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INSTITUTIONAL MECHANISMS FOR SUSTAINABLE SANITATION: LESSONS FROM JAPAN FOR OTHER ASIAN COUNTRIES

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Abstract

Even though access to sanitation facilities has improved in the urban areas of many Asian developing countries, the pollution of public water bodies remains a serious problem. One of the causes of water pollution is improper decentralized wastewater management.

This study explains the evolution of Japan's decentralized wastewater management system and extracts elements that may be useful in developing countries. These elements include the establishment of a qualification and training system for decentralized wastewater treatment facility installation businesses; the introduction of a regular desludging system; the establishment of a qualification and training system for desludging business/workers; and the establishment of a qualification and examination system for operators of PAWTPs or similar facilities mainly targeted for non-household users.

Keywords: decentralized wastewater management, Japan, sanitation facilities

JEL Classification: Q25, Q53

Contents

1. INTRODUCTION

Even though access to sanitation facilities has improved in the urban areas of many Asian developing countries, the pollution of public water bodies remains a serious problem. One of the causes of water pollution is improper decentralized wastewater management. Most urban residents in Asian developing countries use septic tanks, many of which are improperly installed, sometimes making them inaccessible for desludging. Although sludge management is essential for any kind of wastewater treatment, the type of desludging for septic tanks in developing countries is mostly "on-call," which is not reliable. Regular desludging is the first step for decentralized wastewater management, which is good not only for household septic tanks but also for packaged aerated wastewater treatment plants (PAWTPs, or *johkasou* in Japanese) or similar facilities already widely used by non-household users (commercial buildings) in Asian developing countries. The proper treatment and disposal of the collected sludge is also essential. However, the development of sludge treatment facilities is far behind that of sewerage systems in developing countries.

This is in contrast with Japan, where more than 1,000 night soil treatment facilities were built in the 1950s and 1960s, prior to the nationwide development of sewerage systems that started in the 1970s. The incidence of waterborne diseases in Japan was virtually eliminated by 1970. This was attributed to the rapid diffusion of both piped water supply systems and night soil treatment facilities. In the 1960s and 1970s, an older PAWTP type, which treated only black water, was diffused widely among citizens who wanted to install flush toilets as a symbol of modern life but did not want to wait for sewerage system development. From the 1980s, however, the pollution of public water bodies caused by untreated domestic wastewater became highly visible and was attributed to delays in sewerage system development and to the poor performance of the old-type PAWTPs, which released untreated gray water into the environment. To improve the situation, sewerage system development was accelerated, a new type of PAWTP that could treat both black and gray water was developed, and a comprehensive reform of decentralized wastewater management was introduced, with the promulgation of the PAWTP Act (Johkasou Act) in 1983. Under the act, the legal basis for manufacturing, installing, maintaining, inspecting, and cleaning (desludging) PAWTPs became clearly defined. To translate these measures, the act specified the responsibilities and duties of users, the central government, municipalities, PAWTP operators, inspectors, desludging businesses, and training institutions. Accordingly, a system of state certifications for installation workers and maintenance operators was created.

The management of decentralized wastewater treatment facilities had been a neglected issue in Asian developing countries until 10 years ago. Recently, its importance has been recognized, and in a few countries and cities, namely India, Indonesia, Malaysia, the Philippines, Hai Phong City (Viet Nam), and Manila City (the Philippines), sludge management for septic tanks is being strengthened. But the problems of unregulated or too few desludging operators persist in many Asian developing countries (see Araral [2010]). The performance of unregulated desludging vendors is poor, and there are many reports of the illegal disposal of sludge into rivers. Improper operation and maintenance of the decentralized wastewater treatment systems (also known as DEWATS) of commercial buildings due to the lack of human resources is another issue to be urgently addressed.

This study explains the evolution of Japan's decentralized wastewater management system and extracts elements that may be useful in developing countries, including those that use technology other than PAWTPs. These elements are the following:

1. the establishment of a qualification and training system for decentralized wastewater treatment facility installation businesses;
2. the introduction of a regular desludging system;
3. the establishment of a qualification and training system for desludging business/workers; and
4. the establishment of a qualification and examination system for operators of PAWTPs or similar facilities mainly targeted for non-household users.

The establishment of these systems would not consume excessive government resources but would require substantial administrative work. Political support would be essential, since establishing them would affect the relationships between citizens, administration, and sanitation workers. The reward for such efforts would be better decentralized wastewater management systems and the creation of job opportunities, which are badly needed in developing countries. In Japan, nearly 200,000 professionals are working for the betterment of decentralized wastewater management systems.

2. CURRENT SITUATION OF DECENTRALIZED WASTEWATER MANAGEMENT IN THE URBAN AREAS OF ASIAN DEVELOPING COUNTRIES

2.1 Water Pollution Caused by Improper Decentralized Wastewater Management

Water Pollution in Asian Developing Countries

While industrial economies in Asia have improved their public water bodies in recent years, most Asian developing countries have not, and some have experienced a severe deterioration. In Indonesia, 70%–80% of the major rivers are seriously polluted (Water Environment Partnership in Asia 2018).

Improvement of Access to Sanitation Facilities Does Not Mean Improvement of the Aquatic Environment

The pollution of public water bodies is serious, particularly in the urban areas of Asian developing countries, where the coverage of centralized wastewater treatment systems remains low (see Araral and Wu [2016]). Although the percentage of residents in Jakarta with access to improved sanitation facilities has reached 87% (2% to sewer systems, 85% to septic tanks), the rivers in the city, in which the average biochemical oxygen demand (BOD) level is 61 milligrams per liter (mg/l), have become natural sewers (Japan International Cooperation Agency [JICA] 2012). Similar situations can be seen in many Asian urban areas. It is apparent that the increase in access to improved sanitation facilities does not necessarily lead to the improvement of the aquatic environment.

Improper Decentralized Wastewater Management as a Cause of Water Pollution

Water pollution in Asian developing countries may be attributed to: (i) the low treatment efficiency of septic tanks, though they are widely used as household decentralized wastewater treatment facilities; (ii) the large number of septic tanks treating only wastewater from toilets (black water) but not miscellaneous wastewater (gray water), which contains a higher pollution load and is discharged without treatment; or (iii) the improper management of the sludge generated in household septic tanks and in non-household individual wastewater treatment plants.

2.2 Prevailing Decentralized Wastewater Treatment Systems with Poor or Variable Performances

Poor Effluent Water Quality of Septic Tanks

Information on the effluent water quality of septic tanks, which are widely diffused in Asian developing countries, is limited. However, JICA's water quality testing of septic tanks in Jakarta indicates that their average effluent water quality is poor (BOD of 200 mg/l, chemical oxygen demand of 530 mg/l) (JICA 2012). There are similar testing data for Viet Nam (Ha Noi) (Harada et al. 2008) and India (Kazumi 2014) that provide similar figures. We can consider that because of the current lack of sludge management with regular desludging systems, even the inherently insufficient performance standards of septic tanks are not being achieved.

Limitation of Anaerobic Decentralized Wastewater Treatment Systems

In a few countries, improved versions of anaerobic-type wastewater treatment facilities, such as BORDA's DEWATS, have been introduced. Although the effluent quality of these facilities has been improved to some extent from that of septic tanks, they do not comply with the new and recently revised water quality standards of the countries where they have been installed. For example, the effluent water quality of DEWATS installed under community-based sanitation programs (known as SANIMAS) in Indonesia has a BOD of approximately 50 mg/l, total suspended solids of 40 mg/l, and ammonia (NH_4-N) of 50–60 mg/l, which met the standards of Indonesia at the time of installation (2011), but not those of neighboring countries (the Philippines and Malaysia) (Kerstens et al. 2012). It is not possible to meet Indonesia's new effluent water quality standard, which was revised in 2016 to a BOD of 30 mg/l, total suspended solids of 30 mg/l, and ammonia of 10 mg/l.

2.3 Improper Installation of Decentralized Wastewater Treatment Systems, Such as Septic Tanks, which are Sometimes Inaccessible for Desludging Operations

Inappropriate Installation of Existing Septic Tanks

Many septic tanks in old houses in Jakarta were installed underneath the floor in areas such as the kitchen without access covers, seemingly without any consideration for desludging. In some cases, since the elevation of the house floor against the road surface is not sufficient, it is difficult to discharge the septic tank effluent into the street drain, meaning it is inevitably discharged underground, causing groundwater pollution. Similarly, septic tanks installed inside without access covers for desludging can be generally seen in many Southeast Asian countries other than Indonesia. In Hai Phong City in Viet Nam, it is reported that plastic covers are being installed on access holes by

workers of the Drainage Corporation (the desludging entity) after septage removal (Water Environment Partnership in Asia 2013).

Points of Attention for the Installation of Decentralized Wastewater Treatment Facilities

Decentralized wastewater treatment facilities must be installed in a way that is accessible for maintenance, including desludging. Piping to connect them to toilets and street drains must be conducted properly. The elevation of the installation site is also important so that the effluent can be discharged to the street drain by gravity.

Necessary Regulatory Framework for the Appropriate Installation of Decentralized Wastewater Treatment Facilities

In some newly built houses in Jakarta, the septic tank is installed outside the house and facing the street, which is convenient for desludging and enables the effluent to discharge into the street drains. The city administration has environmental impact assessments and a building permission system that checks large buildings' wastewater management; however, such checks are not conducted for individual houses.

It is essential for the decentralized wastewater treatment facility installation business to have the correct knowledge on all the points of attention for the installation works, including the selection of proper locations. Accordingly, technical standards for installation, a qualification system for the installation business, and a training system for installation workers are essential.

2.4 Lack of Sludge Management

Importance of Sludge Management in Decentralized Wastewater Management

Any wastewater treatment facility, regardless of whether it is a septic tank, a DEWATS, or a PAWTP, generates sludge. Unless sludge is properly and regularly removed, its intended treatment performance will not be attained, and it will become a pollution source itself. The volume of generated sludge is larger in aerobic systems than in anaerobic systems. In the United States, where 25% of the population uses a septic tank, the Environmental Protection Agency recommends sludge pump-outs every 4 years, but the final decision is left to the users (United States Environmental Protection Agency 1999). The United States Agency for International Development (USAID) (2010) indicates that in a regularly desludged system, sludge fills less than one-third of the tank. The Swiss Federal Institute of Aquatic Science and Technology (EAWAG) recommends desludging a septic tank every 2–5 years (EAWAG 2008). In Japan, desludging once a year is a legal obligation for household PAWTP users.

Desludging Currently Conducted in Developing Countries is "On-call"

In developing countries, preventive regular desludging has not been conducted, with only a few exceptions. The desludging system mostly used in developing countries is "on-call," in which household owners call vendors only in emergencies when their toilet becomes unusable due to blockages caused by accumulated sludge in septic tanks that have been unmaintained for long periods of time. According to the results of JICA's social survey (JICA 2012), summarized in Table 1, around 45% of Jakarta residents replied that their septic tanks had never been desludged or that they did not know when their tanks had been desludged, while 7% replied that their tanks were desludged more than once a year. It may be possible that if a septic tank is larger than the required size for the number of users, it would not cause any inconvenience and blockages would not occur even if the tank is not desludged for over 10 years. This may be the case for higher-

income users who enjoy flush toilets connected to larger septic tanks. But, even in such cases, the septic tanks would have lost their treatment function and would spread pollutants long before blockages happen. In contrast, most of the house owners who desludged more than once a year were or low- or middle-income respondents. This may be explained by the fact that since their septic tanks are smaller than the required size for the number of users, the tanks would fill in a short time.

Table 1: Frequency of Desludging in Jakarta, Indonesia

Desludging Frequency	Low-Income Level	Middle-Income Level	High-Income Level	Leaders	Share of Total
1. More than once a year	9.0%	9.5%	4.9%	7.3%	7.6%
2. Once a year	11.4%	10.7%	11.3%	17.2%	12.7%
2. Once every 2 years	9.8%	12.2%	12.5%	6.5%	10.3%
4. Once every 3 years	3.7%	7.3%	10.9%	8.4%	7.6%
5. Once every 4+ years	11.8%	15.3%	19.6%	20.3%	16.8%
6. Never desludged	46.5%	38.5%	36.2%	32.2%	38.2%
7. Unknown	7.8%	6.5%	4.5%	8.0%	6.7%

Source: JICA (2012).

Correlation Between the Frequency of Desludging and the Water Quality of Decentralized Wastewater Treatment Facilities

Although there are not many actual data correlating the frequency of desludging and the treated water quality of decentralized wastewater treatment facilities, a test by Harada et al. (2008) of Ha Noi's water quality indicates that while the pollutant removal rate of septic tanks desludged once a year is 71%, the removal rate of septic tanks desludged only once in 10 years is 0%.

Furthermore, testing data by Tadokoro et al. (1988) on old-type PAWTPs (treating only black water) indicated that their treated water quality deteriorates quickly if they are not desludged within 1 year.

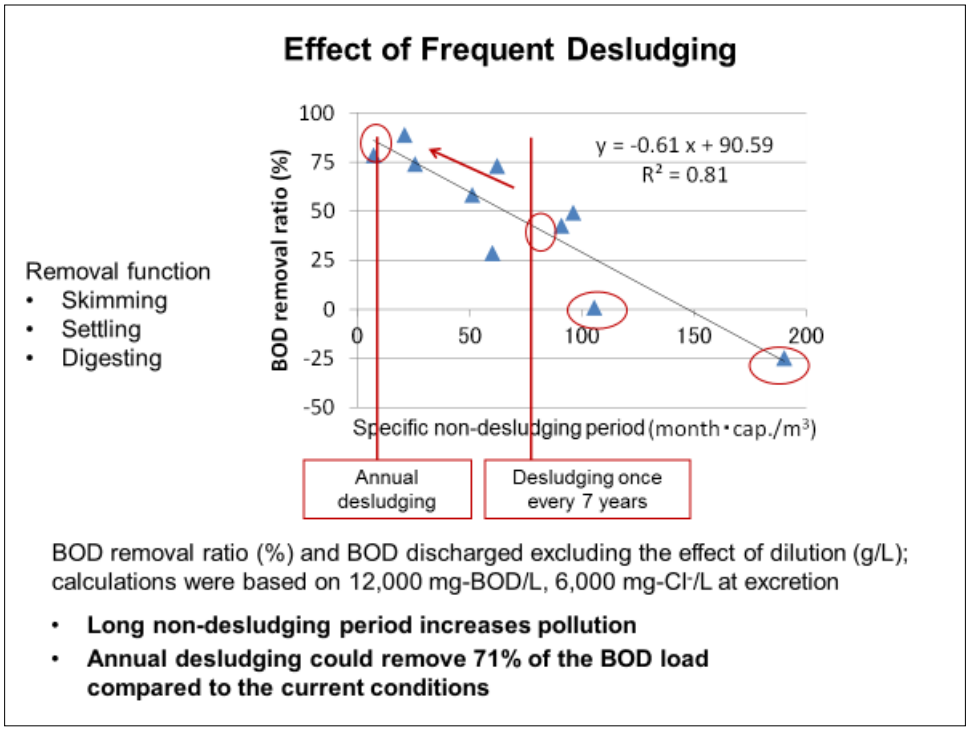
Introduction of a Regular Desludging System

The establishment of a regular desludging system for household septic tanks is the first step for improved decentralized wastewater management since it sets a benchmark for the regular desludging of PAWTPs or similar facilities for non-household users. The realistic frequency of the regular desludging of septic tanks needs to be decided with care, taking into consideration the capacity of households to pay the associated fees, since desludging is very expensive. In Malaysia, the desludging frequency was set at every 2 years initially, but it has since been revised to every 3 years.

Proper Disposal of the Collected Sludge

In many developing countries, municipalities do not recognize their responsibility for building and operating sludge treatment facilities, with the result that their development is behind that of sewer systems. Even where facilities exist, their utilization rate remains low, implying that substantial amounts of collected sludge are disposed of in rivers or other water bodies.

Figure 1: Correlation between the Frequency of Desludging and the Treated Water Quality of Septic Tanks in Ha Noi, Viet Nam



Source: Harada, H. "Better Septic Tank Management: Challenges and Remarkable Effects (PPT)". Presentation. Kyoto University.

On-site Sludge Management in Asia and the Pacific

Sludge management of decentralized wastewater treatment facilities was a neglected issue until 10 years ago. Recently, even in developing countries, the importance of this issue has been recognized, and, in a few countries and cities, sludge management has been strengthened. In India, Indonesia, Malaysia, and the Philippines, etc., sludge management for septic tanks has become an element of their sanitation and wastewater management policy. For example, in Indonesia, the development of sludge treatment capacity in all municipalities is included in their national 5-year development plan, and pilot projects for regular desludging have been implemented in several cities. Meanwhile, in Hai Phong City and Manila City, the regular desludging of septic tanks has been systematized and implemented for over 10 years. Malaysia started to tackle this issue more than 20 years ago and is undergoing a trial-and-error process. Dumaguete City, in the Philippines, established a regular desludging system in 2007 but reportedly returned to on-call desludging services in recent years (SNV 2015).

Septage Management is Not an Issue Limited to the Poor

Though septage management is often considered as an issue for the poor, Harada showed how the regular desludging rate is lower for educated groups than for low/middle education level groups. To introduce a regular desludging system, the most crucial factor is how to engage middle-to-high-income households.

2.5 Unregulated and Insufficient Numbers of Desludging Operators

Inadequate Performance of Unregulated Desludging Vendors

Even in developing countries, there are demands for on-call desludging. Currently, they are rarely regulated or trained, with the result being inadequate performance. In Jakarta, residents complained that private desludging vendors tend to do careless work, removing only the water content of the tank and leaving the sludge, thus resulting in it becoming full again very soon. There are many reports on the illegal disposal of collected sludge into rivers and other water bodies to avoid disposal fees and long trips to facilities.

Improving Desludging Vendors' Service is Essential for Effective Non-household Individual Wastewater Treatment Facilities

The poor quality of desludging vendors is an obstacle for the improvement not only of household septic tanks, but also non-household individual wastewater treatment facilities. If vendors conduct desludging works without proper knowledge of these facilities, which are far more complex and sizable than septic tanks, there is the risk not only of error, but also that the equipment may be broken.

Measures to Improve the Social Status of Desludging Workers is Also Essential

On the other hand, the social status of desludging workers in developing countries is low, and their income is unstable under current on-call systems. To improve DEWATS in developing countries, measures to improve their social status are also required.

2.6 Improper Operation and Maintenance of Decentralized Wastewater Treatment Systems for Non-Household Users

Recent Move Toward Tightening Regulations on Non-household Individual Wastewater Treatment Facilities

The wastewater generated by non-household users, such as apartments, hotels, office buildings, shopping malls, schools, hospitals, and large restaurants, etc. (collectively called commercial buildings) is generally similar to that generated by individual houses, although their volume per square meter is bigger. Therefore, in many countries, stricter regulation is applied to non-household users in comparison to household users. For example, in Jakarta, there are 4,000 commercial buildings for which stricter effluent water quality standards have been applied since 2005, i.e., BOD 50 mg/l, which was revised to 30 mg/l in 2016, and mandatory effluent water quality testing by the municipal environment authority has been introduced since 2005. Consequently, many commercial buildings have replaced their septic tanks with aerobic-type wastewater treatment facilities. Some of them are locally manufactured Japanese-type PAWTPs, while others are imported from other countries such as Australia; both are aerobic facilities (collectively called "PAWTPs or similar facilities").

Improper Operation of Individual Wastewater Treatment Facilities of Commercial Buildings in Asian Developing Countries

In Jakarta, 60% of non-household PAWTPs or similar facilities were not properly operated. The majority of PAWTPs or similar facilities use activated sludge processes wherein, if the sludge concentration in the reactor is too high, treatment performance deteriorates. Therefore, to control the density of sludge, a Mixed Liquor Suspended Solids monitor is required. However, there is no evidence that such control work is being

conducted. Moreover, since PAWTPs or similar facilities use aerobic processes, the sludge volume is large, requiring desludging at least once a year, twice a year in case of all aeration formula types. Nonetheless, there are facilities that have not been desludged since installation (JICA 2012).

2.7 Lack of Human Resources for Operation and Maintenance of Decentralized Wastewater Treatment Facilities

Operating Wastewater Treatment Facilities from Commercial Buildings Requires Expert Knowledge and Experience

For households in developing countries, regular septic tank desludging is the only way to maintain their limited treatment performance. In contrast, PAWTPs or similar facilities used by non-household users feature numerous mechanical parts and devices that require expert knowledge and experience for proper maintenance. Since such human resources are lacking, a system to develop them is required. Once such systems are established, PAWTPs or similar advanced facilities will become usable for households in the future.

2.8 Lack, or Underutilization, of Sludge Treatment Capacity

Necessity to Increase the Capacity of On-site Sludge Treatment

In order to ensure efficient operations from desludging operators (a desludging vehicle can cover a multiple number of septic tanks or PAWTPs in a day), treatment facilities need to be conveniently located (for example, within 30 minutes' drive). In Japan, for example, about 1,000 treatment facilities were built nationwide. Kumagaya City, a typical mid-size city with a population of 200,000 and an area of 160 km^2, has two treatment facilities. It should be noted that in developing countries, if the distance to the treatment facility is too large, desludging operators will dispose of the collected sludge in nearby public water bodies.

In Developing Countries, Sludge Treatment Capacity is Inadequate

In developing countries, sludge treatment capacity is far behind that of the sewerage systems. For example, 10 years ago in India, there were no sludge treatment facilities. Indonesia is an exceptional case; in some cities, there are existing sludge treatment facilities, but some are currently not operating. In Jakarta, there are two sludge treatment facilities, both of which are operating, but their utilization is limited. The reason for this may be due to the low coverage of the regular desludging program and the operators disposing the sludge into public water bodies.

Problems of Sludge Treatment Facilities Recently Built in Developing Countries

Recently, a few developing countries have strengthened sludge treatment capacity in line with their policy for improving sludge management for septic tanks. For example, the Ministry of Public Works in Indonesia has established a target to build sludge treatment facilities in all 700 municipalities. As a result, new treatment facilities have been built in a few municipalities and the two existing facilities in Jakarta have been renovated. Sludge from septic tanks and PAWTPs or similar facilities contain a lot of water, and the basic treatment principles are: i) solid/liquid separation; ii) disposal of solid (dried sludge) by landfill, incineration, composting or reuse as building materials or other measures; and iii) wastewater treatment of the supernatant. These principles are not much different from the principles for treatment and disposal of the excess sludge generated in the Wastewater Treatment Plant. But the on-site sludge has two distinct features; it contains

more sand and screen residues than in the usual wastewater and has a less homogeneous nature due to its being collected from various sources. For example, in Japan, not only the sludge collected from PAWTPs but also night soil collected from vault toilets, is brought to sludge treatment facilities. Because of these features, the pre-treatment process, in which sand and screen residues are removed and sludge from various sources is stored and agitated before the solid-liquid separation, is important. The "pre-treatment" of many newly built sludge treatment facilities in developing countries is not properly designed, resulting in their poor performances.

3. JAPAN'S DECENTRALIZED WASTEWATER MANAGEMENT SYSTEM

3.1 Evolution of Decentralized Wastewater Management in Japan

Achievements in Sanitation: Night Soil Treatment (1950–1960s)

In Japan, vault toilets, which have a water-tight structure and functioned as a temporary storage for night soil, were the most popular historical style of toilet. The night soil stored in the vault toilets in urban houses in Japan was collected and transported to rural areas and used as fertilizer for agricultural production. This night soil recycling mechanism was established well before World War II.

During the rapid economic growth starting from the late 1950s, the traditional night soil recycling systems broke up due to urbanization and the spread of chemical fertilizers, and night soil turned from fertilizer to waste. Meanwhile, sanitary treatment of the increasing night soil in major cities resulted in a serious social problem. To cope with this, municipalities carried out the treatment of night soil and promoted the development of advanced night soil treatment technologies.

In 1953, the government launched a subsidy program for the construction of night soil treatment facilities. As a result, more than 1,100 night soil treatment facilities were built nationwide before the development of sewer systems, which started in the mid-1970s.

In Japan, water-borne diseases (cholera, shigellosis, typhoid) were almost completely eliminated by 1970. This was attributed to the rapid diffusion of both piped water supply systems and the night soil treatment facilities (Ministry of Environment of Japan 2013).

Achievements in Sanitation: The Spread of Flush Toilets (1970s)

During the rapid economic growth starting from the late 1950s, a housing boom occurred, and the demand for flush toilets was high. On the other hand, sewer system development had just started and could not connect to every household. In order to meet the desire for plumbing of those who were unlikely to be connected to the sewer in the near future, PAWTP technology was developed, which could be used for flush toilets in 1950s and 1960s. PAWTPs became a prominent 1970s measure for the dissemination of flush toilets and sanitation improvement, together with the sewer system.

PAWTPs at the time treated only black water (herein after referred to as “the PAWTP black water only-type”). Entering the 1970s, however, the development of small-scale PAWTPs, which treat both black water and gray water, was undertaken.

From Sanitation to Wastewater Management Based on the PAWTP (1980s to the Present)

From the early 1980s, the pollution of public water bodies caused by untreated domestic wastewater, e.g., eutrophication, became highly visible, particularly in closed water areas. Although legal regulations were already established, the effects of the measures for domestic wastewater did not become apparent at the time because of the delay of the development of public sewerage systems. Especially in areas where the PAWTP black water only-type prevailed, pollution problems in public water bodies was attributed to untreated domestic wastewater (gray water), and improper installation and/or maintenance of the PAWTP black water only-type.

In 1983, the Johkasou Law (hereafter referred to as “the PAWTP Law”) was enacted to overcome this situation. In Japan, such laws are usually drafted by the ministry in charge and presented to the parliament. In the case of the PAWTP Law, however, since its contents would affect multiple ministries and no single ministry would write the draft, it was drafted by the parliamentarians supported by the stakeholders of Japan’s decentralized wastewater management system, such as the PAWTP maintenance vendors and desludging operators who deemed it vital for their business. With this law, the legal basis for the installation of manufactured PAWTPs, and their maintenance, inspection, and desludging became clearly defined. To securely translate these measures into reality, the responsibility and duties of PAWTP users were specified and state certification systems were established for both PAWTP installation workers and maintenance operators (Sasaki 2003).

In order to promote the use of PAWTPs that treat both black and gray water, when individuals install them, this facility can be subsidized through a system established nationwide. When the municipalities themselves install the PAWTP in the individuals’ premises as municipal property across their administrated areas, a special subsidy system was launched by the central government in 1998 with the aim of promoting municipalities’ initiatives. The PAWTP Law was amended in 2000 to eliminate the black water only-type and make implementation compulsory when newly installing such facilities.

3.2 How Does It Work?

Prevention of the Water Pollution Caused by Improper Decentralized Wastewater Management

In Japan, while centralized sewer systems are expected to play a central role for the clean-up of rivers and other public water bodies, decentralized systems, which cover areas where sewer installation is not planned in the near future, are expected to play a supplemental role. However, even when there is no choice other than installing decentralized systems, the structural standards, manufacturing, installation, operation and maintenance, including desludging, of these systems are strictly regulated by the PAWTP Law.

Ensure Good Performance of Decentralized Wastewater Treatment Plants

In Japan, decentralized wastewater treatment plants are standardized. Legally, the PAWTP is the only standard decentralized wastewater treatment plant in Japan. A corporate body that intends to manufacture PAWTPs must receive government approval, which is issued when these proposed plants meets the prescribed design standard. If a manufacturer intends to manufacture a new, non-standardized type of PAWTP, it must be tested by a designated institution.

Ensure Proper Installation of Decentralized Wastewater Treatment Plants

In Japan, those building a new house or building must submit a certification application prior to the start of construction to the municipality and seek confirmation by the district construction surveyor deployed by the municipality. Usually, this application is made by the house building company on behalf of the house owner. To the building certification application, the type of PAWTP to be installed, together with a copy of the government approval letter, must be attached. If these are satisfactory, the district construction surveyor issues a building permit.

PAWTP installation businesses are subject to registration with the prefectural governor that has jurisdiction over the area where they intend to conduct business, and they must assign an installation worker certified by the Japan Education Center for Environmental Sanitation in each place of business.

Ensure Proper Sludge Management, Indispensable for Decentralized Wastewater Management

As mentioned previously, the owner or user of a PAWTP installed in a house or building is, under the PAWTP Law, designated as the “PAWTP (Johkasou) Manager”. The Law mandates these managers to desludge their PAWTP once a year, work that can be entrusted to a PAWTP Desludging Vendor.

Regulate Desludging Vendors to Ensure Proper Operations while Providing Job Opportunities and Social Status

All the PAWTP desludging businesses in Japan need to obtain the approval of the local mayor. This approval may be for a limited period and is issued if the desludging equipment and the applicant capability conform to the standards prescribed by the Ministry of the Environment (MOE). The applicant must also show no record of violating the PAWTP Law during the 2 years preceding the application.

In order to protect the desludging workers from the anticipated unemployment because of the diffusion of sewerage systems, municipalities are obligated to support their job transfer according to the Act on Special Measures Concerning Streamlining of Domestic Waste Disposal Business incidental to Improvement of Sewerage (1975).

Ensure Proper Operation and Maintenance of Decentralized Wastewater Treatment Systems for Commercial Buildings

The PAWTP Law requires adherence to the maintenance frequency specified by the MOE, which is once every 4 months for small-scale PAWTPs (e.g., a household type), and more frequently for medium- and large-scale PAWTPs, according to the type of treatment process. For example, in case of activated sludge treatment processes, the required frequency is once a week, while for the contact aeration process with screen and flow equalization chambers or flow equalization tanks, the required frequency is every two weeks.

PAWTP managers must deploy qualified supervisors when the user population equivalent exceeds 500, and may entrust operation and maintenance (O&M) to a registered vendor. The PAWTP Maintenance Vendors are required to use certified PAWTP Operators in order to engage them in the O&M of these facilities. PAWTP managers must also ensure that their PAWTP receives the inspection of the newly installed PAWTP and an annual inspection for water quality (or the number of times designated by the MOE) by the Specified Inspection Agency designated by the prefectural governor. If it is found that O&M and/or desludging is not done properly, an improvement order will be issued to the O&M vendor and/or to the desludging vendor. The PAWTP manager may be ordered to stop using PAWTP for the period of 10 days or less, if required.

Lack of Human Resources for Operation and Maintenance of Decentralized Wastewater Treatment Facilities

In order to secure the number of technicians required for the decentralized wastewater management, the Japan Education Center for Environmental Sanitation (JECES) was established to provide training for professionals in the businesses related to PAWTP in 1966. The following includes details on the certification process for PAWTP workers and operators.

In 1983, the Johkasou (PAWTP) Act was established, which stipulated that only the qualified vendors and/or workers can engage in the installation, O&M, and desludging of PAWTPs. In 1984 and 1985, national examinations for PAWTP Operators and PAWTP Installation Workers started. JECES was appointed as the agency for training courses and the agency for the examinations by the PAWTP Act. As for PAWTP Desludging Technicians, although training and national examination are not legally mandatory, since the desludging vendor is subject to the approval of a municipality, many municipalities give approval on the condition that the applying desludging vendor employs desludging technicians who hold the completion certificate of JECES's training course. Therefore, in reality, only trained professionals can engage in desludging works.

Through the examinations and the training courses, more than 3,000 PAWTP technicians join PAWTP businesses every year. As of 31 March 2016, 213,732 technicians were registered as shown in the Table 2.

Table 2: Numbers of Certified Technicians Engaged in the Management of the Decentralized Wastewater Treatment System in Japan

Certified Technicians	Number of Registrants	Business Content	Legal Basis
PAWTP operators	80,042	Operation and maintenance	PAWTP Act
PAWTP installation workers	86,595	Installation/construction	
PAWTP technical supervisor	29,794	Management of PAWTP with 501 PE or more	Ordinance of PAWTP Act
PAWTP desludging technicians	16,021	Desludging	
Registered PAWTP inspectors	1,280	PAWTP inspection and water quality examination	
Total	213,732		

Source: Ministry of Energy, Japan, "Night Soil Treatment and Decentralized Wastewater Treatment Systems in Japan".

3.2.1 Activities of the Goto Group

The Goto Group was established in 1963 and is a private company engaged in the maintenance and desludging business of PAWTPs in Kumagaya City, Saitama. The company started its operation with the cleaning of vault toilets and the desludging of PAWTPs, and expanded its operations to the PAWTP maintenance business. The company currently employs 43 staff, 16 of whom hold the certificate of PAWTP operator. A further two hold the certificate of PAWTP installation worker and 14 hold the completion certificate of the PAWTP desludging technician training course.

The maintenance of a household-type PAWTP is performed by a single operator and takes 15 minutes. Households pay \4,000/work/house as a fee. In Kumagaya City, the frequency is four times a year, one more than the mandated minimum. After maintenance, a checklist is handed over to the household and shared. A PAWTP operator may cover 12 units per day.

The desludging of a household PAWTP is also performed by a single technician taking 15 minutes/house (excluding the time for transportation). The desludging fee is \11,000/m^3, equivalent to \17,000 for a typical PAWTP for household, the size of which is 1.5 m^3. The required frequency of desludging works is once a year. A desludging technician may cover six units per day.

The service life of the blower for a household PAWTP is about 10 years, if replacement of the failed component is done properly, which costs about \8,000 each time. The blower is exchanged with a new one every 10 years, which costs \50,000/unit. These costs are paid by the household.

The Goto Group provides maintenance and desludging services not only for household-type PAWTPs, but also for mid-size and large PAWTPs installed for buildings and housing complexes. The company has a group of specialists for the maintenance of mid- and large-size PAWTPs. Maintenance of a mid-size PAWTP installed in a housing complex is also performed by a single operator taking 1.5–2 hours. Operators that cover six buildings/complexes per day meet their target.

As an example, the Goto Group received a contract from the Saitama Prefectural Government for the maintenance and desludging of a mid-size PAWTP installed in a housing complex (about 300 residents) with a capacity of 60 m^3/day. The annual contract is \2.1 million. The treatment process of this PAWTP is the contact aeration type, with a required maintenance frequency of every 2 weeks. But, in accordance with the instruction of the prefectural government, maintenance is performed once a week. This housing complex was built in the 1960s–1970s. Accordingly, the PAWTP is considered to have been operating for more than 40 years, but maintains good effluent water quality of BOD 20mg/l or less.

This PAWTP is not only subject to the legal inspection (once a year), but is also subject to a spot check by the prefectural government under the Water Pollution Prevention Act, which regulates all the wastewater treatment facilities whose capacity is 50 m^3/day or more. Therefore, there is no room to pull out. (Notice of spot check will be given 2 weeks in advance. It is impossible to recover the performance of this size PAWTP within 2 weeks if it has not been taken care of properly.)

Secure Sufficient Sludge Treatment Capacity

As stated before, during the 1950s and 1960s, many night soil treatment facilities were constructed throughout the country by local governments. Since the diffusion of PAWTPs, the same facilities are operated as sludge treatment facilities.

3.3 Elements of Japan's Decentralized Wastewater Management System Useful for Wastewater Management in Developing Countries

Effluent Water Quality Standards and Selection of Decentralized Wastewater Management System

In order to achieve good effluent water quality, introducing the aerobic-type PAWTP or a similar facility as a decentralized wastewater treatment facility would be required. However, it would increase the capital and operating expenditure, which would exceed the ability of household users to pay, making it difficult to introduce a uniform regulation in developing countries. Therefore, it would be a realistic policy response for governments, on the one hand, to allow the currently prevailing anaerobic-type wastewater treatment facilities, under the condition that their maintenance, including sludge management, is substantially improved. On the other hand, conversion to the aerobic PAWTP or a similar facility should be promoted for non-household users and high-income households if sewer connection is difficult. Accordingly, regulations concerning domestic wastewater, such as the effluent water quality standards, should be different according to the type of user. Otherwise, such effluent water quality standards would end up as a mere target, not the standards which are actually imposed to regulate polluters based on the established value, as is currently the case in many developing countries.

Qualification and Training System for Installation Business of Decentralized Wastewater Treatment Facilities

Improving the decentralized wastewater management would mandate that, when a new house or building is to be built, a municipal construction surveyor checks the facility in the process of issuing building permits, as is the case in Japan. But, the building permits system works only if the decentralized wastewater treatment facilities are standardized by the performance testing system. In developing counties, however, as mentioned earlier, the standardization of decentralized wastewater treatment facilities, particularly those for household users, would be difficult at this moment. Therefore, it would be a realistic policy response that, while the government allows diverse decentralized wastewater treatment facilities, particularly those for household use, it takes measures to ensure the quality of installation of these various facilities via a qualification and training system modeled on that used in Japan.

Introducing Regular Desludging System for Decentralized Wastewater Treatment Facilities

Many countries issue manuals for maintenance of septic tanks, which indicates their recommended desludging frequency. In many cases, the decision on the timing of desludging is left to the users. As a consequence, in reality, the desludging of septic tanks is conducted only when some troubles such as a blockage happen. If that is the case, the septic tanks would have lost their treatment function, thus spreading pollutants prior to the blockage happening. Therefore, it is essential to establish a regulatory framework in which the timing of the desludging is not left to the users. In Japan, the desludging of PAWTPs is a legal obligation for the users, established as once a year, with the timing controlled by the desludging businesses approved by the municipalities.

It is not clear whether a Japan-type system would work in developing countries, since the high cost of desludging (US$30–$100/unit in Asian developing countries) would become an obstacle. In both Manila City and Hai Phong City, the regular desludging of septic tanks, which has been implemented in a relatively organized manner city-wide for over a decade, is the obligation of the utility (sewer operator) and its cost is recovered by an add-up to the water bill (20% of the water bill in both cities) and by the wide collection from all the household and non-household customers. As the water charge contains a cross-subsidy from non-household users to household users, a similar knock-on effect occurs with the desludging fee. In this way, the average desludging intervals of 5–7 years in Manila City and 4 years in Hai Phong City are achieved. This is a different approach than Japan, but it may fit the actual situation of developing countries.

Qualification System and Training System for Desludging Business and Workers

In Manila City and Hai Phong City, desludging works are performed by water and wastewater operators or sewer and drainage corporations. In many countries, including Japan, however, desludging works of on-site facilities such as septic tanks and PAWTPs are performed by small and medium-sized enterprises. Some of these are micro enterprises, a few of which belong to the informal sector, as also used to be the case in Japan. Consequently, their performance is poor, and they end up conducting illegal activities such as dumping the collected sludge into rivers.

In order to improve this, it would be effective for the government to establish a training system for desludging technicians, and a system in which only the desludging vendors who employ the properly trained technicians are allowed to engage in desludging business so that the authority can regulate them, cultivate their professionalism, and raise their social position.

Qualification System and Examination System for Operators of PAWTPs or Similar Facilities for Non-household Users

Though qualifications such as those for engineers or graduates from an engineering university are not necessary, it is desirable that technicians for PAWTPs or similar facilities attend a professional training course and pass an official examination, and it would thus be good policy for developing nations to ensure such a system monitors skill levels. As practiced in Japan, if the cost of the training and of the examination is paid by the trainees or the companies for which they work, they would become more serious and the sustainability of the training/examination system would be secured.

In addition, the penalty on the non-household users who fail to engage qualified operators for their PAWTP or similar facility must be strengthened.

Development of Proper Sludge Treatment Facilities

In many developing countries, the development of on-site sludge treatment facilities trails the development of sewer systems. For these countries to improve decentralized wastewater management, its development must be accelerated. In reality, some recent facilities built in developing countries are not operating properly due to inappropriate design.

Japan has a 60-year history of developing sludge treatment facilities. More than 1,000 facilities were built nationwide, and while Japan's sophisticated technologies may not be suitable for developing countries, the accumulated knowledge and experiences on the basic process of on-site sludge treatment, pretreatment, solid-liquid separation, disposal of dried sludge, treatment of supernatant (wastewater treatment) would be useful for developing countries and should be shared internationally.

Among the above-mentioned measures, the establishment of qualifications, training, and an examination system for installation workers, desludging business/workers and operators of PAWTPs or similar facilities would consume few government resources. However, these would require political will since copious administrative work is required and relationships between citizens, administrations, and sanitation workers need to be augmented. The 1983 PAWTP Law was achieved by politicians backed by sanitation workers. Similar efforts would create better decentralized wastewater management systems and the creation of work opportunities, which are badly needed in developing countries. In Japan, 200,000 professionals are working for the betterment of decentralized wastewater management systems.

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