INTRODUCTION TO THE CHINA-SWEDEN ERDOS ECO-TOWN PROJECT

Qiang Zhu

Senior Advisor, China – Sweden Erdos Eco-town Project (EETP)

Email: zhuq70@163.com

SUMMARY

The paper gives an introduction to the China-Sweden Erdos Eco-Town Project (EETP). The project is part of the Sida sponsored EcoSanRes Programme undertaken by the Stockholm Environment Institute and the Erdos Municipality and Donsheng District Government, Inner Mongolia in northern China. The project aims to generate the data, technologies and policies required to bring about a major change in the way urban settlements relate to the environment. In this paper components of the project and the planned monitoring and R&D programme are described and the global and local significances are justified. The paper also discusses the difficulties encountered whilst implementing the project and the counter measures.

1 GENERAL INTRODUCTION

The China – Sweden Erdos Eco-town Project (EETP) is part of the Sida sponsored EcoSanRes Programme, which explores, researched and implements ecological sanitation applications in urban and peri-urban areas in developing countries. The project is located in the Haozhaokui Village, Dongsheng District, Erdos Municipality, in the northern China Inner Mongolia Autonomous Region. Dongsheng is a rapidly developing town with an estimated population of around 400 000 in an area of 2200 km^2. The site is at an altitude of 1400 -1500m A.S.L and is characterized by the cold, dry and windy climate. The annual mean temperature is 5.6°C with an annual precipitation of 350mm and a potential evaporation of 2500mm. Dongsheng is one of the richest mining bases in China. Relying on the mining, cashmere textile and petroleum industry, GDP per capita of Erdos in 2003 exceeded US$2000, indicating a noticeable economic development in Erdos. There is however an absence of local water sources. The Yellow River lies 100km to the north and the river water table is 500m lower than the town. Water shortages have become the bottle neck of the social and economic development in Erdos, and conflicting interests in the use of the resource is one of the root causes for eco-system deterioration. The Inner Mongolia and local government have risen significant funding for a pumping project to divert water from the Yellow River to the town, have both the investment and operation and maintenance costs are extremely high. Only one third of the households in the city have a flush toilet, the remaining households share 370 public toilets, most of which are pit latrines[1].

Swedish supported ecological sanitation activities in China began in the northwest Guangxi province under the SanRes Programme in 1997. These activities have since spread to 17 provinces of the State, establishing 685,000 rural urine diversion dry toilets[2]. In the EETP the scope of the R&D has been widened from the previously focusing only on human excreta management to including the management of greywater, solid waste and the agricultural reuse of household residues in small towns and peri-urban areas. It is an ambitious attempt to generate the data, technologies and policies required to bring about a major change in the way urban settlements relate to the environment.

The major research/design issues to be tackled in the EETP are[3]:

- Providing ecosan solutions for human excreta management in multi-storey and single-storey buildings
- Providing ecosan solutions for greywater from multi-storey and single-storey buildings
- Providing ecosan solutions for source separation of solid and organic household waste
- Establishing eco-stations
- Associated studies are planned to include:
  - Public acceptance and awareness of ecosan solutions in the urban area
  - Public health aspects of the proposed technologies and policies
  - Agricultural implications of closing the loop
  - Institutional and legal measures required for the eco-towns development, and
  - Financial implications of building eco-towns

Figure 1 Location of EETP

The physical features of the project are:

The first phase of the project is to build a neighbourhood with forty 4-5 storey buildings and sixteen 2-storey houses in the southern part of the Haozhaokui area (HZK-S) for 826 households and a population of about 2900. All the buildings will be equipped with UD dry ecosan toilets. In the northwest of HZK-S, there will be an eco-station composed of a grey water (GRW) treatment plant and a post treatment pond, composting plant for faeces and organic waste, a solid waste station and the management building. A local estate developer called Daxing Company has been undertaking the construction and marketing of the housing project. Since this kind of eco-town is totally new to China, the local government sold the right of use of the land with a favourable price to the developer as an incentive. The project preparations started in early 2003 and construction began in July 2004. By the end of 2005, 32 four and five storey buildings in the first phase had been finished, and construction of a further ten will soon be completed. All the buildings have been sold. Up to now there are more than hundred households already moving in.

2 DESCRIPTION OF THE ECOLOGICAL SANITATION SYSTEM IN THE EETP

The ecosan system in EETP is composed of four sub-systems to treat the four waste flows from the households, namely, faeces, urine, GRW and solid waste.

2.1 Faeces system

The faeces management system in residential buildings of EETP is composed of urine diversion toilets, faeces drop chutes, faeces bins and bin covers and a ventilation system. Toilets in each floor have a chute for falling faeces. The chute goes through the floor to the basement where the faeces bins are located. The faeces system is illustrated in Figure 2.

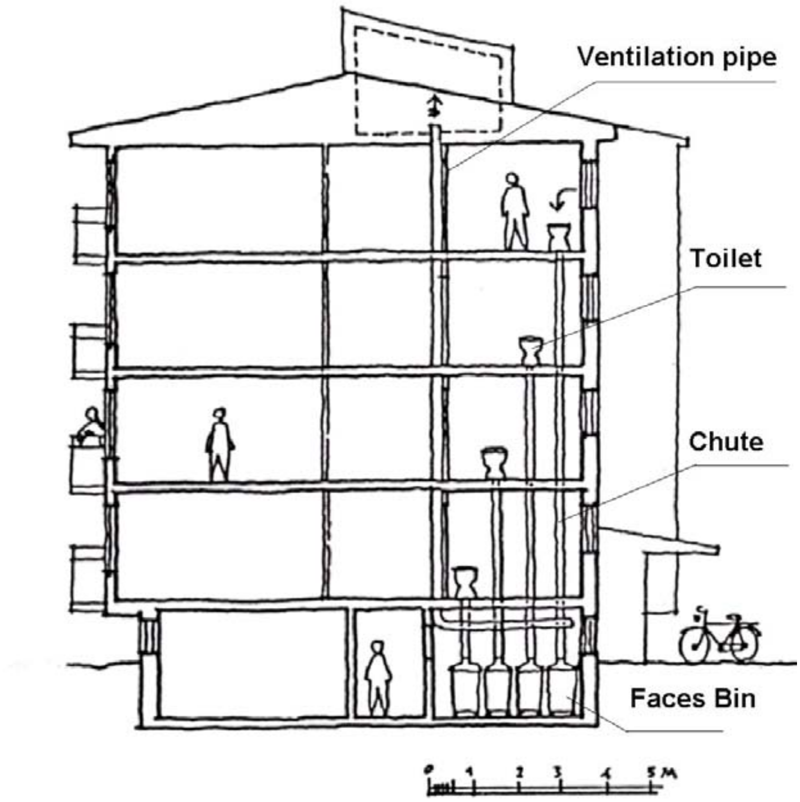

Figure 2 Faces system in the EETP

The toilet co-developed by Swedish and Chinese experts and manufactured by a porcelain company in the southern city of Chaozhou in Guangdong Province includes a porcelain seat toilet and a turning bowl device, see Figure 3. The toilet has two outlets: one for urine with I.D. of 15mm in the front and the faeces hole with I.D of 180 mm to the rear. The turning bowl is made of stainless steel coated with Teflon to avoid faeces sticking to it. The bowl is installed in a stainless steel cylinder. Two mechanisms have been developed to turn the bowl. In the original system, a rod is pushed when the users sits on the toilet seat, which then turns the bowl. When the user finishes and stands, the bowl is turned once more and the faeces drops. Another solution is a connecting lever system that turns the bowl when the seat is lifted[4].

The chute is PVC pipe with O.D. of 280 mm and is fixed on the floor. Faeces drop through the chute into a wheeled bin placed in the basement, which is replaced and emptied every 3 months. There is an access hatch to one side of the basement for lifting the bin to a small truck that transports the bins to the composting plant in the eco-station.

To prevent odour, there is a ventilation system (see Figure 6) composed of a branch and trunk pipe and a fan. By suction of the fan a slight negative pressure is created in the toilet room. Air through the toilet room, down the chute, through the bin, and through the branch and trunk pipe is to be expelled at roof level. To ensure effective ventilation, the route the air passes along are well sealed, and include a locally developed air tight cover for the bin, see Figure 4.

Figure 3 Urine diversion toilet and turning bowl

Figure 4 Air tight bin cover

Figure 5 Push handle for sawdust

To accelerate the drying process and to improve C:N ratio of the faeces, the user is asked to add sawdust before and after use. There are also two mechanisms to dispense the sawdust. Figure 5 shows one of the mechanisms.

2.2 Urine system

Urine drains the urine diversion toilet and from a urinal for men. The urine pipe leads to a total of 22 underground urine tanks located near the buildings. The challenge for the urine piping is the cold weather in winter when temperature can reach -20°C and ground frost penetration reaches 1.5m. All the pipes and inspection wells are located below the freezing line. To avoid the crystallization of urine on the pipe wall, the slope of outdoor pipe is steeper than 0.5% and the pipe diameter no less than 100mm. The urine tank is built of reinforced concrete with a capacity of one month storage with sealed top cover. To avoid urine vapour being sucked into the urinal and the toilet, the inlet pipe of the tank is submerged under the liquid. When the tank is full a suction truck will take urine out for the agriculture use.

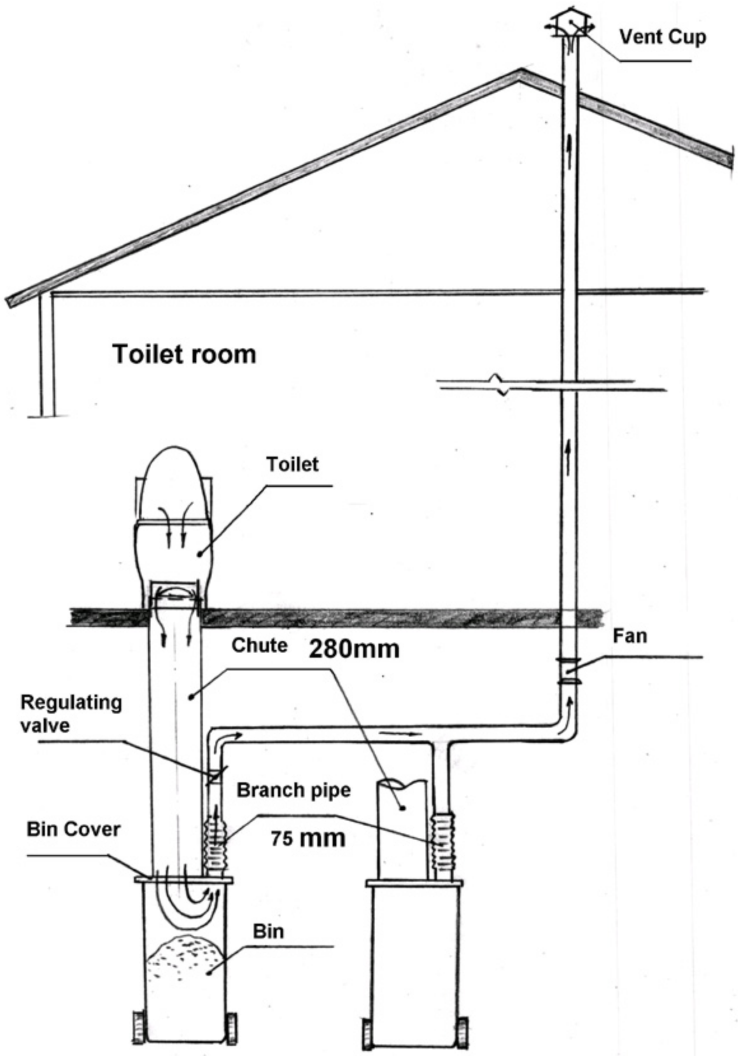

Figure 6 Ventilation system for the faeces system in EETP

2.3 GRW system

The GRW produced per person per day is estimated at 80 liters. Therefore a design flow of 250m³/d for the HZK-S has taken. All the GRW is drained through piping system (including pipes and inspection wells) to the treatment plant. There is little data on the pollution load of raw GRW and the treatment experiences in China. Following a technical and economic evaluation of different solutions, a bio-aerobic treatment technique proposed by a Chinese Institute has been adopted. The treatment plan consists of a septic tank and a complex tank. The septic tank is for settling larger solid particles in the GRW and to control the GRW flow. The complex tank is composed of hydrolisation-acidolysis tank, a bio-contact oxidising tank, a secondary settlement tank, an intermediate tank, and a clean water tank. Effluent from the intermediate tank can meet the demand of Class II drainage water in the China national code. For reuse of the treated water, the outflow will go through a highly efficient fibre filtering device with bind-type long fibre and sterilization treatment with automatic chemical addition.

The designed upper limit of pollutant in the effluent from the treatment plant is based on the national code, see the following table.

Table 1 **Design parameters of GRW system** (Unit: mg/l except for color, pH, turbidity, Coli bacteria)

	Color	COD_{cr}	BOD_5	SS/ turbidity	NH_3-N	PO_4^{3-}	pH	Cation Surface activator	Total remain Chloride	Coli bacteria
Raw GRW Estimated		400	250	200	25	5	6-7			
Drainage Class II	80	120	30	30	25	1.0	6-9			
Reuse	30		20	10NTU	20		6-9	1.0	1.0	3/l

To store the treated water for recycling, a pond has been built with a capacity of about 3800 m^3. There is a railway about 50 m away from the pond and road in the north and the west side of the pond. To avoid seepage flow causing damage to the embankment, the tank is partially lined with a geo-membrane. Part of the slope is left open for growing aquatic plants to further improve the water quality. The treated water is planned to be used to irrigate trees in the HZK-S and in the city and also to provide irrigation to greenhouses.

2.4 Eco-station

The eco-station is composed of GRW treatment plant, storage pond for treated water, composting plant, and solid waste centre as well as a management building. For management of the ecosan system of the EETP, a management and service team has been established. The team is to be operated on the market basis by selling the composted product, urine and recycled waste as well as by serving the neighbourhood.

The composting plant is to compost the faces and the organic waste from the kitchen using high temperature composting. The service team will collect the stored faeces and kitchen waste regularly and transport it to the plant. Some additives including material containing carbon and effective bacteria will be added to the compost.

The household solid waste is to be separated into organic and inorganic components at the household level and then be transported to the solid waste station, where part of the waste is sold for recycling and the other will be transported to the city refuse centre. Recycling of part of the solid waste has been a long tradition in China. Some people make their living from this. However most of the kitchen waste is disposed of and the waste is mixed in the household. To achieve source separation at household level, education and training is essential.

3 MONITORING, RESEARCH AND DEVELOPMENT

The EETP is now entering a new stage of testing the installed system and carrying out R&D activities, which consist of the following

– **Social study**: to investigate the public acceptability, performance and view of the ecosan system

- **Faeces system study** includes: observation of the toilet, absorbance of the bin and bin cover, measurement and experimentation of the composting plant, and testing and improvement of the ventilation system.
- **Urine system study** includes observation of the urinal, the urine pipe and measurements of urine tank as well as establishing the characteristics of fresh and stored urine
- **GRW study** includes monitoring and evaluation of the GRW system, feasibility study on reducing running cost and energy consumption of the existing system, and study on the properties of raw GRW and a small scale experiment of different treatment options
- **Study on agriculture reuse** of the composted product and urine includes the effect of using compost and urine to enhance the crop yield and quality, comparison of using compost and urine with the chemical fertiliser and pig manure, coupling effect of using compost and urine as well as recycling GRW for irrigation on the crop yield, and long term effect of using urine on the soil property and possible mitigation measures
- **Economic comparison** of ecosan systems and conventional systems by conducting a cost and benefit (direct and indirect) analysis. One of the emphases is to take the environment impact into consideration when analysing.
- **Environment impact assessment** of the ecosan system
- **Policy study**

The results (excluding those requiring long term study) will be summarised up and presented at a planned International Ecosan Conference and Exhibition to be held in Erdos in 2007or 2008.

3.1 SIGNIFICANCE OF THE EETP

Completion of the EETP can produce a model which is the first of its kind in China and the world, illustrating a new approach in the relation between urban settlements and the environment. The significance of this new approach can be summarised as follows:

Global significance

- Establish up a model for water resources conservation: water supply for households can be reduced by 1/4 to 1/3 by avoiding toilet flushing
- Establish a model for recycling human excreta, GRW and solid waste
- Establish a model to avoid / reduce environmental pollution

National significance

- China is now advocating building a resources conservation society and to develop a recycling economy as an integral art of creating a well-off society. The EETP is a sanitation model conforming to these principles.
- Urbanisation in China is expected to be continued at a high rate for the next 20-30 years. The ecosan approach demonstrated in EETP will provide a cost-effective and environmentally friendly way to provide sanitation to new urban dwellers and to avoid pollution.
- Water scarcity in China is becoming one of the crises in the new century, especially in those areas with serious water shortage like Erdos. Using the ecosan approach can mitigate this crisis in water.

3.2 DIFFICULTIES ENCOUNTERED AND RESPONSES

The ecosan system in HZK-S has been operating for about 9 months. Overall, the system functions as intended. However, as the system is not yet completed and the households are currently adapting to the new installations several difficulties have been encountered.

At household level, one difficulty has been the addition of water to the toilet by the users. This is in part due to the unfamiliarity of the users with dry systems, but also in part due to problems with cleaning the bowl. It is therefore necessary to find convenient ways for the users to clean the toilet without using water.

The households have also remarked that odours have been entering homes. Through many investigations the problem was identified as being the poor installation of various parts of the system. For example, not all urine tanks have been sealed at the top and the inlet pipe is not always below the surface of the urine so the ammonia in the tank is sucked up to the toilet room and creating bad smells. Additionally, more than half of the ventilations fans have not been installed.

A further difficulty is the different requirements development of this kind has on the estate developer, as there is a clear shift in responsibility from the municipality to the developer in many instances. As described above, the housing projects in EETP is undertaken by the estate developer basically using a marketing mechanism. Compared to conventional housing projects, the ecosan system requires a greater effort and a larger input on behalf of the developer. For example, the UD toilet system costs more than double that of a flushing toilet system. The GRW treatment plant and solid waste station that is usually part of the municipal works now must also be provided by the developer, and some of the commitments made to the developer by government have not been fulfilled. All these have demoralised the developer and at times resulted in a poor installation of the system. To promote ecosan systems in urban areas it will therefore be necessary to compensate the developer for their extra burden by ensuring that the policy and legislative framework is favourable to the ecosan approach and that further incentive measures are taken by the government.

4 CONCLUSION

Awareness raising and education of the households is also essential for the success of the EETP. General speaking, the flushing system is the preferred system for most of the urban population. Even in the EETP case, most of the users have never had the chance to use this system before moving into HZK-S, and dry systems are regarded as a return to the past, and not an element of their modern urban society. Actively informing the users through environmental and health education is essential to making such a project successful. To be use the ecosan system should be seen as an honourable contribution to the conservation of the environment and natural resources.

Continuously monitoring and optimising the ecosan system is also essential as it should provide a clean, safe and convenient system for the household. The EETP has taken a first bold step to try and change urban waste management systems that squander resources and in redefining the relationship urban settlements have with the surrounding environment.

5 REFERENCES

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