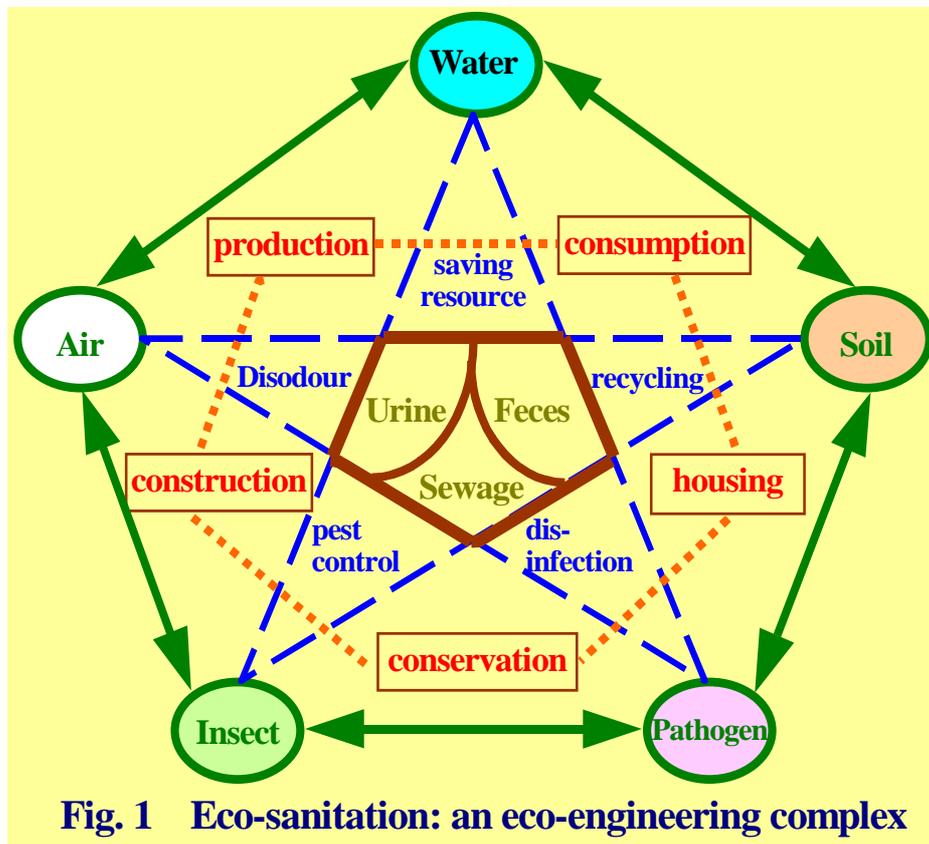


SYSTEM CONSIDERATION OF ECO-SANITATION IN CHINA

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Eco-sanitation can only be assured with a human-ecological understanding of the complex interaction of environmental, economic and social/cultural factors and with comprehensive planning and management grounded on ecological principles.

1 . Old tradition and new transition

As a traditional agricultural society, ancient China paid more attention to water-land sustainability. To survive from the marginal water and land, people have to plan, design and manage their environment in accordance with nature by resorting to making efficient use of resources from their native ecosystem. There were no wastes in ancient China, either in towns or countries, all wastes were degradable and used as fuel, forage or fertiliser for local ecosystem. Chinese people have a long ecological tradition of efficient resource use including wastes recycling and goods repairing. Wasting grain, paper, and clothes, no matter how plentiful they are, is considered immoral behavior that will be punished by God according to ancient tradition. There are salvage stations in every city, which are in charge of collecting used paper, glass, metal, plastics, etc. Newspapers, books, packing boxes, rusted metal utensils, tins, bottles and even toothpaste tubes are sorted there for recycling. Excrement and wasted vegetables are collected by farmers for manure. Sanitation records in China could be dated to 5,000 years ago. The feces and urine collection system was well developed in Chinese cities, through which the night stools were collected door to

door in the early morning by a nightsoil cart then sent to suburbs for crop fertilizing. Complete separation of human and animal metabolism from water cycling without using chemical fertilizer. Surplus food and agro-wastes were used as fodder for livestock without polluting watershed, clothes were cleaned by plant cleaners rather than chemical detergents, biodiversity was maintained to control pests ecologically without using pesticides. There were hundreds upon hundreds of villages in China where agriculture was sustainable for centuries and people are sharing their sanitation system with nature, with cities and with each other. In south China, more human and animal wastes are used to produce biogas and liquid fertilizer to ensure sanitizing, wastes recycling and supply energy to households. While in North China, where the per capita water resource is only 522 m³, human and animal wastes are usually dried or fermented for fertilizer.

However, along with the transition from rural society into urban and industrial society started two decades ago, the philosophy of "man and nature be in one" is transformed into "Man could conquer nature", the reductionism is substituting holism, diversified human ecosystem is being substituted by mono-production and monoculture, self-reliant life style is being substituted by modern life style characterized by high-energy consumption and high environmental impacts. The sanitation change is one of this transition. Nightstool cart is disappearing, bio-gas system is shrinking.

General speaking, the present human society is a somewhat inefficient, immoral, unhealthy, counter--cybernetical and less ecologically viable habitat. Its efficiency of resource using is much lower than that of a natural or agricultural ecosystem. It exploits resource through degradation of hinterland ecosystem and imposes environmental impacts on its surroundings. Its people are estranged and competitive rather than intimate and cooperative. Its artificial living and working environment is far away from the real needs of human health. People more and more rely on electricity, water, car and chemicals to survive themselves, more and more depart from nature.

In order to jump out from this ecologically decaying culture, a refinement of people's concepts, thoughts, values, manners, emotions, tastes, customs and habits should be encouraged. And an eco-cultural revolution in production mode, life style and consumption behavior is necessary. Only when the life style is harmonious with nature in metabolism process, structural pattern and functional development, and human activities are enhancing rather than depleting the life supporting system, that a sustainable development is expected to be realised (Wang, Zhao and Ouyang, 1996).

Contrasted with the mechanical thoughts dominated in early-industrial societies, the human ecological thoughts in ancient China emphasises system nexus and dialectical thinking, advocating Man and Nature be in One. The Tian (heaven or nature), Di (earth or resources) and Ren (people or society) and their relationships have been investigated for thousands of years and formed the concept of Chinese human sustainability. The result is a systematic set of principles for managing the relationship between man and his environment, including Dao-Li (physical relationship with the universe, geography, climate, etc.), Shi-Li (planning and management of human activities, such as agriculture, warfare, politics, medicine.), and Qing-Li (ecological ethics, psychological feelings, attitudes, motives and values towards the environment). The Yin-Yang (negative and positive forces play upon each other and formulate all ecological relationships), Wuxing (five fundamental elements and movements within any ecosystem promoted and restrained with each other), Zhong Yong (things should not go to their extremes but keep equal distance from them or take a moderate way)

and Feng-Shui theory (Wind-Water in Chinese expressing the geographical and ecological relationship between human settlements and their natural environment) are some of these principles. Based on these ecological principles, China has supported 21% of the world population with only 7% of the world arable land and less than 7% of the world fresh water resource for thousands of years.

2. Eco-sanitation system & its principles of design & management

Eco-sanitation is a kind of man-nature metabolism system dominated by technological and social behaviour, sustained by natural life support system, vitalised by ecological process. It interacts with human settlement system, wastes management system, hygiene and health care system and agricultural system.

Sanitation in Chinese is “wei-sheng”: “wei” here means protection, and “sheng” means life. It is a fuzzy word, which means either a state of one’s physical environment such as that of food, water, air, indoor and outdoor environment, or personal behavior in eating, drinking, sleeping and housing while interacting with surroundings, or the state of man’s psychological and physiological health upon exchanging material, energy and information with their environment.

It is an eco-complex between human being and its working and living environment (including sources where food, water, energy and other materials come from; sinks where the odor, faces, flies, pathogens and fertilizers go to; and pools for buffering and maintaining such as house, kitchen, bath room and toilet) and its social networks (including culture, organization, technology and so on).

In this paper, we only concentrate on those relationships caused by man’s water and food metabolism.

“Eco” here is a kind of function, mechanism, and a process. It means eco-awareness of man, eco-efficiency of materials, eco-compatibility of facilities, and eco-vitality of surrounding ecosystem. The overall goal is self-reliance to sustain its structural, functional and process stability through self-organization and recycling.

From both natural and human ecological point of view, the fundamental principles for ecosan design could be understood as:

1. Totality: geographical continuity, hydrological circulation, ecological integrity and cultural consistence;
2. Harmony between structure and function, internal and external environment, implicit and explicit layout, nature and man, objective being and subjective value, material and spiritual goals;
3. Mobility: constant wind and water flowing, vertical and horizontal flow, meandering streams, undulating and far stretching, and five basic movements;
4. Vitality: luxuriant, flourishing and productive fauna, flora and soil and aquatic biome;
5. Purity: clean and limpid water, clean and transparent atmosphere, quiet and secluded surrounding, never overloading its carrying capacity ;
6. Safety: backed by hill, enclosure, explicit, spacious, openness, easy to disperse and defense, disaster resistance;
7. Diversity and heterogeneity of landscape, ecosystem, species, society and culture;
8. Sustainability: negative and positive interlocking feedback, self-reliance, self-maintenance, sufficiency and efficiency, appropriate exploitation and development.

Ecosan has following structure:

Internal:

- Hardware: in-house facilities, lane level sewers, collector sewers, trunk infrastructure
- Software: institution, planning, policy, legislation
- Mindware: attitudes, habits, values, beliefs, capacity, quality

External:

- Technical consultation and service
- Demonstration and training
- Products and parts supply

Its functions are:

Social: healthy, clean surroundings, hygiene, convenience, privacy, social status, reducing the municipality's burden for civil engineering, easy management

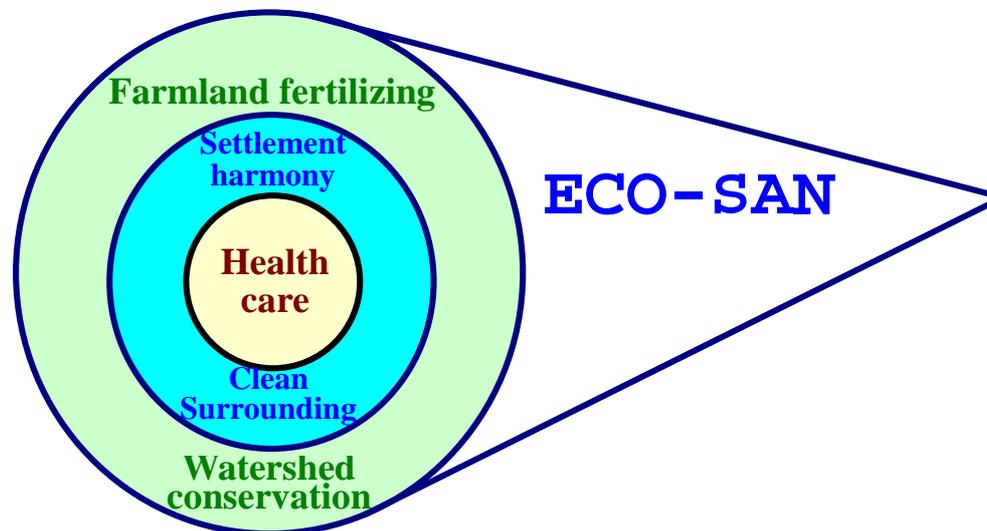
Economic: low investment, low cost of maintenance, water saving, land saving, energy saving, nutrients

Natural: air pollution, surface and ground water pollution, soil fertilizing, pests (flies), pathogens, carbon reduction

Its processes are: physical, chemical, biological, economic, cultural and social process

The goals of ecosan includes:

- Human health
- Settlement health
- Farmland health
- Environment health



3 . strategies of Eco-san promotion in China

By 2000, there are 127 million peoples in China, 25 % has no water supply, 62% has no access to sanitation facilities, annually producing about 500 million tons of urine (containing 5 million tons of N, 0.5 million ton of P and 1.12 million ton of K), and 30 - 60 million tons of faeces (containing up to 0.66 million tons of N, 0.22 million ton of P and 0.44 million ton of K). If they are all returned to farmland, every hectare of farmland could get 56kg of N, 7.2 kg of P and 15.6kg of K.

After an investigation on People's attitudes towards the priority consideration for eco-

sanitation, we got following desired demands for eco-san ranked from most to least urgent and from less to more costs:

1. No odors
2. No flies
3. Pathogen destruction
4. Clean surroundings
5. Convenient use
6. Keeping Privacy
7. Lower cost
8. Easy management
9. Soil fertilizing
10. Water saving
11. Zero pollution to watershed
12. High dignity and social status
13. Comprehensive system having multi-function of bio-wastes recycling and renewable energy generation
14. Integrative design with multi-services such as shower, garbage disposal and garden irrigation
15. Enjoy modern life while harmony with nature

The demand level depends on the economic, ecological and social background of the customers. Poor households and regions pursue the first seven goals, while richer households and regions pay much attention to the last eight goals.

Key issues in facilitating Ecosan:

1. Motivations and Incentives
2. Demonstration
3. Consultation
4. Training
5. Products, parts and materials supply
6. Plan and design
7. On line technological service
8. Policies
9. Economic affordability
10. Condition of local ecosystem

Sanitation security includes the security of air pollution, water eutrophication, pests outbreak, food contamination and disease spreading.

Currently, 62% of Chinese households have no access to any sanitation system having above mentioned functions. 34% of rural areas have no access to water supply system and most of them have no qualified dry sanitation system. Even in cities, 32% of urban households have not yet been covered by appropriate sanitation system.

In rural areas, dry eco-sanitation system is strongly suggest for those areas having no water supply system, while biogas system could be used for those areas having water supply system and connected with pigsty livestock raising

While in cities, a mixed system of improved self-treatment septic tank system connected with bio-treatment processes (having both aerobic and anaerobic treatment effects and could be recycled for grey water use) and dry eco-sanitation system connected with bio-garbage recycling (served by community wastes collection team and composting or bio-digesting process) is strongly recommended for those

neighborhoods having no sewage discharge and treatment system. And water saving facilities, wastes recycling measures should be encouraged even for those urban households having modern sewer system. For public use, a kind of self-support and zero wastes emission eco-toilet is strongly recommended which has multi-functions of green production, water and energy saving, environment cleaning, wastes reduction and employment provision.