

**RURAL SANITATION**  
**IN**  
**ZHEJIANG PROVINCE, CHINA**

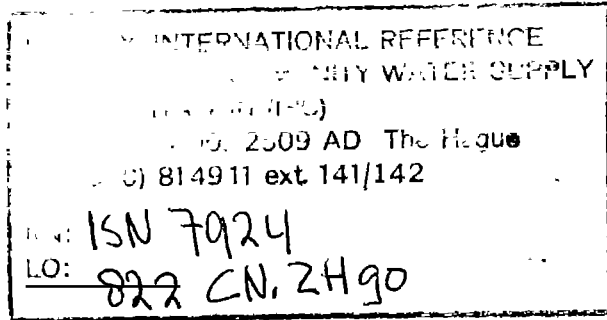
Report of Mission 2-8 April 1990

Martin Strauss

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**International Reference Centre for Waste Disposal (IRCWD),  
Ueberlandstr. 133, 8600 Duebendorf, Switzerland**





Acknowledgements

Acronyms and Chinese Words

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## **Acknowledgements**

I thank the personnel of the Zhejiang Health & Anti-Epidemic Station (ZHAS), the Zhejiang Province Scientific and Technical Exchange Centre (ZPSTC) and the Deqing County Anti-Epidemic Station (DCAS) for the excellent organisation of my visit and of the field tour which was undertaken to Deqing County with the Project Group. The hospitality I experienced both in Hangzhou and in Deqing County rendered my stay very pleasant and made me feel "at home".

A special appreciation goes to Mrs. Zhu An Li of ZPSTC and to Mr. Xu Xiang Kuan of ZHAS.



**Acronyms and Chinese Words**

DCAS	-	Deqing County Anti-Epidemic Station, Deqing
IRCWD	-	International Reference Centre for Waste Disposal
STI	-	Swiss Tropical Institute, Basel
ZHAS	-	Zhejiang Health and Anti-Epidemic Station, Hangzhou
ZPHB	-	Zhejiang Provincial Health Bureau, Hangzhou
ZPHCO	-	Zhejiang Patriotic Health Campaign Office
ZPSTC	-	Zhejiang Province Scientific and Technical Exchange Centre, Hangzhou
Project Group	-	The group of persons from ZHAS, ZPSTC and DCAS who carry out and are responsible for the latrine monitoring programme and the epidemiological study
cun	-	village
shan	-	mountain





## **1. Purpose, Scope and Timing of the Mission**

Following the issuing of the letter of intention by ZPSTEC/ZPHCO and IRCWD/EAWAG in April 1988, ZHAS submitted a research proposal-cum-budget to IRCWD in 1989. Based on this proposal and on several discussions, a collaboration agreement was signed by ZHAS, ZPSTC, ZPHCO, and EAWAG in November 1989.

EAWAG/IRCWD will assist ZHAS with the installation of 400 3-vault latrines, with the monitoring of a number of them for the die-off of *Ascaris* eggs, and with conducting an epidemiological study to assess the relative risk to those farmers using stored/treated excreta vs those using unstored excreta from traditional latrines.

By March 1990, most of the 400 latrines had been installed, the control area for the epidemiological study selected and the protocols for both the latrine assessment and the epidemiological study drafted. This was considered a suitable point in time to undertake a mission to Zhejiang Province in order to establish personal contacts with the investigators and the authorities concerned, to visit and familiarize myself with the pilot area, as well as to discuss the investigation protocols. We agreed to schedule the mission for the period between April 2-8, 1990.

## **2. Excreta Disposal and the New 3-Cell Latrine in Deqing County - A Short Background Report**

### **2.1 Traditional excreta disposal and use**

The family latrine of most farmers is located in the shed behind the farmhouse which also contains the pigsty and the storeroom for the farming implements.

The common traditional latrine consists of a burnt clay pot of approx. 100 l over which a simple wooden seating structure is mounted (see Photograph 1).

When full, the faecal slurry is scooped out into two wooden buckets which, in turn, are then carried on a yoke to the field or vegetable



garden where the content is used for plant fertilization (Photographs 2&3).

Simple pot-latrines are also found on highways, canals and in the fields, allowing passers-by to deposit their faeces in a controlled manner. Farmers living nearby use the contents of these "public" toilets when they fill up.

## 2.2 Development of the 3-cell latrine

In view of the obvious risk of disease transmission through the use of fresh excreta, the personnel of the Deqing County Anti-Epidemic Station started, in the mid-80's, to engage in the development of an improved latrine and excreta storage/treatment system. The R&D activities were initiated after the National Health Patriotic Committee had set the goal for "Health for All by the Year 2000". Deqing County was one of the 10 Counties selected for the demonstration projects. In 1985, the project was initiated by a base-line study on excreta disposal in Deqing County. Qian cun<sup>1</sup>, a village in Mogan Shan Township, was then selected as a pilot village.

The new latrine consists of 3 jars of approx. 120 l each which are connected by short pieces of angled PVC pipes (see Annex 4 and Photograph 4). The toilet seat with the drop pipe is mounted on jar No. 1. The system can be compared to a septic tank: the bulk of the settleable and floatable solids, including the helminth eggs, are retained in jar 1. The liquid and unsettled solid are displaced from jar 1 to jar 2, and subsequently to jar 3. The minimum liquid retention times in jars 1 and 2 are 8 and 12 days approximately (see also Annex 4). All three jars are covered by air-tight reinforced concrete slabs (see Photograph 4).

29 3-cell family latrines were installed and taken into use in Qian cun at the beginning of 1987.

The cost of a latrine amounts to approx. Yuan 300 = US \$ 91 (price level and exchange rate of 1989). Thereof, the plastic sitting commode and the connecting pipes cost \$ 37.

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<sup>1</sup> cun = village



The latrines were monitored 5 times between February and September 1987 to assess the pattern of coliform and egg die-off. The following observations were made:

	<u>Cell 1</u>	<u>Cell 3</u>	<u>% removal</u>
• Tot. coliforms/g <sup>2</sup>	10 <sup>6</sup> - 10 <sup>11</sup>	10 <sup>4</sup> - 10 <sup>6</sup>	≥ 99%
• Tot. Ascaris eggs/100 ml <sup>2</sup>	1000s	10s - 100s	> 95 %

Cell 3 is emptied out at intervals of about 2 weeks. The contents, which are rather liquid (compared to the contents of cells 1 and 2, see Photograph 5), are diluted further with water and then applied to the crops. The cells Nos. 1 and 2 are emptied out once every 1-2 years. Their contents are substantially thicker than the ones from cell 3 (see Photographs 6 + 7), and are treated by disinfecting agents<sup>3</sup> prior to their use on the fields.

DCAS has issued an instruction leaflet for the proper storage, treatment and use of the excreta (Photograph 8).

While devising the new type of latrine, the main criteria was certainly the elimination of the health risk associated with the use of the excreta. This is attempted by allowing solids/liquid separation in jars 1 and 2, and by treating the contents of those jars with a disinfecting agent. Another important criteria is the elimination or at least the reduction of the high losses of nitrogen. During excreta storage, the high loss of nitrogen through the dissipation of gaseous forms of nitrogen (NH<sub>3</sub>, N<sub>2</sub>) is a phenomenon which has, for a long time, been observed and reported by farmers. This is apparently an inherent characteristic of the traditional toilet, where excreta are stored in uncovered jars. The N-loss in the new 3-cell latrines is, however, substantially lower. This, consequently, leads to a higher fertilization potential of the contents of the new latrines over the contents of the old systems.

<sup>2</sup> State Standards stipulate a max. coliform concentration of 10<sup>4</sup>/g, 95% removal of tot. eggs and zero schistosoma and hookworm eggs.

<sup>3</sup> To date, pesticides (org. phosphate) are used as ovicides at the rate of approx. 100 ml/pit prior to emptying. The pesticide costs ¥5 per 500 ml



Pig manure and human excreta have been, for many centuries, the farmers' main organic fertilizers. Today, these fertilizers are still widely used. The new latrine was designed in such a way as to enable the farmers to continue using the stored excreta in essentially the traditional manner.

In order to promote the new latrine, ZPSTC and ZPHB held a demonstration seminar in Deqing County in May 1990, to which the leaders of six counties of Zhejiang Province were called.

### **2.3 The latrine monitoring programme and the epidemiological study**

#### **Latrine monitoring**

The 400 new 3-cell latrines have been installed in **Liao Yuan** village, which is an administrative unit of Mogan Shan Township located on the foothills of Mogan Shan. The area is situated about 80 km north of Hangzhou and is part of Deqing County. **He**, the village which was selected as the control area, lies only a few kilometres from Liao Yuan.

In each village, **20** latrine units will be **selected randomly** for inclusion in the latrine performance study. The main elements of the study are:

- Objectives
  - Assessment of the pathogen concentrations and the pathogen removal or die-off pattern.
  - Assessment of the fermentation pattern and the fertilizing potential of the faecal material (N content).
  - Comparative evaluation of traditional and new latrines.
- Observed and analysed parameters:
  - Colour, consistency and shape of the faecal matter (gives indications as to the degree of fermentation).
  - Odour.





- Density.
- Temperature.
- pH.
- Ammonia nitrogen.
- Water (or solids) content.
- Organic/inorganic fraction.
- E. coli.
- Ascaris eggs (total number and viability).

The latrines will be monitored over a period of nearly 3 years. Particular attention will be paid to the effect of the pesticide (organic phosphate) which is used to inactivate the worm eggs in the jars Nos. 1 and 2.

While the contents of jar No. 3 are rather liquid and homogeneous, the contents of jars Nos. 1 and 2 are "stratified" (particularly so in jar No. 1). The drop pipe which is attached to the jar cover, forces the excreta to pass through the lower part of the jar (see Photograph 6). The solids settle partly to the bottom and partly rise to the top of the jar where they form a thick black floating cover (see Photograph 6). A sampling device will be used to take samples separately from the top, middle and bottom layers of the faecal content.

### **The epidemiological study**

A longitudinal study will be undertaken to determine whether and to what extent the intestinal parasite (helminth) prevalence are lower among the families using the excreta from the new 3-cell latrines than among those using the contents from the traditional latrines.

The major features of the study are:

- Stool examination and deworming of the infected persons at the beginning of the latrine monitoring programme; stool tests after 1, 2 and 3 years.
- At the start, two age groups were planned: the 7-15 years old (those not involved in farming), and the 16-55 years old (those involved in farming). Recent demographic investigations reveal



that the 7-15 year age group comprises only about 170 in each village. Only 1 age group (7-55 years) was, therefore, chosen.

- Total sample size: 500 persons each in the intervention and the control area.
- In a preliminary study, the *Ascaris* and *trichuris* prevalence among the 7-15 years old was found to be 44 and 14%, respectively.  
assumed prevalence among the 16.-55 years old: 35%.
- Assumed reduction in prevalence: 10-15 % among the users of 3-cell latrines.
- See sections 3.3 and 3.4 below for further items.

### **3 My Activities and Observations**

#### **3.0 General observations and impressions regarding farming and excreta use in the area**

- Farmers in Deqing County appear to do rather well economically as most of them have, in the past five years, either built their own new two-storey farmhouse, or are in the process of constructing a new one. (No bank loans are available for private housing construction). All new farmhouses are built according to a standard design and with the main entrance (see Photograph 9), facing south. Therefore, the houses stand in parallel lines. The kitchen (Photograph 10), bathroom and a large central storeroom and meeting room are on ground level, while the living room and the bedrooms are housed on the first floor.
- Where there is a piped water supply scheme, most new farmhouses have 2-3 in-house taps and usually one kitchen, one bathroom and one yard tap. The greywater from the kitchen and bathroom is drained into nearby streams or ponds.
- Farmers tend to use the pig and sheep manure for the rice fields, while the human manure is used mainly for vegetable, rapeseed and wheat cultivations.



- The arable land allocated to a standard-size family is 1.5 Mu ( $\cong 1000 \text{ m}^2$ )<sup>4</sup> in size. Thereof, 0.8 Mu are paddy fields and 0.7 Mu are for vegetables and "dry" crops. In addition, farmers may have small vegetables plots next to their house. The farmers have to sell part of their paddy harvest to the cooperative authorities, but may sell all other harvested crops on the "free" market. Since consumers in nearby towns and cities have a high demand for vegetables, it has boosted farmers' income substantially in recent years.
- On the individual farmer's level, only a low degree of mechanization was noted. However, my visit fell during the first week of April when there are no harvesting or ploughing activities. Nevertheless, no or hardly any mechanical equipment or machinery was seen during the visits to the farmhouses.
- All vegetables, except only a few (e.g. tomatoes, cucumbers, cauliflower), are usually eaten cooked.
- The main parasitic diseases in Zhejiang Province are Ascariasis, Trichuriasis, pinworm, and hookworm in a few areas.

### **3.1 Visit to the latrine demonstration, the intervention and the control villages in Deqing County (see Photograph 11)**

#### **Qian cun - the demonstration village**

- In this village, 29 3-cell latrines were installed and put into operation in 1986/87.
- Three farming families were visited, their toilet installation observed and short discussions held.
- Farmer A: latrine in use for 3 years; pits 1 and 2 are emptied once a year; contents of pits 1 and 2 are treated with pesticide (org. phosphate) and buried at a depth of 40 cm in arable land; topsoil is added and the seeds or seedlings planted a few weeks later; the contents of pit 3 are diluted 3-fold prior to use; the

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<sup>4</sup> 15 Mu = 1 ha = 10,000m<sup>2</sup>



contents of the new latrines have reportedly a higher fertilizing capacity than those from traditional latrines.

The farmer also owns a fish pond of approx. 30x50 m which he fertilizes with excreta; the fish are harvested once a year for the Chinese New Year by draining the pond and catching the fish with nets or by hand; the farmer wears gum boots while wading inside the pond.

- Farmer B: latrine in use for 4 years; pits **1** and **2** are emptied once a year; no odour, no flies are reported.
- Farmer C: finds new latrine much more advantageous than old system; approx. 1 dl of org. phosphate is added to the contents of pits **1** and **2**, which are, reportedly, quite hard to stir; after treatment, the excreta are carried to the fields (rapeseed, wheat) by yoke.

#### **Liao Yuan cun - the intervention village**

- See also Photographs .
- Several farming families were visited and latrines inspected which have only just recently been installed.
- Met the village project leader, Mr Wang Li Yong, and the director of Mogan Shan Township public health station, Mr Wang Jian Fu.
- 400 latrines were installed in 8 sub-villages, most latrines are equipped with plastic toilet seats produced by the Hangzhou Plastic Parts Factory.
- Children's excreta are reportedly collected in chamber pots and then emptied into the latrine.

#### **He cun - the control village**

- See also Photograph 12.





- Farmers in this village appear to be of equal, i.e. relatively high economic status as the families in Liao Yuan cun, the intervention village.
- Met the village leader, Mr Wang Zhu Fu and the mayor of Mogan Shan township, Mr Jin Qiu Yong.
- Human excreta are used in horticulture (miscell. vegetables), paddy seed fields, rapeseed, and on wheat; pig and sheep manure is applied to the rice fields.
- One of the interviewed farmers reported that he applies diluted faecal slurry to his vegetable garden (see Photograph 13) at an approx. 14-day interval, however, he stops application the "latest a few weeks prior to harvest". The vegetables grown include potatoes, low-growing beans, lettuce, and egg plants.
- The source of the village water supply is an impoundment reservoir upstream of the village. Most houses are equipped with 2-3 in-house water taps.
- The interviewed farmer is hardly ever ill. The clinic does regular stool analyses, mainly screening for schistosomiasis.

### **3.2 Visit to the Deqing County Anti-Epidemic Station - Health Control Laboratory**

- My two-hour visit to the laboratory was guided by its head, Mr Zhu Xu Gen.
- Staffed by 7 persons, the Health Control Laboratory carries out chemical, physical and biological analyses of water, nightsoil, food, and air.
- Besides having analytical tasks, the Station also acts as a law-enforcing agency.
- The health control section holds, among other things, training courses for the personnel of township laboratories.



- Discussions were held about the analytical methods for the detection of helminth eggs.
  - Egg analysis in stool: rough screening with copper mesh; dilution and sedimentation (3-4 times); microscopic examinations of the sediment.
  - Egg analysis in semi-solid faecal wastes (e.g. middle layer in cell 1 of the 3-pit latrines or in the contents of pit 3): concentration technique: water suspension; sedimentation; centrifugation; microscopic examination of the sediment. Eggs with larvae are examined for viability by the incubation method.
  - Egg analysis for rather solid faecal wastes: dilution + 1/2 hr sedimentation (3-4 times).
  - Zn SO<sub>4</sub> flotation, a method devised by the team of Prof. Schwartzbrod, University of Nancy, for Ascaris detection, is used in the Dequing laboratory for schistosomiasis control.
  - Filtration with filter fabric ( $\phi = 11 \mu$ ) is used as a first step in the "improved Kato-Katz" method applied for egg detection in fresh human excreta.

### **3.3 Discussion on the latrine monitoring and on the epidemiological study**

- See also Photographs 14 & 15
- A discussion, chaired by Mr Xu, was held at the Wuling Guest House, Mogan Shan, to deliberate about the relevant aspects of the two studies, for which ZHAS has drawn up the protocols. ZHAS, ZPSTC, ZPHB, and DCAS were the organisations represented at the meeting.



- The latrine performance study:
  - 20 latrines will be selected randomly for the detailed monitoring of faecal coliforms, worm eggs and physical and chemical parameters.  
The users of these latrines must come from among those infected by worms but may not receive deworming treatment.
  - Sampling from the latrines:
    - Pit **3** : Every 3 months from May '90 - Feb. '93.
    - Pit **1** and **2** : random selection of 5 latrines out of the 20 to analyse sediment and floating layer.
    - Ovicidal effect of pesticides and ammonia: 2 courses with 5 latrines during the study.
    - Traditional latrines: approx. 5 sampling campaigns
  - Stool sampling among the 20 families: 5 campaigns between May '90 and May '91.
  - Dewormed persons are re-examined 40 days after treatment; if dewormed persons become reinfected, their latrine should, if possible, be included in the latrine study in order to assess the potential route of reinfection.
  - The latrines will be sampled and the samples analysed by DCAS.
  - The following treatment parameters will be observed or measured:
 

Temperature	Colour and consistency
Density	NH <sub>4</sub> and NH <sub>3</sub>
pH	Org./inorganic matter
Water/solids fractions	
Faecal coliform	
Ascaris eggs (no. and viability)	



- The epidemiological study:
  - 500 persons between 7 and 55 years of age each in the intervention and control area.
  - Age grouping was deemed unfeasible since only about 170 persons would fall into the 7-15 category in each area, i.e. too few to allow statistically significant results.
  - Initial stool sampling and deworming of those infected at the start of latrine usage; further stool examinations will be made after 1, 2 and 3 years.
  - The proposal by STI to consider the possibility for nested case-control studies within the longitudinal study, will be deliberated upon directly between ZHAS and STI.

#### **3.4 About a possible collaboration between the Zhejiang Province authorities and the Swiss Tropical Institute (STI), Basel**

- IRCWD has only limited expertise in epidemiology. It therefore called upon STI, with which it has a long-standing relationship, and sought STI's professional support in this project. Dr Marcel Tanner, head of STI's Department of Public Health and Epidemiology, expressed strong interest in joining efforts and in being a discussion partner for ZHAS and the other authorities of Zhejiang Province involved in the study.
- The feasibility and possibility of a collaboration was discussed during the meetings held at ZPSTC on 3 April and at ZHAS on 7 April 1990. Interest was stated both by ZPHB and ZHAS to enter into some form of collaboration with STI, not only for the current latrine study, but possibly also for other activities. The Zhejiang Academy of Medical Sciences is an institution engaged specifically in tropical disease research. The exact form and collaboration procedure would have to be deliberated upon during a first visit to China by STI.





- STI expressed its interest to pay a first visit to the Zhejiang Province. It will send one or two of its collaborators in order to get familiar with the people, culture and the endemic situation in the study area, and deliberate directly with all the authorities involved about the relevant aspects of the study. The cost for such an initial phase will be borne by STI.
- STI's proposal of complementing the longitudinal study by so-called nested case-control studies was discussed. A difficulty was seen in defining a "case" with a helminthic disease.
- I carried a letter from Mr Xu to Dr Tanner in which several comments and questions were made regarding the case-control approach.
- Due to an unfortunate misunderstanding, a visit by some of the STI personnel to China, which could have possibly taken place in July '90, had to be cancelled. The earliest possible time of travel appears to be in October '90.
- I assured our partners that a possible involvement of STI would not in any way curtail IRCWD's engagement neither should it lead to unclear or ambiguous areas of responsibilities, all the more that STI and IRCWD have developed good institutional and personal relationships.

### **3.5 Concluding remarks**

Three months have passed since my visit to Hangzhou and Dequing County. Looking back, I notice that the following impressions have, among others, remained as special highlights:

- In spite of farmers' easy access to and affordability of chemical fertilizer, the use of excreta in agriculture continues to be practised without saying. This is particularly impressive as I live in a society which has largely "lost contact" with its own bodily products and which lets the excrements to be carried away by



water and allows them to be contaminated with municipal and industrial wastes.

- Unlike in many other cultures, including the one in Western Europe, defecation habits, excreta handling and use, as well as deliberation on these matters, is not taboo in the villages I visited.
- For the development of the 3-cell latrine, the traditional defecation practice, as well as the traditional practice and farmers' need of using excreta as a soil conditioner and fertilizer have been taken into account. The 3-cell latrine is composed essentially of the same construction elements as the traditional system in which a burnt clay or stoneware jar of approx. 100 l volume is used for excreta storage.
- The 3-cell latrines, including the plastic sitting commode, are technically well-conceived. They provide safety and comfort and appear to be fly and odour free. The air-tight cover of the jars help to reduce considerably the loss of nitrogen.

Herewith are some critical comments and thoughts regarding helminth egg removal in the 3-cell latrines. These subjects were also discussed during the visit to the investigation area and during the evaluation meeting held at ZHAS on 8 April 1990.

- Although the new type of latrine facilitates the separation of the settleable/floatable solids from the liquid fraction and leads to an overall egg reduction of  $\geq 95\%$ , considerable loads of helminth eggs (tens to hundreds' per 100 ml according to the preliminary assessment) are still recovered from cell No. 3. The percentage of viable eggs has not been determined yet, however, it can be assumed that viability is high since the total retention in jars Nos. 1 and 2 is only about 3 weeks. The outcome of the epidemiological study might reveal whether the achieved egg removal, which is nevertheless substantial, will contribute to an equally substantial reduction of helminth prevalence among the farming families using the improved latrines.



- The current use of organo-phosphate insecticides (Dedevap = Dichlorphos and Tamaron) is questionable since the chemicals are toxic and therefore dangerous to handle. Degradation intermediates of these insecticides might be non-biodegradable and might therefore accumulate in the soil and in plants. The question to be answered here is whether the use of insecticides is really necessary and justified. It is a **balancing of risks**: the potential risk of helminthic infection if the pit contents are not treated with insecticides vs. the risk of using the insecticides which are toxic and may harm the soil environment.
- Farmers are directed to "bury" the insecticide-treated faecal contents. If they actually accept this protective measure, pesticides or other toxic or costly disinfecting agents would no longer be required, as direct contact with the faecal matter would be largely excluded. The risk of infection via untreated, buried faecal matter from cells Nos. 1 and 2 would possibly be lower than via the use of the contents from cell 3, which is likely to still contain considerable loads of viable eggs, and which is applied directly to the plants.



## ANNEX 1

## Photographic Documentation

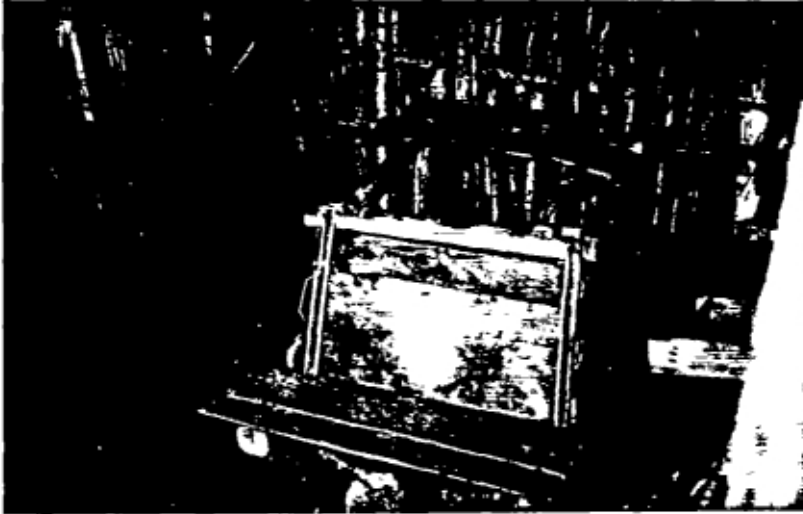


Photo 1: Traditional one-jar latrine



Photo 2: Wooden jars used to carry the excreta to the field



Photo 3: The faecal slurry has been carried to the nearby vegetable garden



Photo 4: The new, 3-cell latrine; used toilet paper is deposited in the basket and later burnt







Photo 5: Jar no. 3; its content is rather liquid



Photo 6: Jar no. 1; a thick scum layer has formed; reinforced concrete covers with drop pipe



Photo 7: Jar no. 2; its content has a light-yellowish color and is thinner than the

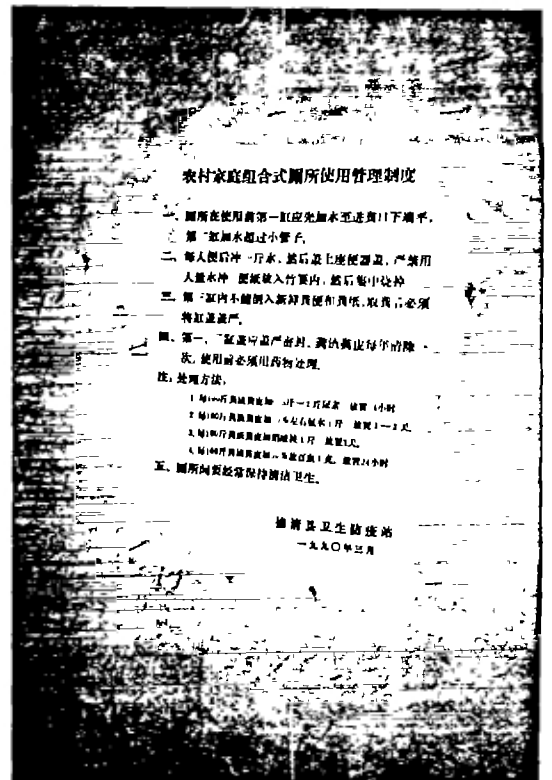


Photo 8: Instructions for the handling and use of the stored excreta





Photo 9: Newly constructed farm houses in the intervention sub-villages



Photo 10: Owners in the kitchen of their new farm house (Qian village)



Photo 11: The investigation area of Daging County in the rolling foot hills of Mogan Shan

Photo 12: The Project Group visiting He, the control village







Photo 13: A farmer in He cun fertilizing his potato bed with diluted excreta from the traditional toilet



Photo 14: Members of the Project Group at the Wuling Guest House, Mogan Shan, during the 4-day field visit to Deqing County



Photo 15: Members of the Project Group discussing technical aspects of the new, 3-cell toilet



**ANNEX 2****Itinerary**

- 1990, Sun/Mon - Flight Dhaka - Kathmandu -  
1/2 April Hong Kong - Hangzhou (arr. Hangzhou 14.00)
- Discussion of work programme
- Tue, 3 April - Meeting and briefing at ZPSTC;  
organisations represented: ZPSTC; ZPPHB, ZHAS;  
lunch hosted by ZPSTC
- Trip Hangzhou - Mogan Shan (Dequing County  
investigation area)
- Briefing by <sup>C</sup>DQAS about the latrine project history
- Wed, 4 April - Visit to He, the control village for the  
epidemiological study
- Visit to Qian, the village in which 29  
demonstration latrines were built in 1987
- Thu, 5 April - Visit to Liao Yuan, the intervention village
- Discussion on details of the latrine monitoring  
programme and the epidemiological study
- Fri, 6 April - Visit to the <sup>C</sup>DQAS control laboratory
- Visit to a village-owned reservoir with excreta-  
fertilized aquaculture at Ming Jing cun
- Sat, 7 April - Trip Mogan Shan - Hangzhou
- Lecture at the ZHAS training centre on pathogen  
die-off, latrine technology and excreta use  
Meeting on the evaluation of the visit and the  
state-of-matters
- Sun, 8 April - Sightseeing, final deliberations and dinner hosted  
by ZHAS
- Mon, 9 April - Departure for Suzhou





**ANNEX 3****Persons met**

- **Zhejiang Province Hygiene and Anti-Epidemic Station**

17 Lao Zhe Da Lu  
Hangzhou 310009, P.R. China

Tel.: 0571 - 77 31 24

- Mr Zhou Shao Cong, Director ZHAS
- Mr Mao Pei Deng, Director Institute of Environmental Health Control and Monitoring
- Mr Cong Li Ming, Deputy Director Institute of Environmental Health Control and Monitoring
- Mr Xu Xiang Kuan\*, Deputy Director Institute of Environmental Health Inspection, Project Group leader
- Mr Shen Tu-hang\* , Epidemiologist
- Mr Hou Seng Liang
- Mrs Wang Ming di
- Mrs Zheng Su Niu\*, Parasitologist

- **Zhejiang Province Science and Technology Commission**

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Tel.: 0571 - 75 40 44/3

- Prof. Chen Chuan Qun, Deputy Director ZPSTC
- Mr Ruan Yong Zhen, Director Dept. of International Cooperation
- Mrs Zhu An Li\*, Translator/Project Group Liaison Officer
- Mr Zhang Rong Xing\*, Senior Eng., Environmental Division

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\* Member, Project Group



- **Deqing County Anti-Epidemic Station**
  - Mr Zu Tian Chang\*, Director DCAS
  - Mr Wang Jin Tang\*, former Director DCAS
  
- **Mogan Shan Township Public Health Station**
  - Mr Wang Tian Fu\*, Director
  
- **Zhejiang Province Health Bureau**

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Tel.: 0571 - 77 75 51

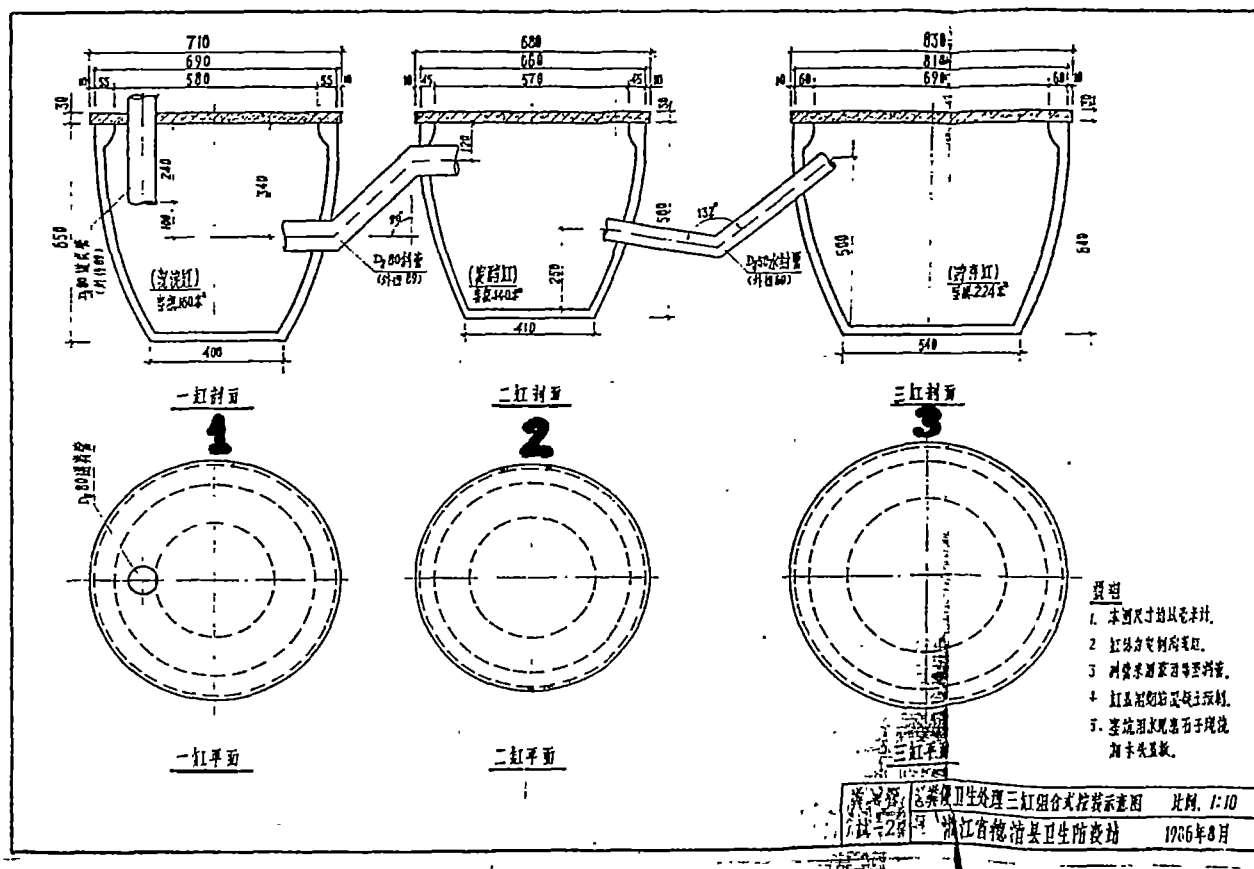
  - Dr Zhuang Bing Jing, Deputy Director
  
- **Zhejiang Patriotic Health Campaign Committee**
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## ANNEX 4: Design of the 3-cell latrine and calculation for the hydraulic retention period

### Design

Sectional view of the 3-cell system developed by ZHAS and DCAS.



### Hydraulic retention time

- Effective volume of cells 1 and 2:

$$V_1 \cong (0.25 \text{ m}^2) \cdot \Pi \cdot 0.65 \text{ m} = 0.127 \text{ m}^3$$

$$V_2 \cong (0.25 \text{ m}^2) \cdot \Pi \cdot 0.58 \text{ m} = 0.114 \text{ m}^3$$

Assumption: 30% of cell 1 and 50% of cell 2 are available for liquid retention when the cells are "full"

1	100	100
2	100	100
3	100	100
4	100	100
5	100	100
6	100	100
7	100	100
8	100	100
9	100	100
10	100	100
11	100	100
12	100	100
13	100	100
14	100	100
15	100	100
16	100	100
17	100	100
18	100	100
19	100	100
20	100	100
21	100	100
22	100	100
23	100	100
24	100	100
25	100	100
26	100	100
27	100	100
28	100	100
29	100	100
30	100	100
31	100	100
32	100	100
33	100	100
34	100	100
35	100	100
36	100	100
37	100	100
38	100	100
39	100	100
40	100	100
41	100	100
42	100	100
43	100	100
44	100	100
45	100	100
46	100	100
47	100	100
48	100	100
49	100	100
50	100	100

$$\therefore V_{\text{eff } 1} \cong 0.04 \text{ m}^3$$

$$\therefore V_{\text{eff } 2} \cong 0.06 \text{ m}^3$$

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$$\underline{\underline{0.1 \text{ m}^3}}$$

- Assumed liquid load:

$$\begin{aligned} & 4 \text{ adult equivalents @ } 1.2 \text{ l/d} \\ & = 4.8 \text{ l/d} \end{aligned}$$

- Liquid retention in cells 1 and 2:

$$t_{1\&2} = \sqrt[4]{F(100 \text{ l}, 4.8 \text{ l/d})} = \mathbf{21 \text{ days}}$$

- Assuming an emptying frequency of 10-14 days for cell **3**, the total **retention time** for the liquid is in the order of **30 - 35 days**.

This period is sufficient to achieve complete or almost complete, i.e. 3 - 4 orders of magnitude, reduction in bacterial and viral pathogens. Protozoa, too, will be inactivated. Helminth eggs, in particular *Ascaris* eggs, will be inactivated to a limited degree, only.

