Towards application of Ecosan for urban areas in Vietnam

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Nomenclature

BOD	Biochemical Oxygen Demand
CEETIA	Center for Environmental Engineering of Towns and Industrial Areas
COD	Chemical Oxygen Demand
CPRGS	Comprehensive Poverty Reduction and Growth Strategy
DEWATS	Decentralized wastewater treatment systems
DWWM	Decentralized wastewater management
DO	Dissolved Oxygen
DOSTE	Department of Science, Technology and Environment
DTUPWs	Department of Transport and Urban Public Works
ECOSAN	Ecological Sanitation
EIA	Environment Impact Assessment
EPA	Environmental Protection Agency
GDLA	General Department of Land Administration
GDMH	General Department of Meteorology and Hydrology
GDP	Gross Domestic Product
GSO	General Statistical Office
HCMC	Ho Chi Minh City
MARD	Ministry of Agriculture & Rural Development
MDGs	Millenium development goals
MoC	Ministry of Construction
MoH	Ministry of Health
MPI	Ministry of Planning and Investment
NEA	National Environment Agency
NGO	Non-governmental Organization
ODA	Official Development Assistance
SADCo	Sewerage and Drainage Company
SENSA	Swedish Environment Secretariat in Asia
SIDA	Swedish International Development Agency
SS	Suspended Solids
VAC	Garden – Fish pond – Livestock breeding model
VDGs	Vietnamese development goals
VND	Vietnamese Dong
WB	World Bank
WHO	World Health Organization
WSP	Waste Stabilization Ponds

Introduction

The United Nations World Summit on Sustainable Development (WSSD), held in Johannesburg, South Africa in Autumn 2002, articulated several targets for the coming decade. Among them, "halve, by the year 2015, the proportion of people who do not have access to basic sanitation". At a recently held regional meeting, with the Water and Sanitation Program (World Bank) in January 2003, it was agreed that most of the water supply targets could be reached by 2015, in contrast to the sanitation targets, that would not be reached unless a new concept was introduced. It was also agreed that sanitation will he in focus during this decade. At the 3rd World Water Forum in Kyoto in March 2003, ecological sanitation emerged as a significant option in meeting the Millennium Development Goals (MDGs).

There are many technical variations of ecological sanitation. What they have in common is that nutrients can be returned to productive use and that they are environment friendly.

The Swedish Environment Secretariat in Asia (SENSA) was established in 2002 with a mandate to help improving and increase the Swedish presence in South East Asia. It will facilitate networking between Swedish activities in different countries in the region, and strengthen interaction between Swedish organizations and South East Asia. Consequently, SENSA will assist and provide guidance and support to Sida's development co-operation within the environment and natural resource sectors.

One of the priority areas identified in the newly developed strategy is improved sanitation and the need for a new appropriate concept. The focus would be on urban environment since urban environmental management is one of the most pressing issues. Among the challenges faced by urban planners and managers is the need to ensure ongoing basic human services such as the provision of water and sanitation. The centralized and highly engineered human waste management systems have not been successful in many developing world contexts. On the other hand, low-cost, decentralized naturally based urban wastewater management alternatives that promote the recovery and reuse of wastewater resources are increasingly relevant.

This study conducted under the contract between SENSA and the GlobConsult Joint Stock Company (Vietnam), aiming at finding out the advantages and disadvantages of different sanitation alternatives that are available or feasible for Vietnamese conditions, from technico-economical points of view. Based on that recommendations and/or research proposals would be developed for further studies. The team consists of Dr. Viet Anh, Nguyen, senior water supply and sanitation expert, team leader, MSc. Hung Long, Nguyen, senior expert in preventive medicine, MSc. Ngoc Quang, Tran, environmental economist, End. Thanh Son, Nguyen and Dr. Tan Sinh, Bach, work arrangement and institutional issues, BC. Lan Huong, Ta, field trips arrangement, Ecosan economics, and administrative works.

The team expresses sincere thanks to Dr. Thuren Anders from SENSA/SIDA for his kind support and assistance during the implementation of the study.

Executive Summary

Urban environmental management is one of the most pressing issues in Asia including Vietnam. Among the challenges faced by urban planners and managers is the need to ensure ongoing basic human services such as the provision of water and sanitation. The centralized and highly engineered human waste management systems have not been successful in many developing world contexts. On the other hand, low-cost, decentralized naturally based urban wastewater management alternatives that promote the recovery and reuse of wastewater resources are increasingly relevant.

In a little more than a decade and a half, Vietnam has undergone a dramatic economic and social transformation. Nevertheless Vietnam remains a poor country. Investment and economic growth will be crucial for Viet Nam's development into the next decade.

The urban poor in Vietnam live in areas with poor infrastructure and the access to basic services (safe water, sanitation, water drainage, electricity, garbage collection) is limited. Most slum dwellers have unstable jobs and unstable incomes and their difficulties in securing permanent registration makes things worse.

Under the framework of a Comprehensive Poverty Reduction and Growth Strategy (CPRGS), the Government of Vietnam, based on the Millennium Development Goals (MDGs), has developed its own Development Goals, called Vietnam Development Goals (VDGs). According to which, the Goal number 7 stated as following (selected):

- Target 2: ensure that 60% of the rural population has access to clean and safe water by 2005 and 85% by 2010. This should be the case for 80% of urban people by 2005;
- Target 4: ensure that all wastewater in towns and cities is treated by 2010;
- Target 5: ensure that all solid waste is collected and disposed safely in all towns and cities by 2010.

The CPRGS recognizes the importance of environmental protection for sustainable poverty reduction and growth and proposes a number of key measures. These include strengthening conservation of natural forests and protection of watersheds through the involvement of the people that depend on them for their livelihood, enhancing access of the poor to clean water, and halting urban pollution.

In this report, some selected projects and initiatives in promotion of advanced sanitation in Vietnam have been discussed. Three of them are introduction of Ecosan urine diverting toilets into Vietnamese communities practicing farming: (1) Vinasanres project in Cam Duc Commune, Cam Ranh district, Khanh Hoa province, (2) Ecosan toilets in Y Yen district, Ha Nam province, and (3), in Hong Thai Commune, Phu Xuyen District, Ha Tay province. The results show the users satisfy with those toilets, confirming number of advantages of them in compared with other sanitation types. Economic comparisions show Ecosan toilet construction cost is mush less than septic tank or other water-borne sanitation alternatives in rural areas. However, the cost for toilet construction is a main concern for poor farmers, but it is not a major selection criteria when people can afford to construct more convenient toilets. Ecosan toilets are mostly welcome in low-income farmers, and in places with water shortage. But in medium-income families and farms, especially where live-stock breeding is developed, people often prefer biogas digesters. Septic tanks and pour-flush toilets are often built in

urban areas. In rural and peri-urban areas, they are built in high-income families and in places where farming is not main activity of the family members.

On the other hand, at the farmer's household level, there is not very high economical benefit from excreta and urine recycling while intensive cropping requires much more fertilizers nowadays. Organic fertilizers, as farmers from Ha Tay province estimate, can assist them to save only 5 – 10% from annual expenses for chemical fertilizers. Furthermore, organics waste require manual handling from toilets to the fields, have slower effect on plants, etc. That leads to us a thinking of the way for promotion of Ecosan in urban areas, if we could provide a good linkage between urban and rural areas, where more organic fertilizers could be supplied from urban centers to ensure the needs for soil improvement.

Biogas is considered as important solution for energy supply and environmental protection in rural areas. Installation of biogas reactors also let farmers understand that they still can produce themselves fertilizers from biogas reactor liquid waste mixed and composted with agricultural wastes and peat. In last ten years, the breeding in developing intensively in the country, together with improved living conditions and quality of life, and improved environmental and sanitation awareness in rural areas, the biogas technology is becoming more well-known and welcome in different places in Vietnam, including peri-urban areas. The economic benefits from biogas implementation are: treatment of human and animal wastes, mitigation of deforestation for seeking of fuel, reuse of nutrient sources for agriculture; and significant improvement of environment and ensuring safe use of fertilizer when manure is digested in biogas reactor and then composted, hence, giving the opportunities for clean agricultural products, reduction of health risks for farmers and users, reduction of losses due to illness. By using biogas for cooking, in average each household can save 60,000 VND monthly. The figure will be more when the household has intensive livestock breading, using biogas for cooking, lighting and warming of breading facilities. The investment cost (including interest) of a biogas pit plant, which is approximated as 2.5 mio. VND per household, can all be paid back in less than 5 years.

Analyzing disadvantages of conventional centralized scheme, a new approach for urban wastewater management is proposed: the decentralized concept, which is based on a simple premise: wastewater should be treated (and reused, if possible) as close to where it is generated as is practical. The basic idea of that is to treat the wastewater (possibly together with refuses) on-site by means of low-cost treatment systems, and make direct use the treatment products (water, compost, biogas). Decentralized sewerage systems are suitable to almost of Vietnamese cities and towns. The advantages of a decentralized approach will be most pronounced in sub-urban areas and small provincial towns where there is no centralized sanitation system yet and integration with agriculture is still an option. Using the natural conditions and self-purification of the water body, the establishment of the small and medium scale wastewater treatment plants will be convenience.

Septic tank is the most common on-site treatment facility in urban and peri-urban areas in Vietnam. In the existing combined sewerage systems lacking of any off-site treatment facility, the septic tank has important function of pollution reduction and prevention of clogging of combined sewer lines. To improve septic tanks performance, to reduce loadings from septic tank effluents on sewerage systems and environment, to create safe and effective reuse of wastewater for agriculture in peri-urban areas, is a decentralized advanced sanitation alternative for number of urban areas especially when the dry sanitation is not applicable.

Ecosan concepts has been being practiced in an agriculture-based country of Vietnam for many years. However there was not enough scientific evidence to ensure all the issues of sustainable sanitation are provided including pollution control, nutrient recycle, health protection and socio-economical acceptance. In the last few tens years, the new Ecosan models are already introduced in Vietnam, but studies are still very few and scattered. Further studies in near future, covering economical and social aspects and hygienic safety among advanced sanitation alternatives, promotion of urban agriculture, establishment of bilateral linkage with mutual benefits between urban and rural areas in provision and use of Ecosan products, etc. should be conducted. Besides, there are still big needs in public health and hygiene education for people in order to ensure safe reuse of urine and excreta in agriculture.

From demonstration projects and studies, technical packages should be developed in compliance with concrete situations. Furthermore, in order to promote advanced sanitation in urban areas, right target groups should be identified. Ecosan policies should be develop through awareness raising and assistance at central and provincial levels, where capacity building for alternatives selection and system construction and management should be carried out at the local level. Ministry of Construction should be a leading role in promotion of advanced sanitation in urban areas in Vietnam. And decentralized sanitation scheme should be promoted for its effective management.

Advanced sanitation has a potential future also in urban areas in Vietnam where it would bring a economic values from improvement of human health, environmental protection, as well as effective and safe nutrient and wastewater recycle. However, for effective and wide implementation of advanced sanitation in urban areas, further studies are required, and capacity building is necessary for different stakeholders, at different levels of policy and decision making.

I. Background information

Socio-economic situation in Vietnam

In a little more than a decade and a half, Viet Nam has undergone a dramatic economic and social transformation. The "*doi moi*" reforms marked a shift from a centrally planned to a "socialist oriented market economy under State management" characterized by the development of the rule of law and implementation of an open door policy with regard to foreign countries. Major reforms have included a return to household-based farming in agriculture, the removal of certain restrictions on private sector activities in commerce and industry, and rationalization of state-owned enterprises. It is generally accepted that this process, launched in 1986, has led to considerable improvements in the overall well being of the vast majority of Vietnamese people. Real GDP per capita growth averaged more than 6 per cent annually over the decade and Viet Nam has graduated from being a rice importer to the world's second largest rice exporter. One of the country's outstanding social achievements has been the reduction of poverty from an estimated 70 percent in the mid-1980s to 36 per cent in 2001, according to the World Bank's internationally comparable poverty line. Nevertheless Viet Nam remains a poor country, with an average GDP per capita of US$ 441 in 2002. As many as 28 million people continue to lack the minimum income necessary to provide a decent standard of living. Many people still live just above the poverty line and the risk of falling back into poverty remains high. In 2003, 40 per cent of the population still lacked access to safe water, of which 37.5 percent were in rural areas (50% of rural population). In the same year, around 30 per cent of children under 5 years old were still underweight. The disparity between urban and rural welfare is widening and ethnic minorities in mountainous and remote areas have benefited only marginally from the development process. The difference in income distribution between the poorest and the richest quintiles is increasing rapidly.

Much remains to be done to consolidate, sustain and build upon recent achievements. The challenges are daunting. As noted in the Ten-year Socio-Economic Strategy for 2001-2010, continuing the upwards momentum of reform, investment and economic growth will be crucial for Viet Nam's development into the next decade. However, the main challenge will be to ensure that all regions, provinces, population groups and ethnic minorities participate in and gain from the development process. As well as macro economic reforms, public administration reform needs to be carried out, the rule of law strengthened, social protection developed, social sectors enhanced and civil society empowered. As far as public administration reform is concerned, the most pressing issue is civil service pay. Salaries remain too low compared with average monthly household expenditure, and poor performance and corruption driven by the need to meet basic living expenses are therefore difficult to correct and contain *(Adapted from UN country team's evaluation, 2003)*

National development strategy

The Government's long-term objectives center around the goal of modernization and industrialization of the country.

The Government's development strategy is significantly broader, however, and rests on four specific pillars:

- Sustainable economic growth, as the force for deepening macroeconomic reforms, overcoming poverty and fostering industrialization;
- stability, political, social and economic;
- equity, ensuring a decent minimum standard of living and equal opportunities for all;
- people-centered development, a cross-cutting imperative to create a development process that is implemented by the people, for the people.

The Government perceives these four pillars as constituting the basic enabling environment for the implementation of specific development initiatives. In this context, an even balance between the four pillars is essential to achieving a sustainable development process. *(Source: World Bank, 1999, 2003)*

The Vietnam Development Goals (VDGs) (see Annex), which are a localized version of the Millennium Development Goals (MDGs), show a consistent improvement of social indicators, from education enrollment to infant mortality. While some regions and some population groups gained more than others, Vietnam continues to reduce poverty considerably faster than other countries at a similar development level. In the early 1990s, its poverty rate was higher than could be expected, given the country's level of economic development. Some time during the second half of the 1990s Vietnam caught up with the "average" country at it s development level, and it largely surpassed it by 2002.

Looking forward, the "story" behind poverty reduction is likely to be sustained by the reform strategy of Vietnam, embodied chiefly in the Comprehensive Poverty Reduction and Growth Strategy (CPRGS). This key policy document combines the completion of the transition to a market economy, with social policies aimed at keeping development inclusive, with an effort to build modem governance.

Poverty has a strong spatial (or geographical) dimension in Vietnam. While positive developments are visible in all regions, poverty rates vary considerably across them, and the speed of poverty reduction varies as well. Poverty is very much concentrated in the two deltas and in the coastal areas. Ethnic minorities are among the groups that will remain poor for longer. Rural-urban migrants are another group potentially at risk. On the surface, members of this group have done well. However, the insufficient development of urban infrastructure and the current administrative mechanisms to limit the mobility of the population, may keep many migrants in poverty too. A polluted environment, restricted access to social services in the case of unregistered migrants, the absence of the strong social networks characteristic of Vietnamese "villages" (or *thon*), are drawbacks that increased expenditures may not compensate. Even if only a fraction of the rural-urban migrants were to fail, the absolute numbers could be large, given that almost one million people will be migrating to the cities every year. Squarely recognizing the problem, through the assessment of the situation of rural-urban migrants groups (registered and unregistered), would be a key first step. It could pave the way to appropriate planning of public actions, from land zoning policies to the accelerated development of urban infrastructure and social services. *(Source: World Bank, 2004).*

II. Environment and Sanitation in urban areas of Vietnam

In Vietnam there are 649 cities and towns. Among those, there are 5 cities managed by central government, 107 cities and towns belong to provincial authorities. The remains are managed by local authorities. Urban systems are divided into 6 categories based on their population and

some other features. The 2 cities belonging to the special category are Hanoi and Ho Chi Minh City (HCMC).

The urban drainage and sewerage systems in all of Vietnamese cities are combined systems, collecting all kinds of domestic, industrial and storm wastewaters. Most of these systems were built since 100 years ago, hence now they are seriously degraded. Irregular maintenance, unplanned construction, illegal land occupation and housing are common infrastructure problems in cities in Vietnam.

In large cities the average length of sewers is 0.2 m per person, while it is only 0.04 – 0.06 m per person in smaller towns. There percentage of population served by drainage and sewerage networks is only 40% in large cities and 10 – 30% in small towns.

All of cities haven't got any centralized wastewater treatment plants. Most of households in first, second and third cities are equipped with septic tanks, after what domestic wastewater discharged into combined sewerage system, or to open channels, natural lakes, causing serious environmental pollution. According to the Ministry of Construction (MOC), there is around 10 - 20% population in the big cities and 30 - 50% population in other cities practice pit latrines, double vault latrines or public latrines. 50 - 80% of households in the cities of first and second class use septic tanks, while in the other cities the ratio is 20 - 30%. Most of septic tanks are not emptyed regularly and often overloaded. Many septic tanks are not emptyed for the last 8-10 years. They are often designed and constructed by households themselves, located in the underground basement, with one or two chambers (without filtration chamber). Number of them were improperly designed, constructed with bad materials, leading to overload or leaking. Hence, that is one from causes of ground and surface water and soil pollution. The public sanitation facilities are usually in very bad conditions of either construction or operation so they are also the sources of serious pollution in cities.

Polluting pit latrines are still used in many urban areas. For example, in Viet Tri city (capital of Phu Tho province, in 80 km north from Hanoi city), there are about 70% of households using pit latrines *(CEETIA, 2002).*

Table 2.1. Types of toilets in Vietnam

Type of toilet	Number	% of total	In urban areas	% of type	In rural areas	% of type
Septic tank	2,734,270	16.42	2,183,798	79.87	550,472	20.13
Sulabh	196,381	1.18	90,007	45.83	106,374	54.17
Pit latrine/Double vault	11,058,755	66.42	1,384,509	12.52	9,674,246	87.48
No toilet	2,650,814	15.92	362,001	13.66	2,288,813	86.34
Not stated	9,769	0.06	2,156	22.07	7,613	77.93
Total	16,649,989	100	4,022,471	-	12,627,518	-

(Source: Nguyen Viet Anh, adapted from Department of Statistics, 2001).

Table 2.2. Sewerage situation in big cites in Vietnam

City	Total population, mio.	Estimated population with sewers, mio. (% of total)
Hanoi City (capital)	2.84	1.67 (65%)
Ho Chi Minh City (largest)	5.38	3.12 (55%)
Haiphong City	1.71	0.89 (60%)
Danang City	0.72	0.32(45%)
Hue City	1.08	0.48 (50%)

(Source: Vietnam State of Environment Report - 2002)

Drainage channel in Hanoi city
(Photo by Viet Anh, 2004)

Developing and promulgating legislation on environment protection

The Vietnam Law on Environment Protection came into force from January 10, 1994. The Government has also promulgated other laws and regulations concerning environment protection such as Forest Protection and Development Law (1991); the People Health Protection Law (1989); Land Use Law(1993); Law of Oil and Petrol (1993), Mineral Resources Law (1996), Water Resources Law (1998); Dykes Protection Ordinance (1989); Criminal Affair Law (reformed 1999); Ordinance of Resources Taxes (1989); Ordinance of Aquatic Resource Protection (1989), Ordinance of Radiation Safety and Control (1996); Ordinance of Vegetation Protection and Quarantine (1993), etc. Hundreds of legal documents to elaborately instruct the implementation of the above laws and ordinances have been issued by the Government and line ministries.

Development of the institutional system of environmental management

In 1993, the National Environment Agency (NEA) was established under the Ministry of Science, Technology and Environment (MOSTE) in order to exercise nation-wide the state

management of environmental protection activities. The Environment Management Divisions attached to the provincial Departments of Science, Technology and Environment (DOSTE) were established. Some districts and towns also have certain cadre for environmental management. In addition, functional units for environmental management have been established in some line ministries and economic sectors.

In 2002, the Ministry of Natural Resources and Environment (MONRE) has been established. Environmental management authorities are under re-organization process for more effective operation. However, generally speaking, the capacity of environmental management institutions in Vietnam remains weak and disproportionate to their tasks.

Sector goals and strategies

National water policy and strategy

The broadest level of national policy and strategy development is provided in the "Socio-Economic Development Strategy for 2001-2010". A number of water related strategies / objectives are presented here.

Under the framework of a Comprehensive Poverty Reduction and Growth Strategy (CPRGS), the Government of Vietnam, based on the MDGs, has developed its own Development Goals, called Vietnam Development Goals (VDGs). According to which, the Goal number 7 stated as following (selected):

- Target 2: ensure that 60% of the rural population has access to clean and safe water by 2005 and 85% by 2010. This should be the case for 80% of urban people by 2005;
- Target 4: ensure that all wastewater in towns and cities is treated by 2010;
- Target 5: ensure that all solid waste is collected and disposed safely in all towns and cities by 2010.

However, the targets are too ambitious, and there are no Action Plans to achieve the targets yet.

Sustainable access to safe drinking water is part of the Government's traditional emphasis on the role that investments in infrastructure can play in reducing poverty (see below). Infrastructure forms the core of key targeted programs to address poverty and these include the provision of clean drinking water systems and seven other components. In 2000, 56 percent of the population had access to safe water. This is a commendable increase from 48 percent in 1990. However, Vietnam is on the lower end regionally and globally for access to safe water (Figure 2.1).

The urban poor in Vietnam live in areas with poor infrastructure and the access to basic services (safe water, sanitation, water drainage, electricity, garbage collection) is limited. Most slum dwellers have unstable jobs and unstable incomes and their difficulties in securing permanent registration makes things worse. The VLSS data show an urban poverty rate of 9%, but this is likely to be an underestimation, as many urban slum dwellers are not registered.

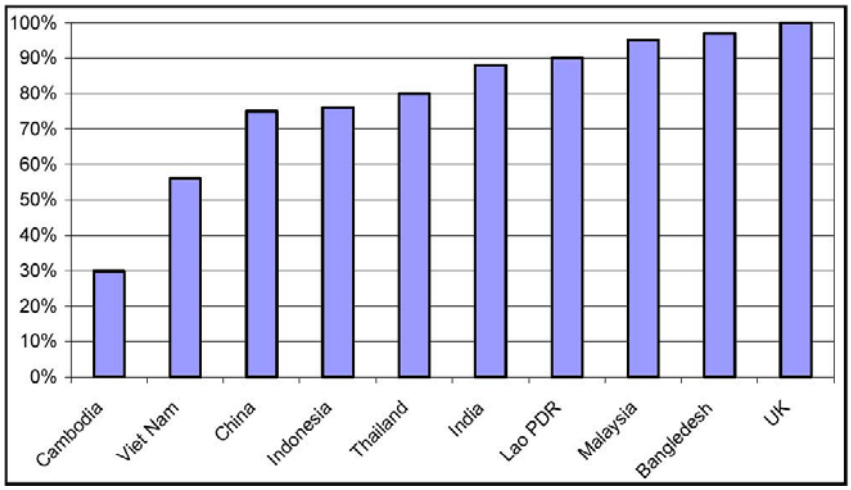


Figure 2.1. Country comparison of access to safe water, 2000 (% of population)
(Source: UNDP (2001a).

Goals and future challenges

The CPRGS recognizes the importance of environmental protection for sustainable poverty reduction and growth and proposes a number of key measures. These include strengthening conservation of natural forests and protection of watersheds through the involvement of the people that depend on them for their livelihood, enhancing access of the poor to clean water, and halting urban pollution.

The first and biggest challenge for this VDGs is implementation of the government's NSEP. This requires concerted efforts to strengthen capacity in government agencies at the central and local level, creating opportunities for community participation, enforcing laws by expanding the choice of regulatory instruments and incentives, and allocating substantial resources to this plan.

The target 2 aims to reach a safe and clean drinking water coverage of 60 percent of the rural population by 2005 and 85 percent by 2010. Although the institutional, financial and policy environments for this indicator are largely in place, Vietnam is unlikely to meet this goal. From 1990 to 2000, the overall safe water coverage increased 8 percent (from 48 to 56 percent). Even if population growth were zero, to achieve the 2010 level, coverage would have to increase an average of 5 percent each year between 2005 and 2010. Sri Lanka, Nepal and Paraguay were the countries with the greatest increases in access to safe water during the last decade, yet these countries averaged only about 1.7 percent growth in coverage annually. Analysis presented in the VDGs background paper shows that a 80 percent coverage in 2015 is probably a more realistic target (UNDP, 2001a). This would still require doubling the current rate of improving access to safe water (from a 0.8 percent to a 1.6 percent net increase per year), but this is more feasible given other countries. experiences.

Targets 3-5 reflect the due attention given to urban development issues in the CPRGS, which stresses the need to develop policies for urban housing development for the poor, and minimize health risks for the poor by adopting pollution control measures. In the CPRGS the Government announces it will develop a national urban development strategy and this would enable the actions outlined to be addressed in a consistent manner while promoting balanced urban development. The government now acknowledges the problem of social exclusion in

the urban areas and the lack of access of unregistered urban migrants to basic services and that labor migration and household registration policies need to be reviewed. This presents an important step forward for addressing the pressing urban poverty issues.

The sixth specific target focuses on reducing pollution in order to improve the quality of water and air. The Government is in the process of finalizing national standards for air and water quality, and also working towards strengthening the environmental monitoring network.

State management organization in water supply and sewerage sector

State management in water supply and sewerage includes the following main contents:

- Establishing, completing the legal framework and submitting for promulgation or promulgating legislative framework of policies and management mechanism according to the jurisdiction;

- Submitting to the Prime Minister strategies, development planning, long-term plans, 5-year plans, national project programmes and other important programmes on water supply and sewerage;

- Providing guidelines, instruction and examination for the implementation of approved legislative documents, strategies and plans, propagating and educating the law and information on water supply and sewerage field.

The management organization system of water supply and sewerage consists of agencies at Central and local levels.

In the Central level, the Ministry of Construction is assigned to universally manage the urban technical infrastructure, including pavements, urban roads, water supply, sewerage, lighting, green parks, urban waste, cemetery, parking places inside urban localities (Item 9, Article 2-Decree No 36/2003/ND-CP dated on April 4th 2003). Besides, concerning water supply and sewerage includes following Ministries:

- The Ministry of Agriculture and Rural Development has the responsibility to universally manage the construction, exploitation, use and protection of rural water supply and sewerage works; universally manage river basins; comprehensively exploit and develop rivers according to plans approved by jurisdictional levels and universally manage the exploitation and use of rural clean water;

- The Ministry of Natural Resources and Environment has the responsibility to submit to the Government principles on assignment and level decentralization of basic examination and jurisdiction to issue and revoke license on water resources; give guidelines and examine the implementation after approval; synthesize data and control the results of basic examination; inventory, assess natural resources and establish data base on water resources; Define and give guidelines on the examination of the implementation of measures to preserve water resources; make assessment and examine the implementation of investment projects of water resources sector.

- The Ministry of Health has the responsibility to give definition of technical and specific criteria on the hygiene and safety of drinking water and domestic water.

On the basis of their function and responsibility, Ministries have set up Departments, Offices to help the Ministers to fulfill the tasks assigned by the Government as well as provide concrete guidelines to localities on State management organization in the local area, including the clear definition of functions, responsibilities, rights and organizational mechanism of specialized agencies assisting People's Committee of provinces, cities under Central authority in State management of sectors and fields.

According to the Governmental Decree No 36/2003/ND-CP dated on April 4th 2003, the agencies assisting the Minister of Construction in carrying out State management function in water supply and sewerage sector have been gathered in one unity, namely Department of Urban Infrastructure instead of a group of experts of Department of Architect - Planning Management like before.

Thus, up to now there has been clear responsibility assignment in State management of urban water supply and sewerage sector at Central level and some organizations have been established. The rest problem is the capability in performance of responsibilities of organizations and responsibility relationship among them.

Government orientations of upgrading and selection of sewerage and drainage systems

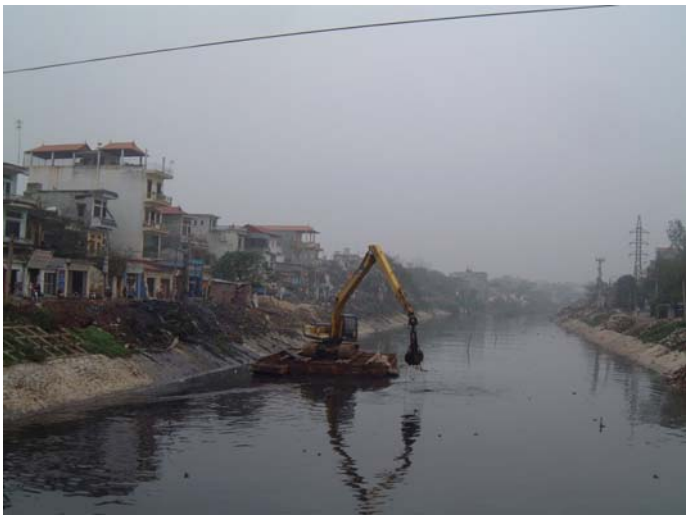
In order to give direction for sewerage and drainage works, on March 5, 1999, the Vietnam Government has approved the Orientation for the Development of Urban Sewerage (ODUS) in Vietnam to 2020 and the immediate objectives to 2005. The short-term objectives up to 2005 are to solve the problems of storm water drainage, to minimize flooding in rainy season for big cities, such as Hanoi, Ho Chi Minh city, etc., to expand the sewerage service coverage from 30 - 40% to 50 - 60%, varying from classes and characteristics of the cities. In particular, Hanoi Sewerage and Drainage Project will cover 80% of its population. In this period the focus also pays for improvement, upgrading of domestic sewerage systems in cities, of which big cities, such as Hanoi, Ho Chi Minh city, are in priority, cancellation of pit latrines in the central urban districts...

The long-term target from 2006 to 2020 is to resolve most of urban drainage and sewerage problems, eliminate inundation in the cities, construct sewerage systems and wastewater treatment plants, which ensure sanitary standards and environmental protection, increase of urban sewerage service coverage up to 80 - 90%. As for urban and industrial centers of major economic growth areas such as Hanoi, Ho Chi Minh city, the sewerage coverage will be 100%.

Along with the rise in investment sources from the Government budget for construction and rehabilitation of sewerage and drainage systems and capacity building for companies engaged in management, operation and maintenance of the systems, the salient feature after 3 years of implementing the ODUS is the significant increase in number of urban sewerage and drainage projects funded by ODA. Starting with the Hanoi Sewerage and Drainage project, phase I, whose construction was commenced in 1996 with ODA fund with total budget of USD 200 million mainly from Japan, there have been now more than 10 out of 61 cities and provincial towns of Vietnam, namely Hanoi, Ho Chi Minh City, Hai Phong, Ha Long, Da Nang, Hue, Thai Nguyen, Vung Tau, Buon Ma Thuot, Da Lat, Viet Tri, Vinh and Nam Dinh, having ODA funded sewerage and drainage projects with total budget of over USD 1 billion from the Government of Japan, France, Denmark, Belgium, Switzerland and international financial

institutions like World Bank, Asian Development Bank. Apart from the Hanoi Sewerage and Drainage Project that is underway and expected to be completed in 2004, projects of other cities and towns are under implementation at various pre-construction phases. This is obviously great conditions in the first years of developing sewerage and drainage in comparison with ODA budget for water supply in 13 years from 1990 - 2003 in almost 61 cities and provincial towns that is just over USD 1 billion.

In respect of most urban drainage systems planning and construction, the combined sewerage system still shall be used in coming 5-10 years. In 10 - 20 years and later, the ring collectors around inner city channels and lakes will be built in order to separate and collect wastewaters for treatment. This stepwise option is also facing many difficulties, especially in construction budget, land acquisition and compensation, etc.. For new urban areas, separate sewerage and drainage systems are often selected.



Upgrading of Hanoi sewerage and drainage system
(Photo by Viet Anh, 2003)

For wastewater treatment technologies, besides conventional technologies, some projects already bravely implement low-cost and natural treatment processes, such as waste stabilization ponds (WSPs), which are simple to operate and maintain, and do not require skilled operating staff. WSPs are widely used throughout the world, and are capable of producing high quality effluent meeting Vietnamese and international standards, without the need for electricity or chemicals. Examples of urban areas with mentioned technologies are Da Nang, Buon Ma Thuot, Thanh Hoa and Lang Co, etc.

So, in most of urban centers on Vietnam the sanitation project are under implementation or development. In most of cases, centralized systems are proposed. It is necessary to start at early stage of the project planning to introduce Ecosan concepts for sustainable sanitation in order to ensure comprehensive alternative analysis and selection, what can help to avoid limitations and losses that centralized sewerage and drainage systems may have.

Wastewater reuse

In Vietnam, the application of raw wastewater, including domestic sewage, industrial effluents and human excreta in agricultural and aquaculture production is widespread,

especially in the northern Vietnam. In Hanoi, more than 400,000 cubic meters of wastewater is discharged daily, and a large amount of this wastewater is pumped or diverted for irrigation and aquaculture production. It is evidenced that wastewater application in agriculture, particularly in fish farming, has brought benefits to the sector as well as surplus profits to farmers from better harvest yields *(Thanh, 1994; Hoan, 1996; Thang, 1996).* However, little is known in Vietnam about the impact of wastewater on the health of farmers, especially those who are directly exposed to the wastewater.

The efficiency gained through the reuse of wastewater also can be seen in the integration of fish farming and the rearing of domestic animals such as pigs, chickens and ducks. In the commune, the application of the garden-fish farming-livestock breeding model (the VAC model) is rather widespread, especially in those households with proximity to the fish ponds supplied with wastewater. Water from the ponds is often used for irrigation of the households' gardens as well as surrounding rice and vegetable fields. The rearing of pigs, chicken and ducks has contributed to the increase of fish productivity because of surplus feeds and manure used for aquaculture, at the same time, sub-standard fish could be supplemented as extra foods for the animals.

The application of wastewater in agriculture also resulted in increased productivity. As suggested by Hoan (1996) and Thang (1996), the annual yield of fish raised in wastewater was more than 3 tons/ha, while the yield of fish without wastewater application was only 500-800 kg/ha. In Yen So Commune, Hanoi sub-urb, the yields are different between wastewater-fed fishponds located in the upstream and downstream of Kim Nguu river, which is serving drainage and sewerage channel for Hanoi city. Experience from local farmers shows that the upstream fish yield are twice higher than the downstream yield, where the wastewater is less strong and nutrient-rich. The yield of rice grown in wastewater almost doubles that grown in natural water. At the same time, farmers can save the cost of fertilizers and additional foods for plants and fish because they can rely on the nutrient supply from the wastewater.

Wastewater fed fishes
in Hanoi peri-urban market
(Photo by Tonderski A., 2003)

Besides the undeniable benefits and efficiency that the reuse of wastewater has brought to agricultural and aquaculture production, possible negative impacts on human health of wastewater irrigation activities are of great concern to the public health sector. The majority of wastewater used in developing countries does not receive any conventional treatment

before being applied directly to agricultural lands. Reused wastewater, especially raw and preliminarily treated wastewater, harbors several pathogens and toxic chemicals, which can cause diseases in human when it is not managed and applied properly. Nematode infections are among the most common diseases contracted by the people working or living in the areas where wastewater is used, having constituted a major concern of health care in the community (*Feachem et al.*, 1983).

Results from the parasitological examination carried out by Trang D.T. et al, 2003 in Yen So commune, Thanh Tri dist., Hanoi sub-urb showed that irrigation with untreated wastewater posed a risk of gastrointestinal parasitic infections. The microbiological quality of the river supplying water for the communal irrigation and fishponds contained high concentrations of helminth eggs and fecal bacteria. The levels of fecal coli-forms in the river ranged from $1.2x10^7$ to $11.8x10^7$ CFU/100ml, while the concentration of nematode eggs was of about 240-2840 eggs/1 litre *(Trang et al. 2003).* These values clearly exceeded the WHO guidelines for wastewater reuse in agriculture and aquaculture, which propose that less than or equal to 1000 fecal coli-form bacteria per 100 ml and 1 human intestinal nematode egg per liter should present in the wastewater intended for use in agriculture *(Mara D. and Cairncross S., 1989).*

At present, little is done in Vietnam to enforce the existing laws and guidelines regarding the reuse of wastewater in agriculture and aquaculture. Especially there is a lack of regulations addressing the health impacts of such reuse to the users. Although Vietnamese environmental standards specify the quality requirements for discharged wastewater to be used for agricultural purposes, there are no standards on the microbiological quality, except for the numbers of total coli-forms (TCVN 6773 – 2000). So far, the WHO guidelines on the allowable limits of nematode eggs and fecal coli-forms in wastewater for irrigation have not been incorporated into the national standards. These limits seem difficult to be obtained in Vietnam, where wastewater producers have encountered problems in treating their wastewater to comply with such regulations, and physiochemical parameters of the water often receive more attention than the microbiological ones. While appropriate treatment of the wastewater is not yet attained, local authorities of the areas where untreated wastewater has been applied should encourage farmers to wear protective measures such as shoes, boots, and gloves when working in the fields irrigated with wastewater. Awareness on the health impacts of wastewater and improvement of hygiene behaviors should be raised in the community so that farmers can protect themselves. Local governments can also partially support the farmers with periodical health check and treatment of the diseases possibly associated with the reuse of wastewater.

III. Some relevant (selected) projects or initiatives in promotion of advanced sanitation in Vietnam

1. Vinasanres project (SIDA support, Cam Duc Commune, Cam Ranh District, Khanh Hoa province, 1996 – 1998) *(Adapted from Calvert P. et al, 2000)*

The actual field testing of toilets was done in the Cam Duc Commune, Can Ranh District, Khanh Hoa Province, about 30 km south of Nha Trang. In this area neither pit toilets nor pour-flush toilets are suitable due to the risk of groundwater pollution. The commune has 9,440 inhabitants in 1,831 households. Most of the households are engaged in farming. Each household has a house on a 300-600 sq.m plot. About half (52%) of the households have their own well, usually 5-15m deep, or a rainwater collection system. The other half collects water from neighbors. There is no piped water supply in the commune. Many households depend

on these shallow wells for drinking water supply and most are contaminated by feces. About one third of households (30%) have a "hygienic" toilet (hygienic = pour-flush, septic tank or double vault in good condition), two thirds (65%) have a simple, shallow pit toilet and the rest (5%) have no toilet.

One of the original aims of the project was to increase the status of dry sanitation systems like the traditional double-vault toilet by developing types that could be attached to the house or even placed inside the house.

The project has been carried out by the Pasteur Institute in Nha Trang (Dr. Bui Trong Chien, Mr. Duong Trong Phi). The six types of toilets, with numbers built during this project, are:

The six different models of Vinasanres toilet were tested in order to determine the storage time necessary for a die-off of micro-organisms within the faecal material in order to make the material safe for reuse as fertilizer in agriculture. In these tests two different indicators were used: the bacteriophage *Salmonella typhimurium* type 28B and eggs from the pig's roundworm *Ascaris suum*. The bacteriophage is believed to mimic well the die-off of viruses and the eggs of *Ascaris suum* to function as a model for the die-off of sturdy parasitic eggs. The study found that there was no significant difference in the technical performance of the different designs and so could not say that one was better than the other. How the families used the toilets therefore appears to be more significant (i.e. putting enough ash, not allowing the vault contents to become wet and storing them for an adequate length of time).

It shows that Ecosan toilet is interested by people, when other are still favor with septic tank and pour-flush toilets. That opinion is also found in many other rural areas where fertilizers from manure and excreta does not play important ratio in compared with other types of chemical fertilizers required for farming. Those people think the septic tank will be their last choice when the economic situation would afford them.

Cost effectiveness in relation to alternative sanitation systems.
The Vinasanres toilets appear to be competitive with the alternatives available in Cam Duc. The current cost of a basic Vinasanres toilet is around 1.03 million VND and a tiled one with Chinese squat pan, or similar, around 1.32 million VND. A septic tank WC would cost around 2 million VND and a Twin Pit Pour Flush toilet around the same as a Vinasanres toilet of similar quality. Obviously the simple pit toilets and very basic vault toilets are cheaper than this but they are not hygienic and increasingly the people of Cam Duc aspire to something better.

Besides, there is no doubt that the treated faecal matter is useful to and wanted by the farmers. They have developed their own awareness of its value and some pay for it in cash or kind. Most of the treated feces has been used on cassava fields, the principal crop of the commune.

The use of urine is also quite widespread, though an awareness of its economic value appears not to have been attained. Some people add it to their manure or composting heaps, others dilute it and use it on mango trees, mix it with animal manure or urine or use it on flowers, vegetables, coconut and cashew or a mix of these. They generally say they are happy with the results.

The potential of ecological sanitation protect public health and to save water by not flushing; to protect the environment and ground water by not contaminating them with pathogens; to

improve soils and save on costs of commercial fertilizer is significant. The Government and people of Vietnam could reap widespread benefits to public health and agriculture through adopting an ecological approach to sanitation. An ecological approach to sanitation can also provide considerable savings in water supply and wastewater treatment in urban and peri-urban areas. The Cam Duc demonstration should therefore be seen not simply as a small demonstration of rural sanitation appropriate for an agricultural commune but rather as the first step in a sanitation revolution which is already beginning in other countries around the world.

2. Intensive sanitation project with ecological sanitation focus in Y Yen district, Ha Nam province (1998 – 2000)

An intensive sanitation project was implemented in 10 communes of Y Yen district of Nam Ha province from 1998 to 2000. The main objectives of this project is to provide knowledge on sanitation for all people including introduction of different model of hygienic latrines to households. Tree introduced latrines include ecological double vault composting latrine, pour-flush latrine and septic tank. The result of survey showed that most of people accepted all three kinds of introduced latrines and ecological one was most accepted. For instant, in Yen Binh commune, there was 81.8% of households wanted to build ecological latrine. The main reason for building this latrine is that it is easy to build, use, maintain and people can reuse of composted material for agricultural purposes. The result of this project also indicated that there was a considerable change in perception and behaviors related to sanitation, individual sanitation and other issues related to people's health. The following table shows that over 50% of interviewed households recognized changes in knowledge environmental sanitation and disease.

Table 3.1. Results from household survey of knowledge of environmental sanitation and disease

Commune	Improve knowledge	Sanitation improvement	Disease reduction	Useless	No idea
Yen Xa	69%	75%	61%	0%	8%
Yen Binh	66%	68%	62%	3%	7%
Yen Phuc	71%	71%	65%	0%	9%
Yen Thang	68%	73%	60%	0%	4%
Yen Tri	73%	78%	67%	1%	5%
Average	69%	73%	63%	1%	7%

However, in Yen My commune, the aspect of hygiene was rarely considered in their answers about choice for hygienic facilities. They lack of information to make choice among criteria of convenience, economy, and hygiene to protect personal and family's health.

Communication activities were always implemented in parallel with mobilization to construct and upgrade latrines in order to increase the proportion of hygienic latrine. The proportion of hygienic latrines is an important indicator for evaluation of the effectiveness of the project. This, in fact, is an practical and effective implementation strategy. The setting of specific controllable targets is very important in the early stage of the project. Regarding difficult

economic condition and common demand for excrement usage in farming, the contents of the communication were focused in double vault and sometimes single vault latrines. These two kinds of latrine ensure demand for fertilizer and sanitation and fit with local level of income.

The evaluation of this project, however, did not focus much on the economic aspect through improvement of sanitation situation. Although there was 39% of interviewed people recognized the improvement of sanitation condition and 35% of households saw the reduction of disease burden (particularly diarrhoea) there was no concrete analysis of economic benefit from the project.

3. Ecosan toilets in Hong Thai Commune, Phu Xuyen District, Ha Tay Province

Hong Thai is a small riverside village located at 40 km south from Hanoi. Villagers here earn their living mainly by cultivating and breeding, reaching the medium socio-economical level for Vietnamese rural areas.

The general condition of local sanitation infrastructure is shown at following table 3.2.

Table 3.2. Sanitation facilities in Hong Thai village (% households)

Sanitation means	1997	1998	1999	2000	2001
Bathroom	21	30	38	51	71
Well	21	34	43	60	83
Toilet	30	40	51	64	88

(Source: Hong Thai village clinic)

90% of current wells in the village is drilled, others are dug wells and communal wells. Number of double-vault Ecosan toilet, septic tank, and other type of toilets available are 60%, 10% and 30%, respectively.

In the village a pilot project of instruction, operation and maintenance of Ecosan toilet (double-vault, ventilated, dry latrine) is run by local authority and Health Center of Phu Xuyen District, under the program of Ministry of Health (MOH). It began 1 year ago and gained some prosperous results. There are 55 toilets being constructed, 40 of those are completed and in use.

Procedure for installation of Ecosan toilets for villagers in project are follows:

- A meeting is held to introduce design of new toilets to villagers
- Villagers register after a thorough consideration
- New toilets are built by villagers themselves under the guidance of engineer from district's health care center.
- Completed toilets are checked and taken over by the engineer before used.

Total construction of a completed ecological toilet is one million VND. One half is supported by project (including a composite pedestal), the other contributed by villagers themselves.

Happy ecosan toilet owner
(Photo by Viet Anh, 2003)

Ecosan toilets evaluation

In general, recently applied sanitation facilities are acceptable and effectively improve local hygienic conditions.

Ecological toilets receive positive response from user because they are free of smell, flies and easy to keep clean. However, there are some disadvantages we noted from discussion with local people:

- Seating pose is not convenient (user's face is turn to the other hole)
- Volume of composted feces is too small – 30 kg for one batch, supplying only 10% fertilizer demand for one medium farm. Now it is used to put down basic fertilizer for crop. Castle manure and big quantities of artificial fertilizer are used respectively for vegetable and rice growing. The later will spoil the soil's fertility.
- Difficult to keep toilet clean, especially with concrete/cement pedestrial. Urine easily settled on channel due to roughness of the cement surface, giving accumulating odor trouble. Ceramic pedestrial has better surface, but easily to break down. Hence, the new product of composite pedestrial can compensate the above mentioned limitations.

In order to force user to keep toilet clean themselves, technical assistants try to persuade them to build the toilet next to their house for convenient use. However, it somehow contradicts traditional arrangement where toilets are built in the garden corner, i.e. far away from houses. It takes time to change this inadequacy.

- For villagers, septic tank is an indicator of ''social level and high hygienic standard'', so they will shift to use septic tank as soon as they have enough money.

4. Biogas reactors in Vietnam

Since 1960s the Biogas campaign already found popularity and positive progress in the Pacific – Asian region, especially in China and India. Biogas is considered as important solution for energy supply and environmental protection in rural areas. Installation of biogas reactors also let farmers understand that they still can produce themselves fertilizers from biogas reactor liquid waste mixed and composted with agricultural wastes and peat.

Biogas technology has been starting to be studied and implemented in Vietnam since 1960s. Before, 1980, there were only few studies on biogas technology in some institutes and universities. Volume of pilot biogas reactors at that time was approximately 15 – 20 m^3 with number of limitations such as not enough feeding materials, improper structure, etc. However, due to technical and managerial limitations those installations did not have adequate efficiency and stopped after few short time.

Only after 1980s, the is real campaign of promotion of biogas technology in Vietnam with technical assistance by several Universities and Research institutes. Some successful products are:

- Biogas reactor with metallic floating cover, brick digester and water seal (Institute of Energy).
- Fixed dome-sharp cover constructed from bricks (Institute of Energy).
- Fixed cylinder-sharp cover made by cement reinforced by bamboo frame. This type of bios reactor was not applied later due to frequent cracks and leakages
- Fixed cylinder-sharp cover made by cement reinforced by steel frame (Can Tho University).
- Biogas stoves and lamps (HCMC Polytechnics University).
- Addition or replacement of manure by botanical materials (Institute of Energy).
- Waste storage and composting (Institute of Energy).

Some Biogas projects in recent years:

- Center of renewable energy, Can Tho University continued to develop biogas reactors in the South with fixed cover made by bricks, in he framework of cooperation with Thailand and Germany.
- Project SAREC S2 VIE 22, including Institute of breeding, Can Tho University, HCMC Industrial University, Hue Agricultural University developed Biogas reactor made by plastic bags which were widely spread out in the country later. Since 1992 to present only the HCMC Agriculture – Forestry University has installed 6,000 plastic bag biogas reactors.
- Since 1994, Vietnam Association of VAC (Garden – Fish pond and Livestock breeding) – VACVINA started pilot project with support from Oxfam Quebec (Canada) and installed 10 plastic bag biogas reactors. Afterwards, with support from FAO, UNICEF, JIVC, Toyota (Japan) and Oxfam Quebec, VACVINA continued to spread out biogas reactors in over the country, with plastic bag digester as a major type. Totally VACVINA has installed more than 5,000 digesters in 40 provinces.
- Since 2003, project Vietnam – Holland cooperation is funded with more than 1 mio. USD for construction of biogas plants at household and community levels in some provinces in Vietnam. This is a biggest project in promotion of this technology in rural areas of Vietnam until now.

In 1996, National program for clean water supply and sanitation launched biogas campaign, installed some hundreds biogas reactors with fixed dome-sharp cover made by composite or cement with steel frame sited on brick cylinder in Ha Tay and Nam Dinh provinces. In 1999, the program has installed about 1,000 reactors in focused district of Dan Phuong, Ha Tay province. The limitation of cement cover is heavy weight, difficulty in scum cleaning. Composite cover show number of advantages, however, its cost is still expensive for most of farmers.

Up to now the most popular type of biogas reactor in Vietnam is fixed dome-sharp cover constructed by bricks.

From 1998, the breeding in developing intensively in the country, together with improved living conditions and quality of life, and improved environmental and sanitation awareness in rural areas, the biogas technology is becoming more well-known and welcomed in all over the country. Until now, there are about 20,000 biogas reactors have been installed in Vietnam, among those 12,000 plastic bags, 3,000 fixed cover, 1,000 floating cover and others. Compared with 75% of population in Vietnam living in rural areas, that is still very modest ratio.

Brick biogas construction
(Photo by CERWASS)

There are some reasons of limited implementation of biogas reactors in Vietnam as follows:

- There is still not optimum technical solution of biogas reactors. Common failures of those facilities are not complying accessories, short longevity, leakages, loss of liquid and gas, reduction of pressure in digesters chamber, low temperature, etc.
- Complexity in construction, installation and use, as well as in repair and replacement of accessories, lack of service providers, etc.
- Biogas reactors are immovable, impossible to sell when needed.
- There is still lack of unity in management of biogas technology promotion activities, technical assistance, scientific review of existing models and experience for finding out of suitable options for concrete conditions.
- Not appropriate promotion policies and investment mechanism in compared with other wastewater treatment facilities (if any).
- Not appropriate and effective use of liquid and solid wastes from reactors.

- Difficult to construct suitable reactor in narrow square and high-densed communities.
- Construction cost is still high for medium living conditions in rural areas. Therefore biogas reactors are not implemented in poor households.
- Unstable input leads to low efficiency of reactors.
- Biogas reactors are only implemented as treatment mean in rural areas, but not studied for wider implementation in other places.

Economic benefits

- Treatment of human and animal wastes, mitigation of deforestation for seeking of fuel, reuse of nutrient sources for agriculture.
- Significant improvement of environment and ensuring safe use of fertilizer when manure is digested in biogas reactor and then composted, hence, giving the opportunities for clean agricultural products, reduction of health risks for farmers and users, reduction of losses due to illness.

Nowadays in Vietnam already have certain experience in handling and disposing wastes, but as yet there are only very few cases where data on which to base relevant economic analyses exist. However, this report tries to provide some preliminary indication of economic justification.

In recent years, a new design of biogas pit is gradually being popularized in rural areas. Constructed of bricks with a dome-shape cover to prevent gas leakage, these pits are of high quality. However, their construction costs are high. The capital cost of a pit is 2,500,000 VND, and the service time is usually above 15 years. At the higher rate of construction cost, at 6% interest, plus 80,000 VND for annual maintenance (effluent chamber cleaning, solids and scum removal, etc), By using biogas for cooking, each household can save 60,000 VND monthly. The figure will be more when the household implement biogas reactors in intensive livestock breading, using biogas for cooking, lighting and warming of breading facilities. As analyzed in Table 2.1 the investment cost (including interest) of a biogas pit plant can all be paid back in less than 5 years.

It is worth to note that there is a change in major purpose of biogas reactor implementation in rural and peri-urban households in Vietnam. At the beginning, the biogas reactors were used as new additional energy source because of serious lacking of electricity and fuel in the country. In recent years, it's implementation is for improvement of living conditions and health, reuse of wastes, generation of new energy source, release of heavy works for women.

Table 3.3. Cost and benefit (in VND) of biogas pit from bricks

Year	Cost per year, VND	Interest per year (i = 6%)	Maintenance expense, VND	Benefit per year, VND	Cost transfer to next year, VND
1	2,500,000.00	150,000.00	80,000.00	720,000.00	2,010,000.00
2	2,010,000.00	120,600.00	80,000.00	720,000.00	1,490,600.00
3	1,490,600.00	89,436.00	80,000.00	720,000.00	940,036.00
4	940,036.00	56,402.16	80,000.00	720,000.00	356,438.16
5	356,438.16	21,386.29	80,000.00	720,000.00	-262,175.55

(For more detailed economical analysis please see Annexes).

5. Decentralized wastewater management in urban areas

Conventional centralized wastewater management systems
In commonly called "centralized" water/wastewater management systems all the waters to be distributed in the urban area is purified at one discrete location, the water works, and the wastewater collected in the area is sent to one discrete plant for treatment and discharge. Centralized wastewater management has been the norm in municipal engineering circles for more than 100 years. Based on the “Pipe it away first, then think about what comes next" philosophy, centralized management is the structure of choice in most cities and countries.

Disadvantages of centralized wastewater management systems:
- Only a minor fraction of the high quality water distributed in urban areas is used for drinking and cooking. The major fraction is used for cleaning, flushing and for watering plants and lawns. A significant amount of the drinking water is required just as a means to transport the pollutants to the wastewater treatment plant.

- Combining all kinds of wastewaters and occasionally storm water, in addition, leads to a highly complex mixture of a wide variety of pollutants fluctuation, heavily in composition and concentration. Thus, effective removal of the pollutants becomes very difficult.

- Wastewater and removed sludge contain components such as phosphorus, which could be used as fertilizer provided the product is not spoiled by problematic substances such as heavy metals.

- Even though the decentralized approach has a very long tradition by nature in Vietnam, centralization is still being common solution for wastewater investment projects. Conventional sewerage systems often are a very costly part of the infrastructure (if rehabilitation is done). The costs for the installation of the sewer system are of almost an order of magnitude higher than the cost for building up the treatment facilities. In many cases, delay of water investment projects often occurs due to lacking of money. Very high operation and maintenance costs are also a big challenge for municipal authorities, especially when cities are in the river delta plates and flat coastal areas, where pumping stations are often required and sewers are laid with limited (minimum) slope. Inadequate operation and maintenance of sewers network may lead to sewer clogging, local flooding, pipe leak, and, as consequence, to pollution of soil and groundwater, or increase of the hydraulic loading of the treatment plant. Higher capacity of pipes and tanks are needed.

New approach for urban wastewater management
The decentralized concept is based on a simple premise: Wastewater should be treated (and reused, if possible) as close to where it is generated as is practical.

That philosophy allows local governments to circumvent one of the major disadvantages of the conventional, centralized management system: huge investments in an extensive collection system that does nothing more than move pollution from place to place. (The phrase "decentralized management" is used here, but it is somewhat of a misnomer, because, while facilities are decentralized, management may be handled by a central entity). In many places were faced with extending service. Its engineers determined that using decentralized treatment methods would be a far more cost-effective solution than extending the city's centralized system into the area.

The elements that decentralized wastewater management systems comprise include: (1) wastewater pre-treatment, (2) wastewater collection, (3) wastewater treatment, (4) effluent reuse or disposal, and (5) biosolids and septage management. Although the components are the same as for large centralized systems, the difference is in the type of technology applied, and, for Vietnamese conditions, form and mechanism of management. It should also be noted that not every decentralized wastewater management system would incorporate all of above elements. The decentralized approach is a new means of addressing wastewater management needs of sewered and unsewered areas in a comprehensive fashion. The basic idea of that is to treat the wastewater (possibly together with refuses) on-site by means of low-cost treatment systems, and make direct use the treatment products (water, compost, biogas). This alternative can meet a sustainable wastewater management requirement and has a promising future, especially for developing country of Vietnam, where the water and sanitation issues are becoming a more and more important issue and are under new period of infrastructure development.

Due to the terrain conditions and there are lakes and ponds in cities, the sewerage system is usually divided into small and independent catchments. Therefore, decentralized sewerage systems are suitable to almost of Vietnamese cities and towns. The advantages of a decentralized approach will be most pronounced in sub-urban areas and small provincial towns where there is no centralized sanitation system yet and integration with agriculture is still an option. Using the natural conditions and self-purification of the water body, the establishment of the small and medium scale wastewater treatment plants will be convenience.

Septic tank is the most common on-site treatment facility in urban and peri-urban areas in Vietnam. In urban centers the ratio of households equipped with septic tanks is nearly 50-80%. In the rest parts of the city the ratio is 20-30%. Desludging of septic tanks is not often followed. Study carried out by CEETIA in the period 1998 - 2002 shows that most of septic tanks are often extremely outdated and damaged. Household septic tanks often consist of 2 chambers and they are placed underground in the house basement. All of investigated septic tanks are working without filtration chambers. Number of those was under designed and operated with rather low treatment efficiency (CEETIA, 2001). The use of the on-site systems for domestic wastewater treatment increases step – by- step in sub-urban areas. As per Vietnamese Building Regulations (Ministry of Construction, 1988) houses and apartment buildings in cities should be equipped with a septic tank (ST), whether they discharge to the soil, surface water or to a sewer network. For individual houses this usually is a 2 – 4 m^3 horizontal flow tank with two or three compartments. Sometimes the last compartment contains an anaerobic up-flow filter. In the existing combined sewerage system that lacks any off-site treatment facility, the ST has the important functions of pollution reduction and the prevention of the clogging of the huge size storm water line.

Improved septic tanks for upgrading urban sanitation system

From 1998, CEETIA, in cooperation with Department of Water and Sanitation in developing countries (SANDEC), Swiss Federal Institute for Environmental Science and Technology (EAWAG) have been working on decentralized sanitation concepts and technologies for urban and peri-urban areas in Vietnamese conditions. At CEETIA's Laboratory, some models of baffled septic tanks with anaerobic filters (BASTAF) have been installed. The experimental data show that baffled septic tank with anaerobic filter could effectively treat black wastewater from toilets, with removal efficiency by COD from 43.2 to 94.9 % (average 74 %), by BOD_5 from 45.3 to 90.9 % (average 71.1%), by SS from 47.6 to 97.2 % (average

75.4%). Based on studied results, system of a settling chamber, 3 ~ 4 baffled chambers followed by 2 ~ 3 anaerobic filter chambers are suggested as one from low-cost and effective solutions for on-site/decentralized wastewater treatment for individual houses, group of houses or for urban residential areas. Effluent from BASTAF goes to the post–treatment facilities, centralized or decentralized. CEETIA also constructed some pilot BASTAFs for some household in Hanoi city. The monitoring data show very positive results for their wider dissemination. Some other low-cost naturally-based wastewater treatment processes are also studied at CEETIA.

BASTAF construction
in Hanoi city
(Photo by Viet Anh, 2003)

Case study on possibility of combination of decentralized and decentralized wastewater management schemes for Ha Dong city, Ha Tay province *(by Nguyen Viet Anh, Tran Van Tuan, HUCE, 2004).*

Ha Dong is a central city of Ha Tay province, located on the Road No. 6 in the 10 km Western side from Hanoi city. Current population of Ha Dong is 94,500 persons in the areas of 1,632 ha. It is estimated the Ha Dong population will be 180,000 up to the year 2020, including peri-urban areas. Located in the Red river delta with high rainfall and low ground level above sea levels, flooding is a current concern of the city wile the existing backward combined sewerage and drainage system can not provide the adequate service. According to the Master plan for Ha Dong up to the year 2020, there will be separate sewerage and drainage system constructed. Total domestic and industrial flow from the city up to the calculation period (2020) is 30,700 cmpd. Those wastewater will be collected by centralized sewerage network and led to the 2 centralized wastewater treatment plants before discharged to La Khe and Nhue rivers flowing through city. Required parameters for secondary treated wastewater are SS = 50 mg/l; BOD_{total} = 15 mg/l. Capacity for the 1st WWTP is 30,700 cmpd, of the 2nd WWTP is 4,500 cmpd.

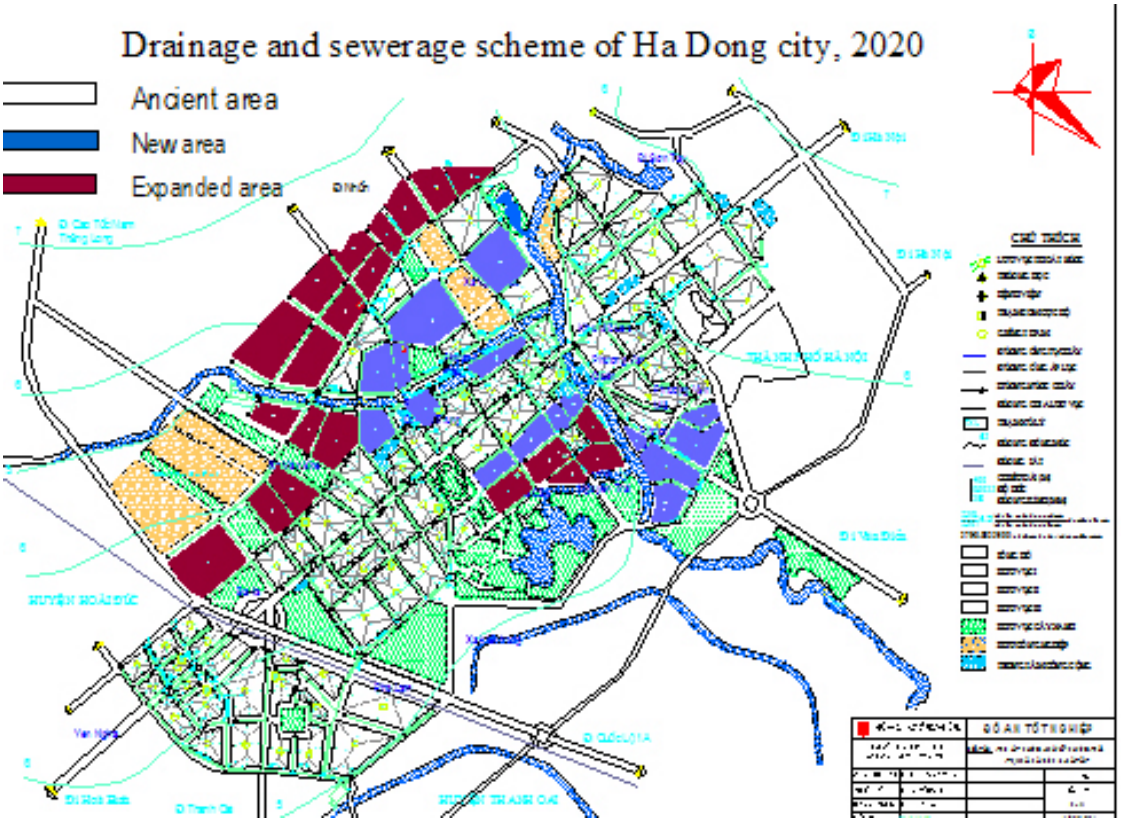


Figure 3.1. Ha Dong city master plan 2020. Drainage and sewerage scheme

Centralized WWTP, the conventional way of most of sanitation projects now in Vietnam, show number of disadvantages, including groundwater and soil contamination, huge investment capital required in short term mobilization (loans), big expenses for system O&M, low community involvement, and no revenue possibilities, especially for low-density areas, etc. The ideas of the study team is to introduce the on-site wastewater treatment facilities by upgrade existing conventional septic tanks which are applied very widely in every urban areas in Vietnam, as a short-term solutions for environmental protection and public health improvement in urban areas, and stepwise combination of those upgraded decentralized systems with centralized WWTPs, but working with much lower pollutants loadings and flow (thanks to flow equalization in decentralized systems). The other options are feasible for areas with more space are on-site or community-based natural treatment systems, afterwards wastewater is discharged into environment directly. However, due to limited spaced in fast urbanized Ha Dong, there natural treatment processes are not included into this economic calculation.

The case study focused on economic comparision between 4 scenarios where 4 different alternatives applied.

Provided that removal efficiency from BASTAF for black wastewater treatment in average is 70%, 60%, 60% for SS, COD, BOD respectively (From CEETIA's experimental results in Laboratory and in pilot models). Daily water consumption per capita is 180 lpcd, while black wastewater volume is 40 lpcd.

- Scenario 1: Separate system. Black wastewater from all households are treated in conventional septic tanks and then discharged into sewers. Gray wastewater is directly discharged into city's sewer network.

- Scenario 2: BASTAF is installed instead of conventional septic tank in the newly (expanded) urbanized area. Assumed that 90% of households in the newly developed areas, including high-rise buildings, will be equipped with BASTAF. The rest households are with septic tanks. The area with BASTAF is 39% of total city's area.

- Scenario 3. This scenario considers possibility of construction of additional BASTAFs after the existing conventional septic tanks in the areas with available spaces. (Assumed that 70% of households from old city's areas will be constructed with households BASTAF. All household in the new areas are equipped with BASTAFs. The area with BASTAF will be 60% of total city's area.

- Scenario 4. Communal BASTAF will be constructed for 60% of households in the ancient area where there is no space for household BASTAF. Effluent from conventional septic tanks in new area of the city is treated additionally in household BASTAF. BASTAFs are constructed in households from expanded city's area.

From the calculation it shown that if the city's of Ha Dong implements the upgraded scheme with the improved septic tank instead of conventional one as an effective decentralized wastewater management option for the city with the existing water-born sanitation network, there will be a significant economic benefit (at least 15% of capital investment and 5% of O&M expenses). Physical benefit can be gained from reduced suspended and organic matters coming to the centralized WWTP, leading to reduction of facilities size and capacity, as well as the volumes of sludge to be collected, treated and transported. Besides, there are still number of non-measurable benefits such as expenses for O&M of the solid free sewerage network, improved environmental quality, improved public awareness and responsibility in environmental sanitation, etc.

6. Nutrient balance analysis in sanitation schemes

Peri-urban areas of the city play very important role in providing agricultural products . The study on nutrient balance at the household scale in peri-urban area practicing intensive farming can give important information for nutrient balance analysis for implementation of Ecosan concepts in urban and peri-urban areas.

In 2003, A. Hedlund, E. Witter and Bui Xuan An have conducted a study on nutrient management on smallholder farming systems in a peri-urban area outside Ho Chi Minh City in southern Vietnam. Most of the farming systems in this study superficially appeared to be integrated as they included both a crop unit and a pig production unit, and sometimes even a fishpond or a bio-digester. The construction of detailed nutrient balances, however, highlighted that in terms of nutrient management the sub-units were poorly integrated as nutrient output from one unit seldom matched nutrient demand, as estimated by nutrient output, in the next unit. Moreover, on most livestock farms a large proportion of nutrients was lost from the pig production unit because the liquid manure was directly discharged into the waterways. Even without the nutrient input through manure applications nearly all farms had extremely high. The current high levels of inputs are likely to be associated with a high risk

for nutrient losses. Lower levels of input and improved nutrient use efficiencies would moreover improve economic returns (Hedlund A. et al, 2003).

The other study by Cau L. N. et al. was conducted in 2002 – 2003 to estimate the budget of nutrients phosphorus and nitrogen about Hanoi city in the attempt to propose an indicator of urban sustainability in terms of nutrients. Hanoi citadel area with a total area of 84.1 square kilometers was selected as the case study. By using the obtained data, major nutrients input flows in the forms of water, food, and mineral fertilizer, and output flows in the forms of wastewater and solid waste were estimated and identified.

The estimated results showed that, in the year of 1999, the total N input and output were around 14,000 tons and 16,000 tons, respectively. Major input was live stock commodities (71% of total input) and crop commodities (25%), and major output form was as wastewater (88%). The total P input and output were around 2600 tons and 4200 tons, respectively. Major input was again livestock commodities (77%) and crop commodities (17%). The output was 71% as wastewater and the rest as solid wastes. The amounts of nutrients recycled through composting were also estimated, which contributed only about 1.3% of nitrogen flow and 4% of phosphorus flow. The difference of input and output still remains uncertain, because of the accuracy of the data used in the study is not as reliable to make such discussion. But the order of the size of flow and recycling was grasped. The small contribution of recycling by composting indicates that there is room of improvement about the budget of nutrients of the studies area.

Nutrients recycling was not well done for both N and P. The estimated results of N and P recycled via uses of compost produced from the generated solid waste showed that approximately 11 % of N content and 12 % of P content in the generated solid waste were recycled. In comparison with the total output, the N recycled amount accounts for approximately 1.5 % and that for P accounts for approximately 3.5 %. This indicated that Hanoi citadel still consumes more nutrients from external sources or it depends much on the external nutrients sources.

(For more details please see Annex).

IV. Discussions towards implementation of Ecosan for urban areas in Vietnam

Ecosan concepts has been being practiced in an agriculture-based country of Vietnam for many years. However there was not enough scientific basics to ensure all the issues of sustainable sanitation are provided including pollution control, nutrient recycle and health protection. With international cooperation, especially with Swedish scientists, in the last few tens years, the new Ecosan models are already introduced in Vietnam, but studies are still very few and scattered. There is not special study yet with Ecosan in urban areas. Also, there is special study on economical aspects of Ecosan, except some cases done with the Ecosan toilet, Biogas digesters and VAC models in rural areas. The two last cases studies mostly focused on economical comparision between Ecosan and conventional options to show the benefit for economic growth, but no figures stating about environmental benefits. That requires further study in near future. That relates also to the concepts of Ecosan implementation by local users. The main reason for selection of Ecosan facility is for better living and working conditions (less nuisance and dirty, release from (women's) manual works with wastes and fuel) but not for effective use of nutrients or global environmental protection.

Even Ecosan concepts are accepted but the is still big gap between successful demo-projects and large scale implementation. There are certain barriers to implement Ecosan concepts in urban areas. One from major reasons is limited information. There is still very limited awareness about Ecosan concepts, and especially in technical solutions of Ecosan, in both public and decision-making sides.

There is still limited studies about urban agriculture, and almost very few studies on urban Ecosan. In order to introduce Ecosan in urban areas, it is necessary to introduce urban agriculture, its importance and understanding, together with environmental protection and health care.

As discussed in previous chapters, there are already some good models of advanced sanitation implemented in Vietnam, such as Urine diverting Ecosan toilets, Biogas plants and VAC intensive farming in rural and peri-urban areas, decentralized wastewater management in urban areas with improved on-site water-born sanitation facilities, etc. Those models show feasibility for practical implementation in future, but require further study and adaptation. Besides ‘’ready-for-urban’’ advanced sanitation schemes, it is necessary to bring sustainable development concepts of Ecosan from rural into urban areas, i.e. to conduct ‘’ruralization’’ for sanitation and environment. It relates to both existing urban areas and rural as well as peri-urban area under urbanization.

There is a question for feasibility of Ecosan in urban areas. We are in agricultural based economy – we do not have to forget about rural areas, i.e. sanitation system would work sustainably if we could establish a connection/link between urban and rural areas. The problem is to determine the right scale of system and related locations. (e.g. market or output for the Ecosan products). In that case people will be convinced to go for Ecosan.

Besides, another question is, somebody will be interested in getting of composted fertilizer from dry toilets from urban centers? It should be created some how. In Vietnam, in order to achieve intensive cropping, many farmers prefer chemical fertilizers instead of handling of human excreta. The technical assistance is very needed in cooperatives and communes so that people could understand which fertilizers should be used for a green and clean agriculture. That question also related to creation of demand for Ecosan products for a healthy agriculture.

For a demonstration project, a small town, where the sanitation infrastructure is still not, or is still very poor, and a living standard of the people is still note high, is a potential location for Ecosan. It is easier to start from place with not constructed yet infrastructure and demand for the capacity building.

Urban agriculture should be promoted. It will be other option implemented in parallel with Ecosan. We do not say only let’s do Ecosan. We can say: let’s do urban agriculture., than there will be demand from Ecosan products. In Vietnamese urban centers, there is certain limitation in area for developing of urban agriculture activities which could contribute significant input into the food balance. However urban centers in small and medium scale towns and townlets are great locations where most of citizen, with limited income, are practicing urban agriculture. Besides, nobody can doubt about role of urban agriculture in the peri-urban areas of all of cities and towns in serving of the agricultural products to the centers and surrounding areas. Number of peri-urban areas are also practicing wastewater (mostly from urban centers) reuse in irrigation and aquaculture. Those places have great potential for promotion of Ecosan concepts.

Furthermore, there is still unsolved question among Ecosan alternatives. While the dry sanitation, which seems ''best option'' from technical points of view, is not easy for implementation scaling up in most of urban centers, then the upgraded from existing systems with settled sewerage, simplified sewerage, or on-site water-born treatment with improved septic tanks followed by natural wastewater treatment processes, etc. are the ones from feasible options for low-income cites, from both social and environmental points of view. In our opinion, don't say we will rehabilitate existing systems. Within available possibilities, we have to try to improve it first, with consideration towards long-term planning for sustainable development. In any case, the wastewater and nutrients reuse should be taken into account and encouraged, and, besides economical and social aspects, they might be reused safely.

For implementation of Ecosan concepts and models there is necessary to have a suitable policy from the Government. The policy maker should understand first the idea of Ecosan and what the country and region could get benefit from that for sustainable development. An example of fast dissemination of Ecosan concepts in the country while the leaders understand Ecosan and get involved is the Uganda. With Vietnamese specifics, as described above, the Ministry of Construction (MOC) is responsible for development and management of water and sanitation in urban areas. At the central level, MOC should be targeted to introduced the Ecosan concepts for urban areas, and the capacity building as well as the Ecosan demonstration projects should be born with participation (or management) of the MOC. After getting new concepts and successful results from demonstration projects, the Ecosan could find the way to be disseminated in urban areas, starting from integration of Ecosan concepts in to the Government policies, regulations, standards, until the practical implementation on the sites. There is also one point to be noted that there is still not good cooperation and coordination among related sectors in Vietnam, including the ministries. Thus, capacity building should be not only for MOC, but also for the other ministries and sub-ministries organization, so that Ecosan could be understoodable in his development course.

There special technical packages needed for different sites. Together with that: form of management should be indicated. There is no universal management and technical option. Ecological sanitation is a decentralized system, based on household or community management. Hence, the decentralized concept should be also promoted, in both technical and non-technical meaning. Until now, though the decentralization is highlighted by the Vietnam Government as a priority in administrative reform course of the country, it is still slowly realized. The provincial level already get certain autonomy, but the lower levels are still much depended, due to limited capacity, financially subsidized, and lack of adequate legislative environment. The same situation in the sanitation sector. The study carried out by CEETIA in cooperation with GHK (UK) under DFID support in 2003 – 2004 show that there is a big need in building up the capacity for people and organization at local level in order to achieved effective decentralized wastewater management. Besides, the good news showing great opportunities for urban Ecosan in Vietnam is the Government already set the course to shift the form of public service organizations from fully subsidized into public utility enterprises, where the public service activities are provided under the contracted based form with involvement of private sectors, and self-finance mechanism should be implemented at those enterprises. In Hanoi, and in the most of other cities in Vietnam, the Sewerage and Drainage company (SADCO) is taking care of main sewerage and drainage channels and pumping stations, while the district and commune authorities are responsible for the management of small sewerage and drainage network in yards, alleys, etc. In peri-urban area, where the SADCO's service still can not cover, and the wastewater management is closely related to its

reuse, then the wastewater network management is provided by the Department of agriculture and rural development of the local district. In those places the decisions are taken with active participation of the local community. So far, those existing ‘’decentralized’’ and ‘’community-based‘’ models are very suitable for implementation of Ecosan concept while adequately introduced.

V. Proposal for further studies

Title: ‘’Selection of appropriate sanitation systems for urban and peri-urban Vietnam: establishing the costs of alternative technologies’’

Introduction

There are several sanitation technologies that are potentially applicable in urban and peri-urban Vietnam. These include:

(a) Off-site systems:
- conventional sewerage,
- simplified sewerage,
- settled sewerage (with improved septic tanks),

(b) On-site systems:
- pour-flush toilets and land treatment,
- ecological sanitation toilets (including the (improved) Vietnamese double-vault urine-diverting composting toilet).

Figure 5.1 shows the variation of cost of conventional sewerage, simplified sewerage and pour-flush toilets with population density in a peri-urban area of the city of Natal in northeast Brazil in 1983: simplified sewerage was always cheaper than conventional sewerage and became cheaper than on-site sanitation at the relatively low population density of ~160 persons per ha. This information does not exist for any Vietnamese urban or peri-urban area, yet it is critical that this information is colleted in order to permit more optimal decisions to be made about sanitation investments in Vietnam. Furthermore, it needs to be collected soon so as to provide essential support to the Government of Vietnam in its activities to meet the Development Goal for sanitation in its country.

Proposal

It is proposed to select three "typical" urban/peri-urban areas in Vietnam and to design and cost the three off-site, and where appropriate both on-site, sanitation technologies listed above.

One typical area would be an area where (all) households have improved septic tanks: the purpose here would be to determine whether settled sewerage is more feasible, and – if it is – how much less costly, than conventional and simplified sewerage.

A second area would be an area currently without septic tanks but with an unsatisfactory on-site system: the aim here would be to determine whether the least costly solution is simplified sewerage (and how much less costly it is than conventional sewerage) or whether the existing on-site system can be upgraded or if it should be replaced by another more satisfactory system such as pour-flush toilets or Ecosan toilets specially adapted for peri-urban areas.

The first two areas would be in, for example, the metropolitan area of Hanoi, but the third should not. Rather it should be in a much smaller urban center, one that is at the interface of urban and rural (a District Center, for example, but basically an urbanized or semi-urbanized community in a predominantly rural/agricultural region). Here the purpose would be to determine the feasibility of Ecosan toilets or whether it is possible (and economically sensible) to apply Ecosan principles to other sanitation technologies in a wholly novel way – for example, whether urine diversion, collection and reuse can be applied to simplified and/or settled sewerage; if so, to determine the costs and benefits of so doing.

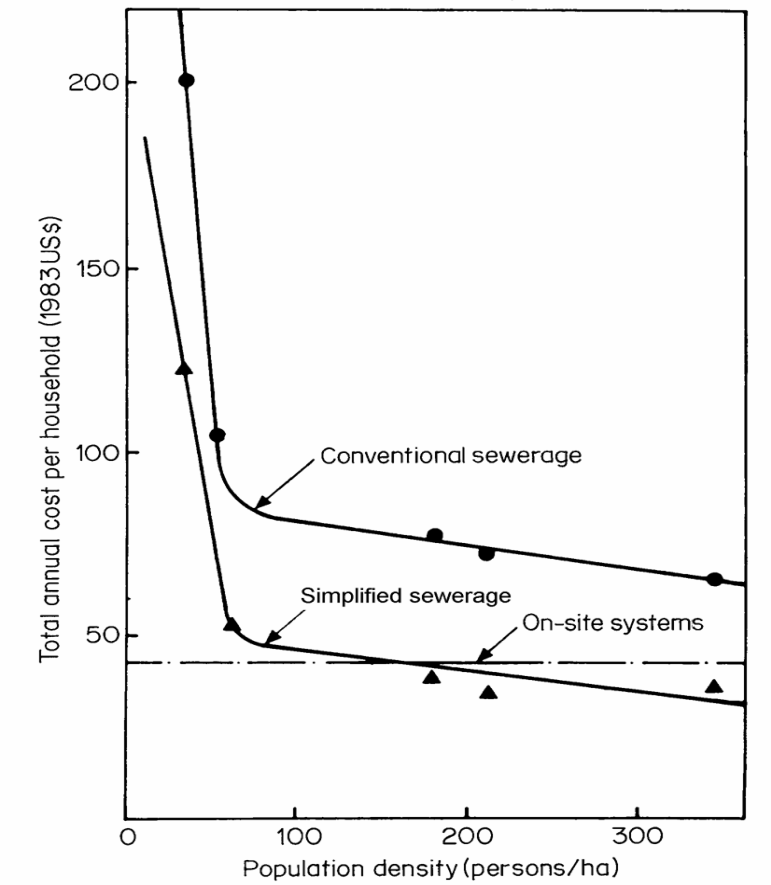


Figure 5.1. Variation with population density of the total annual costs per household of conventional and simplified sewerage and on-site sanitation (pour-flush toilets) in Natal, northeast Brazil, 1983 *(Source: Mara. D.)*

VI. Conclusions

In Vietnam there are number of good models in water supply and sanitation where the modifications of Ecological sanitation principles could be found. Besides successful technical options which are found in rural, peri-urban and urban areas, including dry sanitation and nutrients reuse (mostly in rural areas) and water-born sanitation and wastewater reuse (for peri-urban and urban areas), there have been found good models in non-technical issues that are necessary for successful Ecosan implementation such as community involvement in water community participation and local authority's responsibility, with mobilizing of local and community's resources (including manpower, money, space, etc.) for infrastructure upgrading and its management, etc.

First economical calculations show the benefit of implementation of suitable Ecosan model not only in rural areas. However there are still very limited studies in this direction carried out. In order to have adequate information of economical comparision among sanitation alternatives, including conventional and ecological, there further studies should be proposed. Only getting comprehensive data from demonstration projects, the decision makers can be convinced to disseminate Ecosan or advanced sanitation systems in urban areas.

For Ecosan implementation in urban areas, more information on available options are needed. The special technical and non-technical packages also needed for different sites. The network on Ecosan for rural and urban areas among related agencies, including line ministries should be developed. While, in Vietnam, Ecosan concepts can be successfully promoted in rural and peri-urban area through such organizations as Ministry of Health (MOH), Ministry of Agriculture and Rural Development (MARD), etc., The Ministry of Construction (MOC) should take the leading position for promoting of Ecosan in urban and urbanized peri-urban areas. At local level, the respective Department of Construction or Department of Transport, Urban Public Works Service (TUPWS) are responsible. The central Government should develop suitable legislative environment for its dissemination. Working in that environment, with guided technical packages from line Ministries or resources organizations, local authorities, i.e. provincial, districtial and commune levels, and the local people will decide, which solution is most suitable and could be selected. Besides, suitable form of management, decentralized, should be developed.

It should be ensured the organized interactions in socio-economical life between urban centers and peri-urban and rural areas. Only in that case the products from Ecosan systems such as treated wastewater, organic fertilizer, could be utilized efficiently and safely, and, on the reverse direction, green and clean agro-products could be provided and served to urban centers effectively. The demand for those products should be created by adequate local policies. Furthermore, those issues should come to the policies, programmes and planning stages for development of each city and town.

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