

Title	Septic Tanks need Urgent Improvement for Management of Urban Sanitation in Hanoi Vietnam
Author(s)	Harada, Hidenori; Matsuda, Tomonari; Nguyen, The Dong et al.
Citation	Annual Report of FY 2006, The Core University Program between Japan Society for the Promotion of Science (JSPS) and Vietnamese Academy of Science and Technology (VAST). 2007, p. 331-342
Version Type	VoR
URL	https://hdl.handle.net/11094/13223
rights	
Note	

Osaka University Knowledge Archive : OUKA

<https://ir.library.osaka-u.ac.jp/>

Osaka University

Septic Tanks need Urgent Improvement for Management of Urban Sanitation in Hanoi Vietnam.

Harada Hidenori*, Matsuda Tomonari*, Nguyen The Dong**, Nguyen Thi Kim Thai*** and Saburo Matsui*

* Graduate School of Global Environmental Studies, Kyoto University, Yoshida-Honmachi, Sakyo-Ku, Kyoto 606-8501, Japan (E-mail: h_harada@gakushikai.jp; matsuda@eden.env.kyoto-u.ac.jp; matsui@eden.env.kyoto-u.ac.jp)

** Institute of Environmental Technology, Vietnamese Academy of Science and Technology, 18 Hoang Quoc Viet, Hanoi, Vietnam (E-mail: ngtdong@fpt.vn)

*** Center of Environmental Engineering of Towns and Industrial Areas, Hanoi university of Civil Engineering, 55 Giai Phong Road, Hanoi, Vietnam (E-mail: canhthai@vnn.vn)

Abstract Sanitizing human excreta is one of the basic human needs. Hanoi city have a sewerage development plan but the establishment of the sewerage for the whole city may take a few decades. To sanitize human excreta before sewerage development, the present sanitation facilities such as septic tanks should be utilized for management of urban sanitation in Hanoi. The purpose of this study is to show the present state of sanitation systems in urban Hanoi and provide the key issues to manage present sanitation facilities, especially septic tanks. Statistical investigations were conducted using interview for 750 households with questioners. The sanitation-system distribution and excreta flow in urban Hanoi were estimated and 90.0 % of excreta in urban Hanoi was flushed into septic tanks including public one and 86.7 % of effluent from septic tanks were discharged into sewer pipes. A 94.6 % of the households equipping septic tanks did not have a custom to desludge regularly and 89.6 % of the households have never dislodged before. Dissemination of the necessity of regular desludge is considered crucial issues to improve sanitation in urban Hanoi.

Keywords septic tanks, statistical investigation, household interview, urban Hanoi, Vietnam, excreta, toilet

Introduction

Sanitizing human excreta is one of the basic human needs. A 2.4 billion people, however, had no adequate sanitation facility as of 2002 (WHO and UNICEF, 2005). Although a number of cities have made attempts to develop sewerage, the installation requires a huge amount of money and time, and the area covered by sewerage with modern treatment facilities are still limited in developing counteis. Septic tanks may be a major facility to treat human excreta at present, but the septic-tank management was reported to be in serious conditions in general (ADB, 2001; Straus *et al.*, 2003).

In Hanoi that is the capital of Vietnam, most of municipal sewage is discharged into water bodies not through modern treatment facilities (JICA, 2000). Likewise many other cities in developing counties, the city has a sewage development plan (JICA, 1995), but the area covered by sewerage is still limited as of 2006 and the establishment of sewerage for the whole city may take a few decades.

Present sanitation facilities such as septic tanks should play an important role to manage urban sanitation in Hanoi before the sewerage development. The utilization of the facilities together with the sewerage development can reduce the development cost (IDI-J, 2004). Some studies, however, have demonstrated that the lack of septic-tank management in urban Hanoi (JICA 2000; Fink 2001). The state of present sanitation systems and septic tank management are considered to be crucial information to utilize and improve the

present sanitation facilities in urban Hanoi.

This is the statistical investigation of sanitation systems in urban Hanoi. The purpose of this study is to show the present state of sanitation systems in urban Hanoi and provide the key issues to manage present sanitation facilities. A sanitation-system distribution and an excreta flow in urban Hanoi are estimated statistically. In addition, the septic-tank management in urban Hanoi is examined and key issues to improve the management are suggested.

Materials and methods

This study conducted statistical investigation of sanitation systems in urban Hanoi, interviewing 750 households with questioners.

The sample design

Hanoi city is composed of nine urban districts with a population of 2.0 million and five sub-urban districts with that of 1.2 million as of 2005 (Hanoi statistical office, 2006), and each district is organized by dozens of communes in terms of administrative units. There are 128 communes and 450,000 households in the nine urban districts. Each commune is, in additions, consisted of a number of the groups of households, which are not administrative units.

The sample design in this study is required to follows a statistic methodology for the statistic results and analysis. The survey unit is a household, the target population is defined to include all households in urban district of Hanoi city, and then the sampled-household number is 750.

The sample is selected based on a probability sampling method of a multi-stage sampling to be the representatives of the whole targeted population. The authors are able to access the data of the household numbers of each commune, but not to obtain the data of smaller units. At the first stage of sampling, 25 communes are selected with probability proportional to household numbers of each commune (*i.e.* sampling with probability proportional to size). At the second stage, five groups are picked out from each commune by systematic random sampling after visiting each commune office to acquire data of the group list in the commune. At the third stage, six households are finally sampled from each group after visiting each group leader to obtain data of the household list in the group, which includes household names and addresses. Thus, 750 households are randomly sampled from households in urban districts of Hanoi city.

The survey population is determined as all households registered on household lists in each group of communes of urban districts of Hanoi city. Households unregistered in the list are, therefore, excluded in this study.

The survey methods

The survey is conducted by door-to-door interviews to the 750 households with questionnaires. The interviewers firstly contact to the leader of each group in communes, and visit each sampled household with help of the leader. Absent households are visited again several times. The interview follows questioners written in Vietnamese, and conducted in Vietnamese by Vietnamese interviewers.

The questioner was completed based on the pre-survey results for around 20 households. The completed questioner is composed of five sections as briefly shown in **Table 1**. The interview takes approximately 30 minutes for each household. Some questions are checked by interviewers' observation.

Table 1 The five sections of the questioner and question examples in each section

Section	Examples of the questions
General information of toilets and greywater	Having any toilet or not; the type of the toilet; the place to flow toilet waste; the place to flow greywater
Information of pit/tanks for toilet waste	Having any outlet or not; the place to flow the effluent; the year of tank introduction; having any cover to access septage; the shape, volume of the tank, the number of compartments of the tank
Information of the septic-tank management	Putting additives into the tank or not; Having ever desludged or not; desludging regularly or not; the when desludging
Information of the household	The educational level of the household head; the type of the house; the area of the house; population in the house
Road conditions around the house	The house along Pho, Duong, Ngo, Ngach or Hem; the width is the road in front of the house

Table 2 The selected communes of the survey

District	Commune
Ba Dinh	Quan Thanh, Doi Can, Giang Vo
Dong Da	Tho Quan, O Cho Dua, Lang Thuong, Kim Lien, Kham Thien
Hai Ba Trung	Bach Khoa, Thanh Nhan, Vinh Tuy
Hoan Kiem	Hang Buom, Chuong Duong, Cua Nam
Hoang Mai	Hoang Van Thu, Tan Mai, Vinh Hung
Long Bien	Ngoc Thuy, Phuc Loi
Cau Giay	Trung Hoa, Nghia Tan
Thanh Xuan	Khuong Mai, Thanh Xuan Bac
Tay Ho	Buoi, Phu Thuong

Results and Discussion

The communes selected based on the sampling methodology are shown in **Table 2**. The interview was started at the beginning of December 2005 and finished at the middle of May 2006. The response rate of the survey was 92.5 % (694 households of 750), composed of 634 households living in detached houses (91.4 % of all respondents) and 60 households in apartment houses (8.6 % of those). The following discussions are limited to detached houses.

Present sanitation systems in urban Hanoi

Toilets in urban Hanoi

The interview results of the toilet-possession types and toilet types for households living in the detached houses are shown in **Table 3**. Most of households living in detached houses owned toilets for each household (*i.e.* owned toilet). A small portion of households shared toilets with other households (*i.e.* shared toilet), who are mainly relatives living near their houses. The households not having any toilets (*i.e.* no toilet) were composed of nine households using public toilets, one household using a neighbor's toilet, and one households not using any toilets but using some bags for excretion.

Table 3 Interview results of possession types of toilet and toilet types

Item	Estimate rate	S.E	Frequency
<i>The toilet-possession type</i>			
Owned toilet	96.06%	1.33%	609
Shared toilet	2.21%	0.89%	14
No toilet	1.74%	1.04%	11
Total	100.00%	-	634
<i>The toilet type of households</i>			
Cistern-flush toilet	78.33%	5.13%	488
Pour-flush toilet	18.46%	4.70%	115
Double-vault toilet with urine-diversion	1.44%	0.55%	9
Double-vault toilet without urine-diversion	1.44%	0.66%	9
Bucket latrine	0.16%	0.18%	1
Toilet directly over water bodies	0.16%	0.20%	1
Total	100.00%	-	623

“The toilet type of households” in **Table 3** was interviewed to households answering “owned toilet” or “shared toilet”. A 96.8 % of the households equipped flush toilets in urban Hanoi. Here, we would like to focus attention on the 1.44 % use of double-vault toilets with urine-separation. The northern Vietnam has a history, in which human excreta have been used for agricultural purpose in a similar manner with East Asian countries, but the excreta was not used in sanitary ways in most cases. Due to sanitize human excreta and to prevent Vietnamese from infecting excreta-related diseases, the health authority started a campaign to introduce the double-vault toilets with urine diversion to Northern Vietnam in 1956 (Winblad and Simpson-Hebert, 2004).

Table 4 shows the results of the year when each toilet was built depending on five-toilet types: bucket latrines, double-vault toilets with urine diversion, double-vault toilets without urine diversion, pour-flush toilet, and cistern-flush toilets. The significance of differences of the year among the four-toilet types, excluding bucket latrines, was examined by the Kruskal-Wallis test because the data is not accorded with the normal probability distribution. The Kruskal-Wallis test is applied to investigate the difference of non-parametric data among groups, and the significance was confirmed ($P < 0.001$). The result of the test is interpreted that the house-built year of at least one toilet type is significantly different from others.

Then, the multiple comparison of the years among four-toilet types was tested. The significance of differences of the years and test values were determined by the Mann-Whitney U test with Bonferroni correction (five comparisons among 4 groups), as shown in **Table 5**. The results together with the data in **Table 4** were interpreted that double-vault toilets with urine diversion was significantly older toilets than cistern- and pour-flush toilets, and the cistern-flush toilets were significantly newer toilets than others. The number of cistern-flush toilet will increase and the management of cistern-flush toilet and its related-facilities such as septic tanks should be more significant issues, although a number of pour flush toilets will be still used. Water consumption for toilets is considered to increase to flush excreta.

The importance of double-vault toilets with urine-separation should not be dismissed since the interests on toilets with urine diversion is growing in the context of Ecological Sanitation (Winblad and Simpson-Hebert, 2004; Langergraber and Muellegger, 2005). Although the toilet might be replaced to other toilets in urban Hanoi, it may have a possibility to achieve both sanitizing and recycling human excreta in rural areas.

Table 4 Interview results of the house-built year depend on each toilet type

Toilet type	Median (year)	Average (year)	S.D. (year)	Frequency (-)
Bucket latrine	1980	1980.0	-	1
Double-vault toilet with urine-diversion	1981	1957.4	43.4	9
Double-vault toilet without urine-diversion	1988	1975.1	28.9	9
Pour-flush toilet	1990	1988.1	8.7	100
Cistern-flush toilet	1998	1994.7	13.8	474

Table 5 The significance of differences of the house-built year among four toilet types and test values (*P<0.05, **P<0.01 and ***P<0.001)

	Double-vault toilet with urine diversion (n=9)	Double-vault toilet without urine diversion (n=9)	Pour-flush toilet (n=100)	Cistern-flush toilet (n=474)
Double-vault toilet with urine diversion (n=9)	-	Not tested	236.5*	325.0***
Double-vault toilet without urine diversion (n=9)	-	-	264.0	282.0***
Pour-flush toilet (n=100)	-	-	-	10539.0***
Cistern-flush toilet (n=474)	-	-	-	-

Destination of excreta in urban Hanoi

The flowing place of toilet waste was interviewed for the households with pour-flush or cistern-flush toilets and the results are shown in **Table 6**. It was founded that most of the flushed excreta flowed into some pits or tanks. The excreta from 3.2 % and 2.8 % of flush toilets were, respectively, discharged directly to open channels and to sewer pipes. Hanoi has no sewerage treatment plant for municipal wastewater except in limited industrial areas, although some plants is in pilot stages at the beginning of 2006. It is considered that the excreta discharged directly to open channels and to sewer pipes reach water bodies not through any treatment facilities, in addition to the excreta flushed directly to water bodies.

The 99.8% of the households flushing excreta to pits or tanks (558 HH of 561) had some kinds of outlet of their pits or tanks to discharge effluent. Here, we define that the pits or tanks with outlet for effluent as septic tanks and it is, then, interpreted that the tanks/pits of the 558 households with the outlet were septic tanks and most of excreta from flush toilets flowed into septic tanks in urban Hanoi. The most effluent from septic tanks were found to flow into sewer pipes, as indicated in **Table 7** that summarize the interview results of the flowing places of septic-tank effluent for households with septic tanks defined above.

Table 6 Interview results of the place where toilet waste flows for the households with flush toilets

Item	Estimate rate	S.E	Frequency
To pits or a tanks	93.19%	4.32%	561
Directly to open channels	3.16%	2.43%	19
To sewer pipes	2.82%	2.33%	17
Directly to water bodies	0.83%	0.41%	5
Not sure	-	-	1
Total	100.00%	-	603

Table 7 Interview results of the place where septic-tank effluent flows for the households with septic tanks

Item	Estimate rate	S.E	Frequency
To sewer pipes	96.23%	1.20%	536
To open channels	1.80%	0.54%	10
Others	1.98%	1.22%	11
Not sure	-	-	1
Total	100.00%	-	558

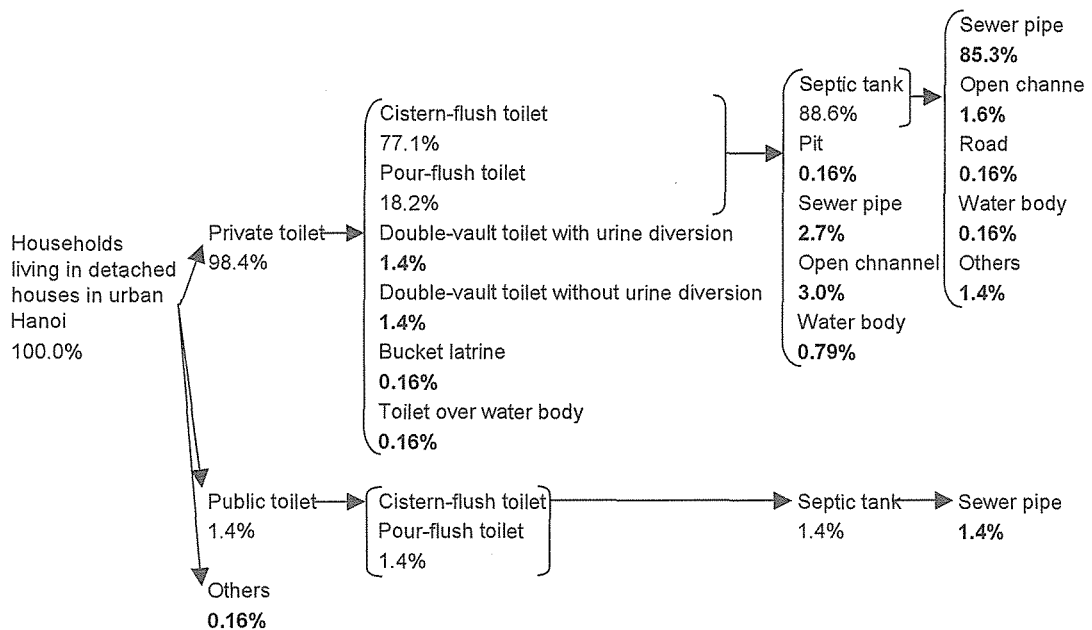


Figure 1 An estimated excreta flow: ratios were calculated to excreta from whole detached houses in urban Hanoi; bold figures are the ratios of each excreta portion at its final destination in this study.

So far, the flow of toilet waste (*i.e.* excreta) at each stage was described. The whole flow of excreta from detached houses in urban Hanoi is estimated as shown in **Figure 1**. Public toilets in urban Hanoi equip pour- or cistern-flush toilets connected to septic tanks in general (interviewed to Urban Environment Limited Company Ltd.). The shared toilets and owned toilets are integrated to private toilets, and the households having no toilet and using a neighbour's toilet are also included into private toilets in **Figure 1**.

The major flow (85.3 %) of excreta from whole detached houses in urban districts of Hanoi is predicted to be defecated at private toilets, flushed into septic tanks, and discharged into sewer pipes. It is finally estimated that 90.0 % of excreta is flushed into septic tanks including public one and 86.7 % of effluent from septic tanks are discharged into sewer pipes. It should be clear that the septic tanks play a major role of treatment of excreta.

Destination of greywater in urban Hanoi

The flowing place of greywater was interviewed for the households with flush toilets and the results is shown in **Table 8**. It was founded that most of the greywater flowed into sewer pipes. The ratio of greywater flowing into septic tanks was very limited (4.0 %).

Table 8 Interview results of the place where greywater flows for the households with flush toilets

Item	Estimate rate	S.E	Frequencies
To sewer pipes	91.4%	4.0%	550
To septic tanks together with toilet waste	4.0%	1.9%	24
Directly to open channels outside	3.5%	2.5%	21
Directly to water bodies	0.83%	0.41%	5
Others	0.33%	0.31%	2
Not sure	-	-	21
Total	100.0%	-	623

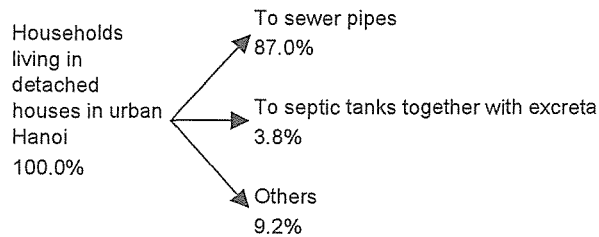


Figure 2 An estimated greywater flow: the ratios are calculated to greywater from whole detached houses in urban Hanoi.

The whole flow of greywater from detached houses in urban Hanoi is estimated as shown in **Figure 2**. The households without flush toilets are not considered to discharge greywater into sewer pipes or septic tanks in general but into others such as open channels and water bodies. It is calculated that the major flow (87.0 %) of the greywater is discharged into sewer pipes, which are not connected to sewage treatment facilities. Most greywater is indicated to reach into water bodies not though any treatment facilities including septic tanks.

Septic tanks in Hanoi

The state of septic tanks in urban Hanoi is described in this section based on the interview results. The results of the septic-tank structure are shown in **Figure 3**. The square-septic tanks accounted for 96.2 % of the all septic tanks (**Figure 3(a)**). The following results and discussions are limited to the data of square-septic tanks. The inside of each septic tank is separated into some compartments in general, and the number of compartments of each septic tank is represented in **Figure 3 (b)**. In spite of the authority's recommendation of three compartments in each septic tank, 27.2 % of the square septic tanks were composed of less than two compartments.

The covers to access septage were investigated and the results of the question whether the septic tank has any covers for septage access is set out in **Figure 3 (c)**. Although the execution of septage removals (desludge) is crucial in terms of the maintenance of septic tanks, 41.2 % of the septic tanks did not equip any access covers to septage. The households without the covers answered that, if necessary, they would access septage by the following ways: detaching a toilet pan and making a hole, braking a part of toilet floor and making a hole, or other ways. The 58.9 % of the septic tanks had covers fixed by cement and those covers were, in general, veiled with tiles of the toilet floor. When the septage is removed, the tiles have to be broken. Only 4.7 % of the septic tanks equipped the cover, which was openable and closable without breaking anything.

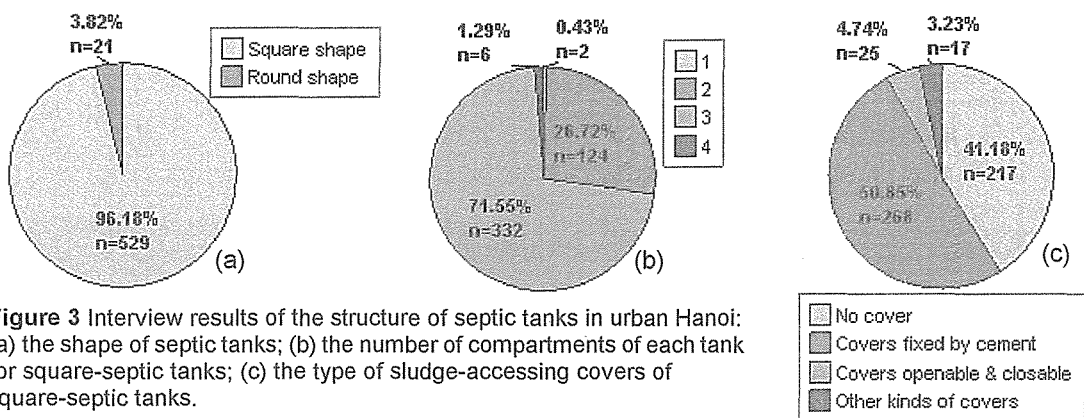


Figure 3 Interview results of the structure of septic tanks in urban Hanoi: (a) the shape of septic tanks; (b) the number of compartments of each tank for square-septic tanks; (c) the type of sludge-accessing covers of square-septic tanks.

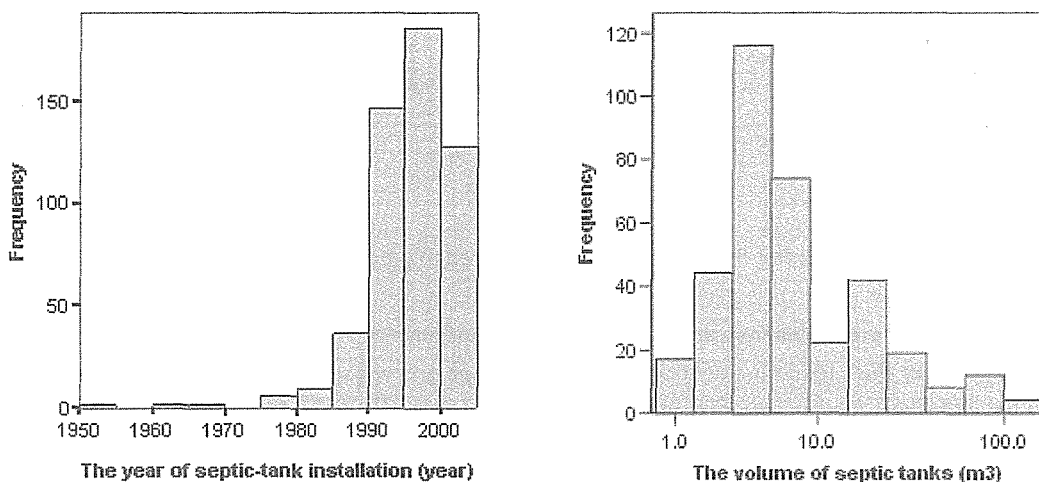


Figure 4 (left) Interview results of the installation year of square-septic tanks (n=514)

Figure 5 (right) Interview results of the volume of square-septic tanks (n=358)

The average and median of the years of square-septic tank installations were, respectively, 1996.8 with the standard deviation of 5.8, and 1997, and a histogram of the years appears in **Figure 4**. More than 99 % of septic tanks were installed after the year of 1975. The average and median of square-septic tank volumes were, respectively, 12.8 m³ with the standard deviation of 20.4 m³, and 5.4 m³, and a histogram of the volumes are represented in **Figure 5**. The volumes of the square-septic tanks in urban Hanoi were various.

As the relation between the years of tank installation and the cover types (no cover, cover fixed or cover openable & closable) was expected, the significance of the differences of the year among three-cover types were determined by the Kruskal-Wallis test and the difference was, however, not significant with the confidence coefficient of 0.05. This result is interpreted that the year of square-septic tank installation does not have significant influence on the type of the covers.

The state of septic-tank management in urban Hanoi

The state of septic-tank management in urban Hanoi is described in this section based on the interview results. The ratios of households with/without the use of chemical/biological additives for square-septic tanks appears in **Figure 6 (a)** and the figure shows that a large portion of households in urban Hanoi used additives. The

general purposes to use additives are to promote degradation of septage and to prevent clogging and foul odor of the tanks. It is implied from the use of additives that a number of households pay some attention to septic-tank management.

The ratios of the households with/without desludge experiences and with/without regular desludge from square-septic tanks are shown in **Figure 6 (b)** and **(c)**, respectively. It is found that the septage in most septic tanks have never desludged and only 5.36 % of households equipping septic tanks have a custom of regular desludge, although regular desludge is essential to maintain septic tanks. The interval time of regular desludges of the household desludging regularly from square-septic tanks is represented in **Figure 7**. The range of the interval period was between 2 months and 5 years, and the average and the median are 2.4 years and 2.0 years, respectively.

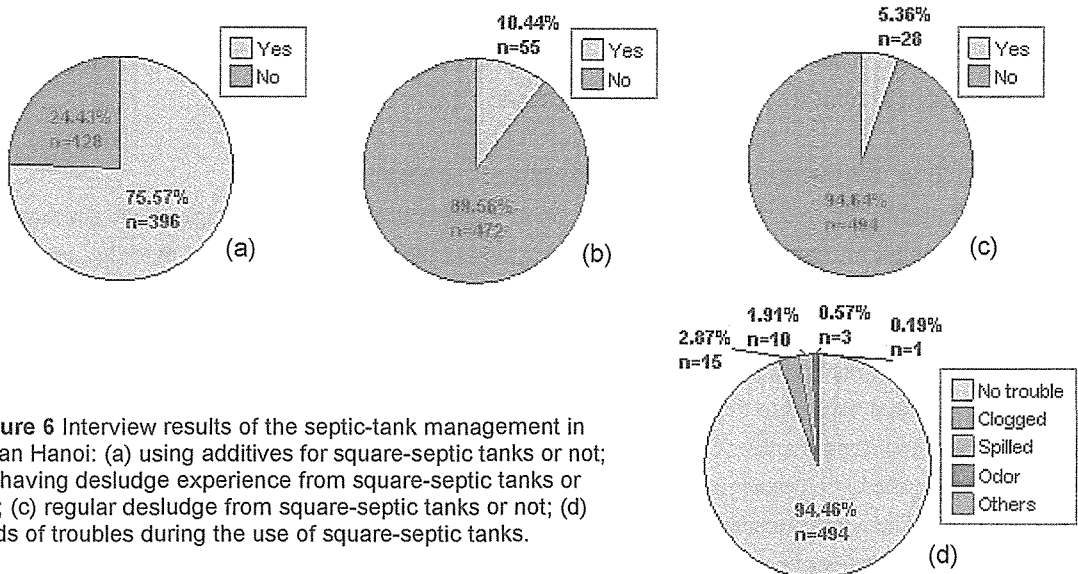


Figure 6 Interview results of the septic-tank management in urban Hanoi: (a) using additives for square-septic tanks or not; (b) having desludge experience from square-septic tanks or not; (c) regular desludge from square-septic tanks or not; (d) kinds of troubles during the use of square-septic tanks.

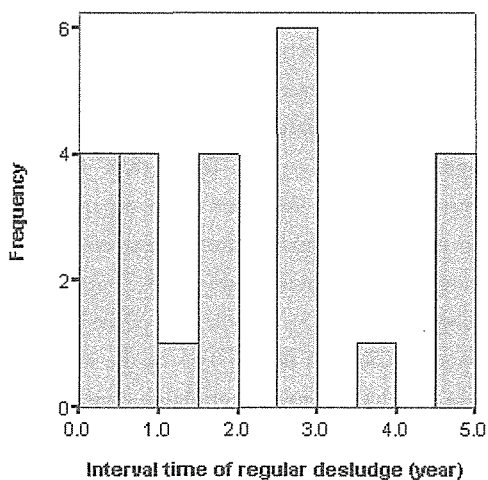


Figure 7 The interval time of regular desludge for square-septic tanks (n=24)

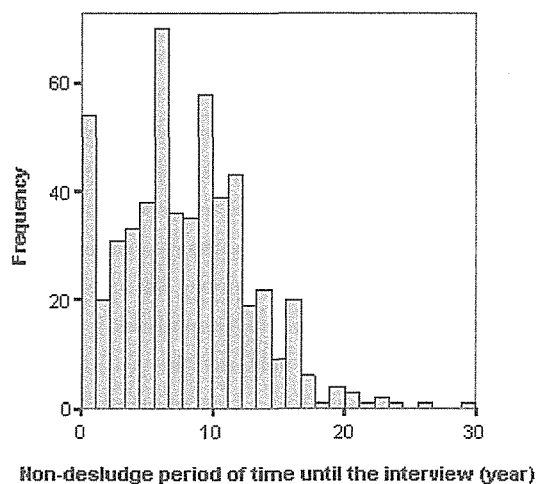


Figure 8 The non-desludge period of time until the interview for round- and square-septic tanks (n=547)

The non-desludge period of time until the interview of households equipping septic tanks is set out in **Figure 8**. Only this result includes the data both of square- and round-septic tanks. The 9.9 % of the periods were less than one year. It means that 9.9 % of the households desludged or started to use the septic tanks during the last one year. The average and median of the period were 8.0 years and 7.0 years. The 80.8 % and 67.8 % of septage of the households were, respectively, stored for more than 3 years and 5 years, although the necessity of regular desludge every three years was recommended in general. The maintenance of septic tanks is concluded to be serious in terms of desludging.

Figure 6 (d) shows the result of the question whether each household has ever had any kinds of septic-tank troubles or not. Although the conditions of many septic tanks was concluded to be serious, 94.2 % of the households equipping square-septic tanks have not had any troubles from the aspect of each household. Only small portion of the households had troubles such as clogged tanks, spilled tanks and foul odor. Even if the households do not feel any troubles for septic tanks, the executions of regular desludge from septic tanks is an urgent matter to maximize the performance of septic tanks.

Characteristics of households with or without regular desludge

In order to examine the characteristics of households with/without regular desludge, eight questions for households equipping septic tanks were tabulated by regular desludge (Yes/No) and desludge experience (Yes/No), as shown in **Table 9**.

In terms of the septic tank structure, the smaller, older and two-compartment septic tanks have a large tendency to desludge regularly and to experience desludge (Q.1, 2 and 3). It may be the reason that the ratio of septage-accumulated volume to the volume capacity of small and old septic tanks is considered to be higher than large and new septic tanks. Small and old septic tanks are likely to become full earlier, have some troubles, and require to be desludged. However, large and new septic tanks will also require to be desludged sooner or later. There was a tendency that the number of compartments of large septic tanks was not two but three compared to small septic tanks.

Although the covers openable-and-closable were considered to be easy to desludge, the regular-desludge rate among households with covers openable-and-closable is only 8.0 % equal to covers fixed, and even the ratio among households without any covers is still 2.3 % (Q.4). The little effect of the volume and installation year of septic tanks on the type of covers was founded. Septic tanks in urban Hanoi is, in general, located under toilets, most of which are in the houses, and it was mentioned during interviews that some households were afraid of foul odor after desludging and they preferred the covers fixed than to covers openable-and-closable in order to prevent foul odor. In terms of desludge, the types of covers may not be crucial issues in urban Hanoi, although existence of some cover is considered to be better than no cover.

The regular-desludge ratio among the household experiencing any septic-tank troubles (48.3 %) was much higher than the ratio among the households without experiencing (2.9 %) (Q.5). The 82.8 % of the household experiencing any septic-tank troubles had desludge experiences (Q.5), and the 56.0 % of the households experiencing desludge had a custom of regular desludge (Q.8). The households desludging regularly were composed of 50.0 % of households experiencing septic-tank troubles and 50.0 % of households not experiencing septic-tank troubles (not shown in the table). It is interpreted that the most households desludge after experiencing the septic-tank troubles to solve them, and more than half of those households may have a custom of regular desludge. On the other hands, the half of households desludging regularly has desludged even that it has never experienced septic-tank troubles.

Table 9 Cross tabulation of states of regular desludge and desludge experience by 8 items

Item	Regular desludges			Desludge experience		
	Freq.	Yes	No	Freq.	Yes	No
<i>Q.1 The year of tank installation</i>						
Average	507	1987.3	1997.1	512	1990.4	1997.4
Median	507	1991	1998	512	1993	1998
<i>Q.2 The volume of square-septic tanks</i>						
Average	353	4.8	13.0	357	6.1	13.5
Median	353	3.0	5.5	357	3.0	6.0
<i>Q.3 The compartment number of square-septic tanks</i>						
2	122	7.4%	92.6%	124	15.3%	84.7%
3	328	3.4%	96.6%	331	6.9%	93.1%
<i>Q.4 The types of covers</i>						
No cover	214	2.3%	97.7%	216	6.0%	94.0%
Covers fixed	264	8.0%	92.0%	267	14.2%	85.8%
Covers openable	25	8.0%	92.0%	25	16.0%	84.0%
<i>Q.5 Having some troubles about tanks or not</i>						
Yes	29	48.3%	51.7%	29	82.8%	17.2%
No	489	2.9%	97.1%	493	6.1%	93.9%
<i>Q.6 Using additives or not</i>						
Yes	391	4.1%	95.9%	395	9.1%	90.9%
No	127	9.4%	90.6%	128	14.8%	85.2%
<i>Q.7 Educational level</i>						
Low (Non certificate, primary, Lower-secondary)	70	11.4%	88.6%	71	18.3%	81.7%
Middle (Upper-secondary, Technical worker, Vocational)	256	4.7%	95.3%	260	9.6%	90.4%
High (College and University, Postgraduate)	192	3.6%	96.4%	192	8.3%	91.7%
<i>Q.8 Desludge experience</i>						
Yes	50	56.0%	44.0%	-	-	-
No	-	-	-	-	-	-

The households without the use of additives had the higher regular-desludge ratio and the higher desludge-experience ratio than the households with the use (Q.6). It is interpreted that households using additives did not have a tendency to desludge compared to the households not using additives. The reason may be explained as follows: some households thought that the use of additives can remove the necessity of regular desludge. Some of the households using additives mentioned in the interviews that they did not require to desludge due to the use of additives. Additives may, in fact, have same effects to prevent apparent troubles such as clogged or spilled tanks. However, the necessity of desludge should be informed carefully to households using additives.

The relation between the educational level of households and the desludge state was examined based on the assumption that high-education households would understand the importance of desludge and the regular-desludge ratio might be high compared to low-education households. However, the regular-desludge ratio of high-education households was lower than middle- and low-education households (Q.7). One reason of the low ratio may be the structure of septic tanks: high-education households had a tendency to equip larger septic tanks than low-education households (not shown in the table). It is implied that even the high-education households do not enough understand the necessity of desludge. The importance of regular desludge should be disseminated to all-educational-level households.

Conclusions

The statistical investigation of sanitation systems in urban Hanoi was conducted in this study, and the distribution of sanitation systems in Hanoi was estimated together with excreta flow of urban Hanoi. A 90.0 % of excreta was flushed into septic tanks including public one and 86.7 % of effluent from septic tanks were discharged into sewer pipes. It should be clear that the septic tanks play a major role of management of sanitation in urban Hanoi. In addition, 94.6 % of the households equipping septic tanks did not have a custom of regular desludge and 89.6 % of the households have never dislodged before. Dissemination of necessity of regular desludge is considered crucial issues to improve sanitation in urban Hanoi.

The outcome of this study can be utilized as basic data to make sanitation strategy in urban Hanoi. The utilization of septic tanks is considered to be important in the strategy and the proper management manner of septic tanks should be investigated in the context of Hanoi in order to maximize the performance of septic tanks. In addition, treatment facilities of septage will require to be developed in in/around Hanoi to treat septage desludged from the households in urban Hanoi.

References

- Asian Development Bank (2001) *Asian Environment Outlook 2001*, ADB, Manila, Philippine.
- Hanoi Statistical Office (2006) *Hanoi Statistical Yearbook 2005*, Hanoi Statistical Office, Hanoi.
- Infrastructure Development Institute-Japan (2004) *Guideline for low-cost sewerage systems in developing countries (draft)*, IDI-J, Tokyo.
- JICA and Hanoi People's Committee (2000) *The Study on Environmental Improvement for Hanoi City in the Socialist Republic of Vietnam*, JICA, Tokyo.
- Langergraber, G. and Muellegger, E. (2005) Ecological Sanitation- a way to solve the global sanitation problems?, *Environment International*. **31**, 433-444.
- Sasha Fink (2001) The sustainability of toilets in Hanoi, Vietnam, *International Journal of Economic Development*, **3** (3).
- Straus, M., Barreiro, W.C., Steiner, M., Mensah, A., Jeuland, M. and Bolomey, S. (2003) Urban management – situation, challenges, and promising solutions, *Proc. of IWA Asia-Pacific Regional Conference*, Bangkok, October 19-23.
- WHO and UNICEF (2005) *Water for life: making it happen*, WHO and UNICEF, Geneva.
- Winblad, U. and Simpson-Hebert, M. ed. (2004) *Ecological sanitation- revised and enlarged edition*, Stockholm Environmental Institute, Stockholm.