings.

The exceptionally high level of policy-making interest in ecological sanitation in China was demonstrated by the wide variety of presentations from Chinese experts and the high number of Chinese participants. Among these were representatives from major national scientific academies and institutes, as well as from relevant departments of the government of Guangxi province. The province harbours what is at present the most extensive ecological sanitation programme in the world. As was demonstrated by the keynote address to the Conference of *Wang Rusong,* Professor of Eco-Environmental Sciences at the Chinese Academy of Sciences, the role of ecological principles in providing workable solutions to problems of modern living attracts major scientific attention in today's rapidly industrializing China.

The importance attached to ecological sanitation in China is due to the threat to health posed by the presence in the landscape of untreated faeces. A 1993 survey indicated that 94% of human excreta were used in agriculture, but that only 13% was sanitized This represented a major

health hazard as *Pan Shunchang* of the China Academy of Preventive Medicine told the Conference. Dysentery, typhoid fever, and other diarrhoeal diseases account for more than 70% of the infectious diseases in China. As for parasitic infections, 531 million people are estimated to be infected with roundworm, 194 million with hookworm, 212 million with whipworm and 870,000 with schistosomiasis. The sanitization of human excreta prior to its use on the fields is therefore a prerequisite for disease control and prevention.

Since 1987 the Chinese Ministry of Health has promoted improved standards in hygienic disposal of excreta and coverage has risen dramatically from 7.5% in 1993 to the current level of 45%. This has been achieved through the promotion of different types of sanitary toilet facilities suited to different environments. Among the various models using different technological approaches the urine-diverting ecosan toilet is the most recent to be introduced (or reintroduced rather as urine-diverting toilets have a long history in China). High standards of construction and maintenance in all cases are promoted to assure hygienic use and health gain. According to Unicef, studies show that this drive for improved sanitation has brought villages many environmental and health benefits.

Improved sanitation has reduced air, water and soil pollution in Chinese villages:

- 80% odour reduction
- 96% reduction in fly population
- 70% reduction in roundworm (ascaris) eggs in soil
- 89% reduction in hookworm larvae
- reduction of faecal coliform contamination on vegetables from 22% to 4%
- 46% of villages with improved sanitation have water which meets Chinese safety standards, compared to 10% without.

Unicef, Beijing

In 1998, Guangxi province, of which Nanning is the capital, became one of the first three provinces in China to receive Sida and Unicef support through the National Patriotic Health Campaign Committee Office (NPHCCO) of the Ministry of Health for a pilot ecological sanitation project using urine-diversion toilets. Once the technology was successfully tested, a campaign to improve the rural environment entitled the 'ecology and sanitation revolution' was launched with support from NPHCCO and Unicef.

During the Conference, participants were taken on a field visit to eight villages in Yongning county near Nanning. Here the concept of the 'ecological village'has been promoted by Yongning county officials and a range of infrastructural and environmental improvements have been carried out.

Yongning has a population of 912,000 in 21 small towns, 240 villages and 1,774 hamlets. The various communities visited by the Conference participants were of similar size: around 30 households comprising 150 to 180 people.

By the end of 2000, 45 villages in Yongning county had successfully introduced the 'eco-village' package. A further 44 villages were scheduled for 2001 but implementation was delayed by the severe floods affecting Yongning in June 2001. Around 4,000 urine-diverting 'ecosan toilets' have so far been installed in eco-villages in Yongning and another 3,000 in other villages in the county.

Reasons for the success of the ecological village scheme in Yongning County:

- Political leadership and sound administration, including grass roots organization; close collaboration between government departments.
- Strong technical guidance and effective use of demonstration models.
- Effective mobilization of finance from central government, local government and villagers.
- Building on tradition and actual living conditions, solving perceived problems;
- A comprehensive approach whereby whole lifestyle uplifted, linking sanitation to health, agricultural production, domestic and economic improvement.

Luo Daguang, County Magistrate, Yongning county

The ecosan toilets in Yongning have a fibreglass squatting pan divided into two compartments, the one at the rear covered by a moveable lid. School toilets have pedal-operated ash-dispensers developed specifically for the programme; household toilets have a container with ash and a ladle.

Technical assistance to assure sound construction – for toilet-washrooms as well as biogas digesters, roads, electricity connections, water supplies, and other amenities – is provided by specially trained

teams. Various government departments are involved, including Health, Agriculture, Forestry and Urban Development. Each participating village receives a community subsidy of RMB 30,000 (USD 3,750) towards the cost of communal amenities.

Conference visitors were impressed by their tour of the 'eco-villages'. The new toilets are usually installed inside the house (which is not only more convenient but reduces the cost); are fully tiled; and many incorporate a basin or shower for washing – unthinkable with the old facilities which were too unpleasant to linger in. The cost of the total installation is RMB200-400 (USD 25-50), for which a subsidy of RMB30 is provided.

The participatory element in the programme comes not at the individual level – with households opting in or out of certain types of improvement, or a range of options being presented from which families make a choice. Once the village committee decides to participate in the scheme, in its essentials the programme takes a mandated course and everyone co-operates. The element of choice comes at community level.

In each village, work begins with comprehensive planning, followed by small-scale installations: biogas digesters, toilets and kitchens. This builds confidence for more ambitious endeavours. Construction is guided by technical teams, trained by experts and equipped with the relevant professional knowledge. Public health education is also emphasized: the maintenance and correct use of facilities – including the use of ash to cover faeces – is essential. Health impacts from sanitation programmes can prove elusive unless people fully understand the connections between toilet behaviour and disease transmission. As yet, it is too early to assess the impact on health of ecosan villages although data is being collected. However, the aesthetic and convenience impact is profound, and the rise in the quality of life, especially for women, was evident.

At present, extension of the Yongning programme to 170 villages is planned for the next three years. At that stage, around 10% of villages/hamlets in the county will have been reached. As the concept takes root and moves beyond the demonstration phase, subsidies to families and villages will be gradually phased out. This should speed up the rate of implementation. It is not difficult to picture the day when the ecosan toilet-washroom has become a consumer product as universally desirable and familiar in Yongning as a television set has already become.

3. PUTTING THE MESSAGE ACROSS

Any radical solution to an age-old problem – especially one where the existing solution is widely approved and supported by vested interests – is bound to face difficulties in gaining widespread acceptance. Where the subject is one which, in many cultures, is surrounded by silence and taboo, as is the case with human excreta and defecation behaviours, those difficulties are multiplied. Although Conference participants included those who have helped pioneer the approach scientifically, technologically or practically, there were also many who work as professionals or policy-makers in sanitation systems, but whose familiarity with ecological sanitation was limited. If the Conference was to be a launch-pad for wider dissemination of the ecosan message, the message itself needed to be fully explored.

The two keynote presentations undertook this task at the outset of the Conference: Ecosan – the Big Picture by *Steven Esrey* of Unicef, New York, and System Consideration of Eco-Sanitation in China, by *Wang Rusong* of the Research Centre for Eco-Environmental Sciences, Beijing. Esrey's presentation looked at ecological sanitation within the global picture of pressure on natural resources, while Wang's exposition concerned the position of ecological sanitation within contemporary Chinese political thought and development practice.

Esrey's emphasis was on 'closed loop thinking'. He cited the system of sanitation and recycling of nutrients used on spaceships, and the need for the spaceship on which we live – planet Earth – to be operated in a similar way. At present, earth's self-cleansing capacity – its capacity to absorb and neutralize wastes and maintain ecological integrity – is being pushed to its limits. This can only worsen in the face of rapid urbanization with all the waste generation and pollution that implies. Current sanitation solutions, which among privileged populations consist of flush toilets and sewage pipes and for many others consist of pit toilets or no organized system of sanitation at all, are not only inadequate but are contributing to the crisis.

Environment - pollution:

When 19th century solutions were developed, the *assumption was that human excreta were* only suitable for disposal. The odours associated with faeces – not the content – were thought to cause disease. So water was used as a transport and a sink, and excreta flushed into the landscape where – it was assumed – it could be safely absorbed.

Steven Esrey, Unicef, New York

'Closed loop thinking' connects food with people and people with food. The 'closed loop' is between the consumption of food; its passage through the human digestive system; the sanitization of that part of the resulting excreta which contains pathogens – the faeces; the recycling of nutrients from excreta in plant growth; and the production and consumption of food. Where animals enter the loop, they too consume plants, and their manure – less controversially – are also reinvested in plant growth.

The advantages of the 'closed loop' consist not only in the fact that there is no pollution output and that human health is, therefore, extra-protected as compared to other sanitation methods; but that human excreta have a high value as soil conditioners and fertilizer. This is a potential aid to the reduction of poverty-related under- and malnutrition and can increase household food security. It also has the potential to reduce dependence on chemical fertilizers and relieve the environment from all their attendant problems.

The idea of resource re-utilization central to Esrey's presentation was echoed by Wang's wide-ranging review of eco-sanitation within Chinese systems of thought and sanitary practice. He pointed to the need for the evolution of an 'eco-culture', respecting ancient traditions and blending them with modern values to build the sustainable society. Wang drew upon Chinese technology and philosophy to explore the essential values of the ecological approach. He placed emphasis on the holistic nature of ecosan, with its mix of physical, chemical, biological, economic and cultural processes and its balanced support for the health of human beings, their settlements, farmland, and the environment.

Professor Wang also looked at strategies for dissemination of ecosan in China. He listed its strong points, which can be used to popularise the concept. He then reviewed the means through which this can be done:

design principles, the structure of ecosan services, and the 'instruments' for ecosan's effective dissemination. He called for excellence in hardware – technological, financial, and servicing support; in software – institutional reform, system development and policy support; and in mindware – behavioural inducements, value changes and human capacity building.

Urine - fertilizer:

- China produces annually 500 million cubic metres of urine, containing 5 million tons of nitrogen (N), 0.5 million tons of phosphorous (P) and 1.12 million tons of potassium (K).
- Also 30-60 million cu/m of faeces containing 0.66 million tons of N, 0.22 million tons of P, and 0.44 million tons of K.
- If all was returned to the land, every cultivated hectare could receive 50 kg N, 7.2 kg P and 15.6 kg K.

Wang Rusong, Beijing

An important part of the ecosan message is the impossible burden on freshwater resources imposed by non-ecological systems, especially sewerage. Many presentations underlined the high degree of pollution to surface waters inflicted by current flows of untreated effluent into rivers and other water bodies. In India, for example, all major rivers are heavily polluted and 70% of this pollution comes from sewers – in spite of the fact that only 200 out of 400 major cities and towns are even partially sewered. What was new to many participants was the degree to which groundwater supplies are also being contaminated by sewers, in both industrialized and developing countries.

Where sanitation consists of dug pits for the storage of excreta, and the area has a high water table, is flood-prone, or has other contra-indicative hydrogeological features, it has been open to criticism for its potential contamination of both soil and water. *Mike Barrett* of the Robens Centre of Public and Environmental Health in the University of Surrey, UK, pointed out that where rainwater, wash water or urine is mixed with human faeces it may act as a conduit for pathogens into the water table. Where the base of the storage pit intersects with the water table, contamination is inevitable.

Barrett had made a study of protected springs in Kampala, and had found that where the installation was in a poor state of repair as was often the case, there were peaks of microbiological contamination in

the wet season when excreta discarded on open land were washed into the system. However, some contamination took place even in the dry season, invariably from leakage from pit toilets to the water table.

While his findings in Kampala will not have surprised many Conference participants, the more striking evidence presented by Barrett concerned conventional sewerage in the UK city of Nottingham. Here, sewage-derived bacteria and viruses were found to be penetrating to significant depths (50 metres) within groundwater aquifers. Although there were some variations from one test-site to another, leakage from the sewers was significant whatever the age and construction material of the installation. Because the aquifer had been overdrawn, it was being recharged from surface water drawn into the city, and from leakage from water pipes. Of this recharge, 10% was from the sewers.

Although there is some way to go before ecological sanitation principles have gained a solid footing in the water and public health engineering industry and its associated institutions, they have already made a considerable impact on international thinking on sanitation policy. *Roland Schertenlieb* of the Swiss Federal Institute for Environmental Science and Technology (EAWAG) presented to the Conference the Household-Centred approach to Environmental Sanitation (HCES) recently adopted by the Environmental Sanitation Working Group of the Water Supply and Sanitation Collaborative Council (WSSCC). This approach is based on a set of principles on environmental sanitation, articulated at a meeting in Bellagio in early 2000, which reflect ecological values.

The Bellagio Principles:

- The purpose of environmental sanitation is to promote human dignity, health and environmental security
- Both providers and consumers of services should participate in decision-making
- Human excreta and wastes should be perceived as potential resources
- Sanitation issues should be dealt with as close as possible to the source of waste generation.

WSSCC

Systems of environmental sanitation, which includes management of solid wastes, drainage and stormwater, should be designed in such a

way as to balance the needs of people with those of the environment to create a healthy and productive life for all. In its key characteristics, the HCES approach addresses the same shortcomings in the whole area of wastes and resources management as ecosan addresses for human excreta. It is based on the recognition that 'business as usual' – especially where water is used to transport excreta – cannot provide services for the poor, pollutes the environment, promotes the under-use of organic residues, and is unsustainable even in the industrialized world over the long term.

As the name suggests, the household is the focal point of HCES planning, reversing the usual order of centralized, top-down planning. By placing stakeholders at the core of the planning process, services respond to the needs and demands of users rather than those of the central planners. The concept anticipates that the users will play a deciding role in the design of the service, and that all environmental sanitation problems will be solved as close as possible to where they occur. Only problems which cannot be solved by the household will be 'exported' to the next level: neighbourhood, town, city, province etc. The amount of clean water imported across boundaries is reduced because wastewater is recycled for non-drinking purposes.

The other essential characteristic is that 'wastes' are seen as a resource. A circular system of resource management based on the household at the centre, emphasizes conservation, recycling and reuse of resources. By encouraging households to adopt appropriate technologies the re-use of products otherwise wastefully discarded is maximized, and the amount of downstream pollution is minimized.

Finally, the Conference respected that the gender dimension of ecological sanitation has to be addressed by the ecosan message, with due respect shown for the different roles and responsibilities of men and women in sanitation. As was pointed out in a presentation by *Ingvar Andersson* of UNDP, gender perspectives in sanitation have not yet been thoroughly explored. Indeed, most sanitation programmes have been built around assumptions that the typical consumer of services is some sort of 'gender-neutral' being who does not in fact exist.

Social issues include women's greater desire for privacy, and the harassment and loss of reputation to which women are subjected in some cultures if they fail to perform toilet functions modestly. Security, too, is increasingly an issue in violent urban environments and in rural areas away from human dwellings where privacy might be sought.

Parents often withdraw their daughters from schools without proper (or separate) sanitation facilities for girls, for fear that their modesty or safety will be compromised. Women are also responsible in the household for sanitary education of children, and for children's toilet functions. This may preclude the use by young children of facilities which they are too small to use safely. Where there is no piped household supply women also usually collect water, and therefore carry a greater burden where it is needed for toilet flushing. All responsibilities for domestic cleaning and hygiene also devolve onto women. Therefore, any sanitation programme, including ecosan, needs to take gender aspects on board and adapt technologies and health education messages accordingly.

All these presentations underlined the fact that the message of ecological sanitation was about something far broader than toilets or engineering systems: it was about an approach which embraced resource conservation and re-use, human dignity, public health, and environmental security. More widespread acceptance of the approach depended upon advocacy with policy-makers, professionals, the general public, the sanitation industry, and the users of the end-products. For this advocacy to be effective, a sound scientific foundation for ecosan propositions is required.

4. SCIENTIFIC RESEARCH: KEY ISSUES

4.1 Health and safety

The sanitary revolution of the 19th century was primarily inspired by the epidemics of disease, especially cholera, which rampaged through crowded slums and tenements in rapidly expanding cities. Ever since, the overwhelming rationale for investments in sanitation systems has been the protection of public health. Infrastructures of pumps, pipes and sewers have been given much of the credit for lowering disease rates in the industrialized world from the late 19th century onwards. Although their extension has subsequently overloaded the environment and caused a new generation of problems, the health imperative remains the driving motivation for public investment in sanitation.

Ecological sanitation will not be widely accepted as an alternative to conventional systems until and unless public health engineers and civic authorities are convinced that it is superior in terms of human health and safety. Since excreta-derived products are to be deliberately re-introduced into the environment there is a double onus on ecosan advocates to prove that it is safe.

The objective of recent research has therefore been to provide scientific answers to questions concerning the reduction of pathogens in excreta and the safe re-use of urine and sanitized faeces in agriculture. Pioneering research work in this area has been undertaken by micro-biologists at the Swedish Institute for Infectious Disease Control, Stockholm, and there have also been studies in Central America, South Africa, Vietnam, and China The sharing and comparison of results from microbial research was an important feature of the Conference.

Thor-Axel Stenstrom, Head of Department of Water and Engineering Microbiology at the Swedish Institute for Infectious Disease Control, made a number of presentations at the Conference. The most important finding he presented was that – if requirements of time, temperature and pH level are met – ecological sanitation can be as effective as, or superior to, conventional wastewater treatment in bringing about pathogen reduction. Investigations so far are on a small scale and more studies are required. This finding is extremely encouraging in building an *a priori* case for ecological sanitation on grounds not only of environmental security but in order to promote human health.

Among Stenstrom's wide range of concerns in examining safety issues was the identification of the best method of evaluating microbial die-