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TABLE OF CONTENTS

Abstract

The Asia-Pacific region has problems related to both sanitation and wastewater management, having a large proportion of its population without access to basic sanitation, and pollution worsening in the rivers, lakes and coastal waters of a great majority of countries, which is particularly threatening the sustainable and healthy development of their urban economy.

The present report reviews the current situation of sanitation and wastewater management in the Asia-Pacific region, and highlights the challenges faced in both urban and rural contexts. Concrete examples of how administration, utilities and operators, and civil society organizations are responding to the challenges in the following areas are introduced: sanitation and wastewater management, including off-site/on-site sanitation and septage management, human resource development, institutional and regulatory frameworks, and circular economy (wastewater reuse and sludge recycling).

This report emphasizes on the importance of partnerships to enable the sharing of knowledge, successful experiences and good practices in sanitation and wastewater management, which is needed to achieve all the tasks required to mainstream wastewater management. Accordingly this report concludes that, partnerships, existing ones for achieving the SDG sanitation targets, and new ones, such as the Asia Wastewater Management Partnership (AWaP) proposed by Japan, should be encouraged.

1. Introduction

1.1 Background

The Asia-Pacific is not only a vast region in proportion, but is also characterized by a diversified natural environment and diverse climatic patterns, ranging from tropical to temperate climate zones. In comparison to other regions in the world, the Asia-Pacific region has a larger population and a bigger economic growth, but has also high disparities in levels of economic growth and development. In addition, the region is the most vulnerable region in the world in the matter of water-related disasters, particularly through the influence of climate change.

The situation for sanitation and wastewater management is far from being satisfactory with very different conditions between countries that have achieved, or almost achieved, universal access to improved sanitation facilities and those still struggling with low toilet coverage. More specifically, if many countries in East Asia and Southeast Asia have reached satisfactory sanitation conditions, other countries such as Indonesia, Cambodia and Laos are facing serious problems. The situation is not better in South Asia where 600 million people still practice open defecation, which ultimately threatens people's health.

With the exception of countries such as Japan, Korea, Singapore and China, a majority of countries in the region, for example in Southeast Asia, has not taken effective measures to reduce the amount of untreated or unsatisfactorily treated wastewater discharged into the environment. As a direct result, water pollution in rivers, lakes and coastal waters is worsening and threatens the comfort and safety of people's daily living conditions.

Further to the problem of sanitation access is the lack of availability and capacity of human resources for wastewater and sludge management, as well as adequate institutional, legal, regulatory and financial frameworks to support the sector. Thus, despite improvement over the last 15 years measured by the Millennium Development Goals (MDGs), the region is still facing many challenges and tasks for the improvement of sanitation and wastewater/sludge management.

1.2 Objectives

The main objective of the report is to present the current situation of sanitation and wastewater management in the Asia-Pacific region and highlight the challenges faced in both urban and rural contexts. More specifically, this report also addresses:

- the overview of wastewater management in the Asia-Pacific region
- the situation and challenges of off-site and on-site sanitation, including fecal sludge management;
- the issue of securing human resources for sanitation and wastewater management in both the administration sector (governments) and the management sector: technicians, engineers operating and maintaining wastewater/sludge treatment systems in the developing countries of the region;
- the issue of policy, wastewater management planning, as well as legal, regulatory and financial systems in order to achieve integrated sanitation for all and sustainable wastewater management;
- the issue of sanitation access, equity and open defection in rural areas;
- the challenges with regard to promoting behavioral change on scale to increase adoption and usage of improved sanitation, and;
- the need for ensuring appropriate technological choices for on-site sanitation in rural areas and quality of construction.

Another important objective is to provide recommendations on the way forward towards sanitation and wastewater management improvement through the introduction of case studies and good practices from different countries of the region.

1.3 Methodologies

To cover in this report most comprehensively and from various perspectives the large number of issues in sanitation and wastewater management in both the urban and rural areas of the Asia-Pacific region and provide recommendations for improvement, the theme leader (JSC) used the expertise and knowledge of a wide range of organizations and bodies in Japan, a country actively engaged in the improvement of the water environment in the countries of the Asia-Pacific, which are:

- JSC member organizations: the Sewerage Business Management Centre (SBMC), the Japan Sewage Works Agency (JS), the Japan Sewage Works Association (JSWA), the Japan Environmental Sanitation Center (JESC) and the Japan Education Center for Environmental Sanitation (JECES);
- two important organizations striving for improvement in the water sector in the region: the Water Environment Partnership in Asia (WEPA), founded by the Ministry of the Environment in Japan for the improvement of the water environment in Asia through the strengthening of water environmental governance, and the Japan International Cooperation Agency (JICA); the most active development aid agencies in the area of water and sanitation in the Asia-Pacific region.

In addition, JSC received the contribution in rural sanitation of WaterAid India, a prominent civil society organization, which acted as the co-theme leader. Resources, which include case studies, from each of these organizations and bodies have been used for this report.

2. Situation assessment

2.1 Situations and solutions

2.1.1 Overview of wastewater management in the Asia-Pacific and its related problems

The Asia-Pacific region, with over 4.6 billion people by 2016, is the home of nearly 60% of the world population. The region continues to experience a rapid population growth, urbanization, industrialization and changes in consumption patterns, including shifting diets toward highly water-intensive foods such as meats, which have led to a significant increase in water demand, and placed a huge burden on water infrastructures in many countries of the region. Consequently, the quantity of wastewater produced and its pollution loads are constantly increasing. Unfortunately, a considerable amount of wastewater in this region is not properly treated before being discharged. It is estimated that from 80% to 90% of generated wastewater, especially in developing countries within the region, is discharged directly into water bodies without any treatment or only partially treated by simple on-site sanitation systems such as septic tanks, causing substantial levels of contamination in ground and surface water sources, as well as coastal ecosystems.

Predominance of septic tanks with poor performance in urban areas

Challenges for effective wastewater management are quite similar in the developing countries of Asia. These include a low percentage of improved sanitation systems, especially in rural areas, inadequate sewerage network coverage, and lack of sewage and sludge treatment facilities. WEPA (Water Environment Partnership in Asia) partner countries for instance (including Cambodia, China, Indonesia, Japan, Lao PDR, Malaysia, Myanmar, Nepal, Sri Lanka, Philippines, Republic of Korea, Thailand, and Vietnam), especially those countries in Southeast Asia, are still heavily depending on septic tanks and other low-cost onsite sanitation facilities such as ventilated improved pit toilets, double-vault latrines, composting toilets, and pour-flush toilets with twin pits. It is reported that approximately 88% of households living in the urban areas of Vietnam have a septic tank, Meanwhile, in Thailand, Philippines, Lao PDR, Indonesia and Cambodia, the percentage of households in urban areas equipped with septic tanks is 83%, 72%, 58%, 63% and 44%, respectively (WHO-UNICEF, 2017). The number of septic tanks is expected to grow rapidly in the future. Unfortunately, septic tanks are poorly designed, not properly constructed, operated and maintained in most of these countries. In addition, the low contribution of septic tanks to water quality conservation is pointed out as a problem, since septic tanks in most areas treat only black water, while gray water is directly discharged to the environment without any treatment, thus causing huge negative impacts on the nearby water environment. Low treatment efficiency, often ranging from 30–60% based on results from several studies, lower than that for centralized sewerage systems using aeration, has been observed in these countries (WEPA, 2015). Although septic tanks are widely used in WEPA countries, most of these countries do not have specific policies, legal and institutional frameworks for appropriate design, construction, operation and maintenance. According to a recent study from the World Bank (2015), it is estimated that 75% of the septic tanks in Vietnam and 66% in Indonesia have never been emptied.

Lack of proper septage management

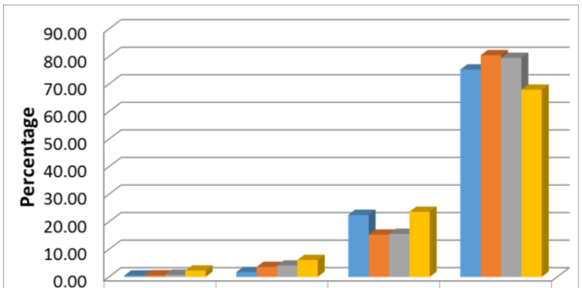
The sludge generated from these on-site systems (hereafter referred to as "septage") is rarely collected, and, even when it is collected, is often illegally dumped or improperly/partially treated before discharged in the open environment (Figure 1). It has been reported that only 4% in Indonesia, 10% in Philippines (mainly in Metro Manila), 4% in Vietnam (World Bank, 2013), less than 1% in Nuwara Eliya of Sri Lanka, and 30% in Thailand of generated septage has been safely disposed or treated (AECOM & SANDEC, 2010). In many cases, septage is not prioritized by both central and local governments, and often handled by private service providers, such as in Indonesia, Philippines, Thailand, and Vietnam. In Indonesia, for instance, more than 150 septage treatment plants were constructed since the 1990s, but due to the lack of effective septage emptying services, many plants stop functioning and only less than 10% of them are still in operation, while many among these 10% are not operating well (World Bank, 2016).

Figure 1. Discharge of collected septage at "dumping points" in Bandung, Indonesia
(Source: Author)

Figure 2. Poor effluent quality of treated septage due to ineffective septage treatment system – Effluent sample taken from a septage treatment plant in Denpasar- Indonesia with a capacity of 400m^3/day (Source: Author)

Negative impacts on surface and groundwater quality

As a result of poor domestic wastewater and septage management, many major rivers and lakes in Indonesia, for example, have been polluted, mainly by organic contamination and nutrients (nitrogen and phosphorus). Most of water quality parameters have exceeded the national water quality standard. Figure 3 shows an example of the situation in Indonesia, where most of the major rivers have been categorized as heavily polluted due to poor management of domestic wastewater and septage from septic tanks. In addition, it is estimated that about 70% of groundwater in cities in Indonesia is heavily polluted with sewage bacteria as a result of leaking septic tanks—yet half of city dwellers use groundwater for their daily needs (World Bank, 2013).



	Meet Standard	Lightly Polluted	Medium Polluted	Heavly Polluted
2012	0.49	1.73	22.52	75.26
2013	0.57	3.64	15.33	80.46
2014	0.78	4.10	15.63	79.49
2015	2.30	6.13	23.62	67.94

Figure 3. Categorization of major rivers in Indonesia (Source: Budi, 2016)

In addition, according to Kuyama (2017), recorded data show that domestic wastewater is considered a major source of organic pollutant in most WEPA partner countries, followed by agricultural and industrial wastewater (Figure 4).

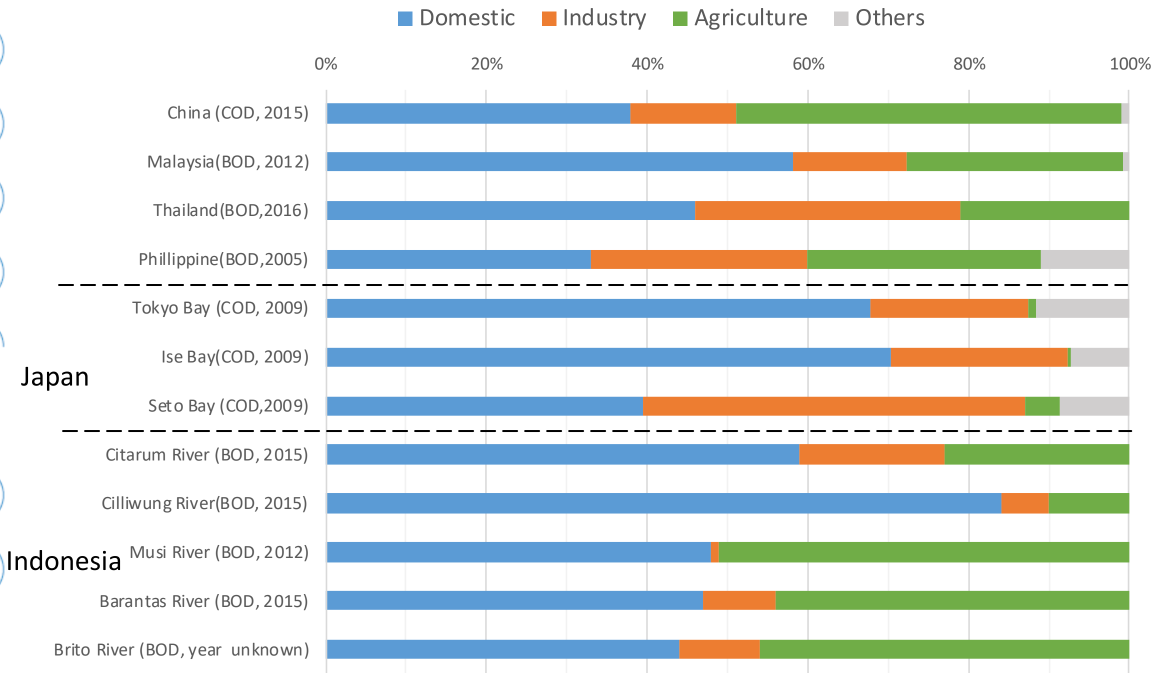


Figure 4. Pollution sources by sectors in selected WEPA countries (Source: Kuyama, 2017)

Huge economic costs due to poor sanitation

Water pollution due to poor sanitation not only affects to the environment, human health, but also causes huge economic impacts. A study from the World Bank in the East Asia and Pacific region—Indonesia, Philippines and Vietnam, showed that the previously described situation has caused huge socio-economic, ecological and environmental negative impacts in the studied countries, including Indonesia, Philippines and Vietnam. The economic impact of inadequate sanitation in these three countries is huge and increasing, with a total cost of US$8.5 billion. The breakdown of this cost includes Vietnam—US$780 million, or 1.3 percent of GDP; Philippines—US$1.4 billion, or 1.5 percent of GDP; and Indonesia—US$6.3 billion, or 2.3 percent of the GDP (World Bank, 2013)

Low coverage rate of sewerage treatment

Figure 5 presents the relationship between the GDP per capita in 2012 and sewage treatment coverage ratio in WEPA partner countries. From this figure, it can be seen that sewage treatment ratio in many developing countries within WEPA countries such as Lao PDR, Cambodia, Myanmar, Nepal, Vietnam, Sri Lanka, and Indonesia is still quite low, less than 10%. Meanwhile, in emerging economies like China and Malaysia, this ratio is higher than 60%. In developed countries (Republic of Korea and Japan), the rate is much higher. Meanwhile, the sewage treatment ratio in rural areas in most WEPA countries is much lower, with an exception of Japan, Malaysia and the Republic of Korea. Figure 5 also reveals that the Asian countries with a GDP per capita of less than 4,000 US$ still have low coverage ratio. Accordingly, GDP growth might be one of the key driving factors required to achieve the targeted ratio of wastewater treatment in each country.

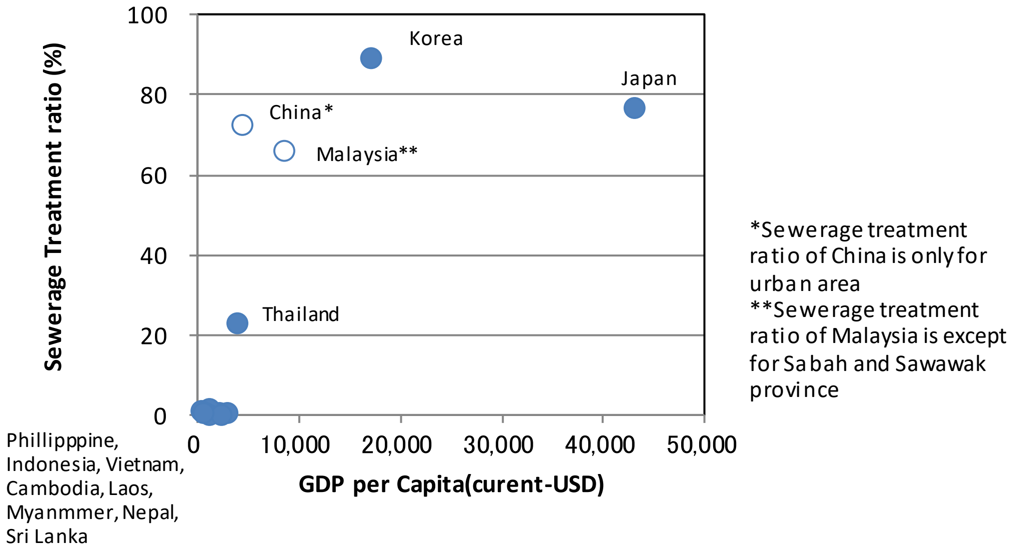


Figure 5. Relationship between sewerage treatment coverage ratio and GDP per capita in selected Asian countries (Source: WEPA, 2018)

As it may take long time for developing countries to gain a similar level of GDP per capita to that of developed countries, an alternative approach to the conventional wastewater treatment and management approach is therefore urgently needed.

Is decentralized wastewater management an alternative option?

Advocates of decentralized wastewater management opines that the construction of conventional and large-scale centralized wastewater treatment systems with advanced technologies, often imported from developed countries, have failed in many cases as these are not considered cost-effective and feasible options for many developing countries in Asia. A new approach for decentralized wastewater management, which has been successfully implemented in many countries recently, would be a promising and viable alternative solution for developing countries in Asia with inadequate wastewater treatment facilities, and at the same time having rapid urbanization and population growth (Figure 6).

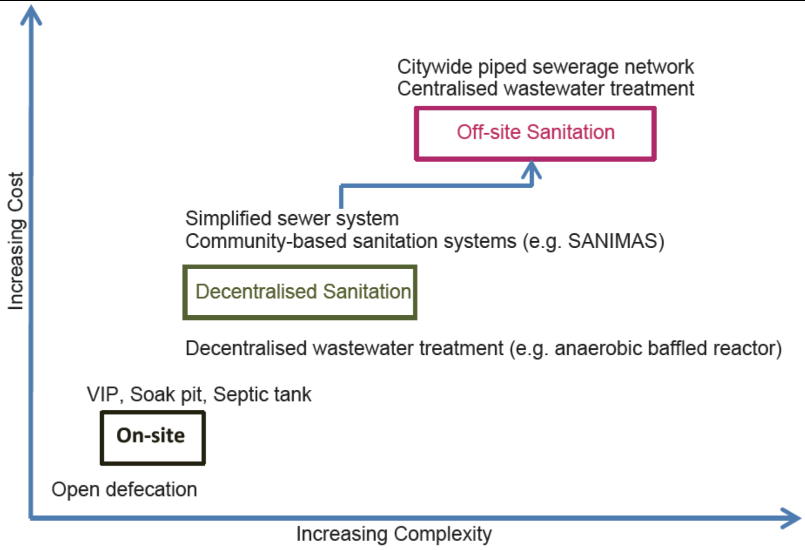


Figure 6. Decentralized sanitation fills the gap between on-site and centralized sanitation options (Source: Modified from (WSP, 2013))

Decentralized wastewater treatment systems (DEWATS) are becoming of special interest because of their potential to reduce treatment costs in the long term, minimizing environmental impacts and facilitating wastewater reuse (Daigger, 2009; Nhapi, 2004). In Japan, it is said that, sometimes, the costs for the sewer network of a centralized system can be up to five times higher than the sewage treatment plant itself. In contrast, by using DEWATS the sewer cost can be reduced significantly (Figure 7). In addition, the cost of the treatment unit may also be lower, if anaerobic treatment technologies are applied such as with the BORDA DEWATS. DEWATS have been proven in many countries in Asia, the highest potential of such type of DEWATS lying in low income urban populations, peri-urban and rural areas. Good examples have been observed in case studies in Indonesia, Malaysia, and Manila City in the Philippines. Successful cases of decentralization are also recognized in Japan, where about 2,500 decentralized systems with modern treatment technologies are associated with large blocks of buildings that treat and reuse their own wastewater (Yamagata et al., 2002). It is strongly believed that decentralized wastewater treatment systems could fill the gap between on-site systems like septic tanks and centralized treatment options. Thus, it is considered a promising solution for effective domestic wastewater management in many Asian countries, although it is not a universal solution for any local problem and the issues of sludge management and unsatisfactory effluent water quality of the anaerobic-type DEWATS are yet to be solved.

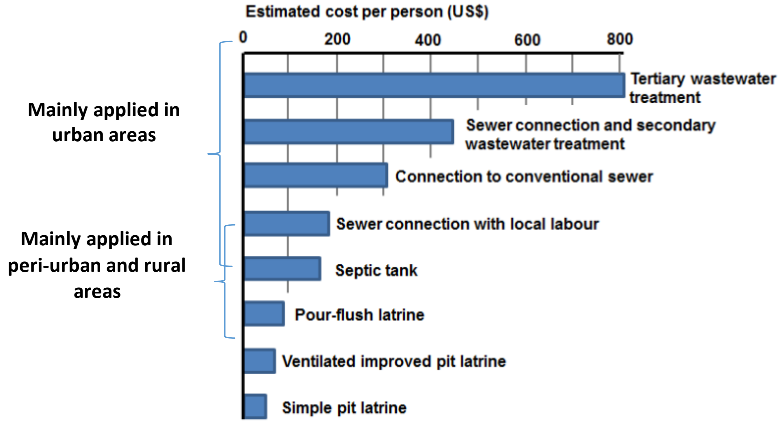


Figure 7. Cost estimate for different levels of sanitation technologies (Source: UNDP, 2006)

Since there is no single solution for all problems, the selection of any technological option should take into account various aspects under each local context, including technical, socio-cultural, institutional and economic factors such as consumer's affordability and willingness to pay, cost effectiveness, environmentally sound, socially and technically acceptable technologies with high reliability, and especially simplicity in operation and maintenance should be given high priority, especially in developing countries.

Figure 8. Example of anaerobic type DEWATS system (SANIMAS) installed and managed by a Community-Based Organization in Bandung, Indonesia
(Source: Author)

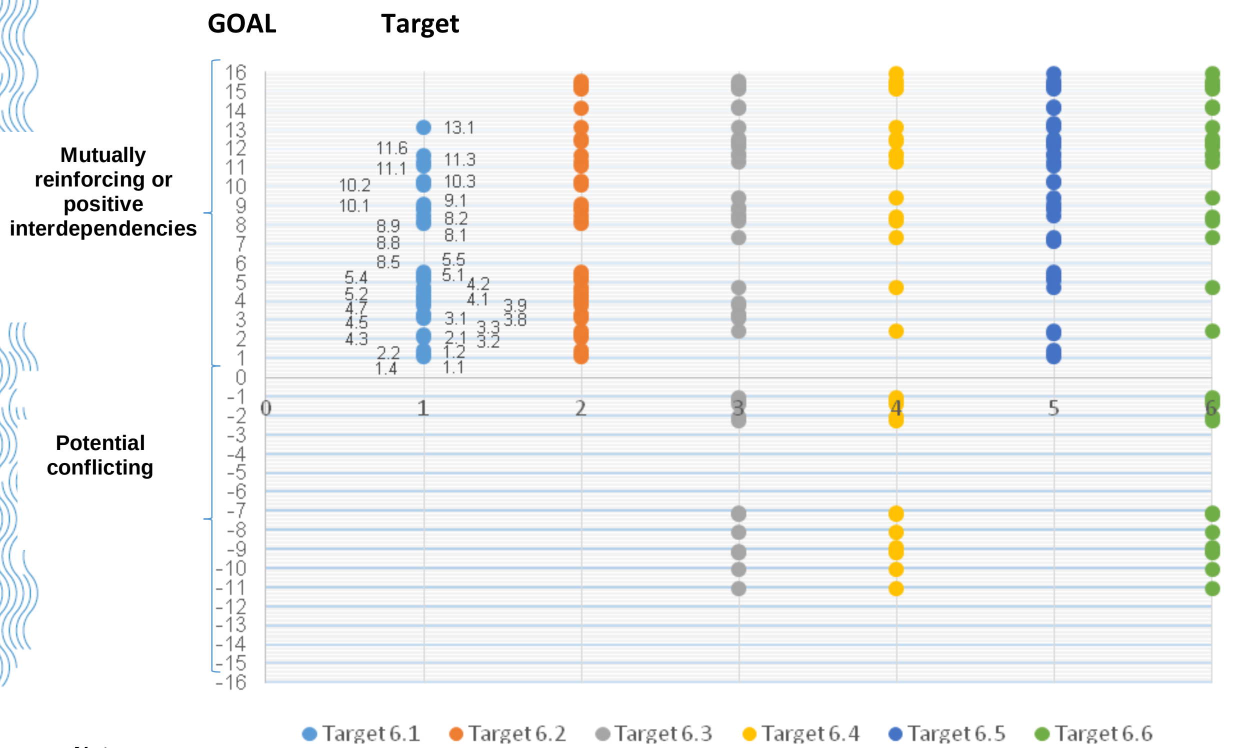
2.1.2 From Millennium Development Goals to Sustainable Development Goals

In September 2000, the United Nations Millennium Declaration was adopted by the world leaders, committing to a new global partnership to reduce extreme poverty and setting out a series of time-bound targets, with a deadline of 2015 and 1990 being chosen as the baseline year, that have become known as the Millennium Development Goals (MDGs). MDGs included 8 goals, 18 targets and 48 indicators. The Goal 7 of the MDGs was to ensure environmental sustainability. It included a target (7C) that challenged the global community to halve the proportion of people without sustainable access to safe drinking water and basic sanitation by 2015. After 15 years of implementing, many gaps still remain in different areas of the MDGs despite enormous progress having been made. It is estimated that 2.3 billion people still lacked of basic sanitation services, and 892 million people still defecated in the open in 2015, particularly in South and East Asia (WHO and UNICEF, 2017).

The percentage of people in the region without access in 1990 was estimated to be 64 percent, and the figure dropped to 37 percent by 2016, equivalent to 1.7 billion people. According to the MDG target of halving the proportion of people without access to basic sanitation by 2015, many countries in the region still missed the MDG sanitation target by substantial percentage points. Further reduction of this figure is therefore needed. Moreover, there were still more than 500 million people in South Asia and about more than 80 million people in East Asia and the Pacific region that practiced open defecation, accounting for the majority of the world's open defecators.

In addition, the MDG targets on improved sanitation have merely focused on increasing the proportion of the population using improved toilet facilities, and paid far less attention towards ensuring that the effluents from these toilet facilities (both wastewater and septage) are adequately collected and treated before being discharged into the environment. Consequently, the situation of wastewater and septage management has not yet been improved over the last 15 years.

After 15 years, the world leaders gathered again at the historic United Nations Sustainable Development Summit on 25 September 2015, and adopted the new 2030 Agenda for Sustainable Development, including 17 Sustainable Development Goals (SDGs) with 169 targets and more than 230 indicators, aiming at going further to end all forms of poverty. The Sustainable Development Goal 6 on water and sanitation is built upon the MDG-7C, but considered much more comprehensive, which stresses on the importance of looking at the entire water cycle from source to end, including critical aspects of water such as wastewater and excreta/septage management, integrated resource management, water use efficiency, conservation and ecosystem rather than just emphasizing on on-site sanitation facilities. In the 2030 Agenda for Sustainable Development, the water and sanitation goal has been placed at the core of sustainable development, which has strong linkages with other SDGs. Thus, achieving the water goal is essential, not only for human health, food and energy security, sustainable economic development, social progress and sound ecosystems, but it is also important for ensuring the expected results and co-benefits that can be achieved for many of the targets across the other SDGs.



Note:
Numbers showed on the x-axis indicate target 6.1 (1) …target 6.6 (6). Numbers showed on the y-axis indicate goal 1 (1), goal 2 (2)…, while negative value indicate that these targets may have some potential conflicts with relevant targets in SDG-6.

Figure 9. Type and nature of interlinkages between water targets and other SDGs' targets (Source: Prepared by the authors, based on information from UN-Water, 2016)

As presented in Figure 9, the majority of target-level linkages between goal 6 and the other SDGs are positive, thus implementing the goal 6's targets support a large number of other targets, and vice versa. Examples of synergies that can be harnessed include increasing access to water supply, sanitation and hygiene (target 6.1, 6.2) in homes and healthcare facilities, schools, workplaces, complemented by appropriate wastewater treatment and safe reuse (target 6.3), as a way to reduce risks of waterborne diseases (target 3.1-3.3, 3.9) and malnutrition (target 2.2); supporting agriculture in general (SDG 2) and education (target 4.1-4.5); securing energy needs in general (SDG 7) and ensuring a productive workforce (target 8.5, 8.8); and address poverty (target 1.1, 1.2, 1.4), gender inequality (target 5.1, 5.2, 5.4, 5.5) and other inequality (target 10.1-10.3). Figure 7 shows the nature of interlinkages between water targets and other targets under different goals, some of which are mutually reinforcing/positive interdependencies and others which are potentially conflicting.

2.1.3 Off-site sanitation

Despite being the most adequate and cost-effective solution in densely populated urban areas, centralized sewerage systems are not widely used in many countries of the Asia-Pacific region, particularly due to economic constraints in view of the large initial investment required for their construction. Once again the picture is contrasted throughout the region with countries that highly expanded their sewerage network – such as Japan, Singapore, Korea, Malaysia and China – and other countries in the path to development. While sewerage projects in urban areas are gradually being implemented, particularly via the support of international donor organizations such as the Japan International Coordination Agency (JICA) or the Asian Development Bank (ADB), the pace of such projects is not matching the current needs.

Sewerage development is particularly not making progress in Southeast Asian countries. This is partly due to the large investment and time required for the construction of such systems, and also because many septic tank users do not feel discomfort or have critical issues with these facilities, despite the fact that they are limited in performance and rarely maintained. As a result, the incentive and people's willingness to connect to a sewerage system when available and pay for the associated sewerage charge are low, effluent water quality is not improving and water pollution in rivers or other water bodies is not stopped. Additionally, slums along the rivers of many large cities in various countries of Southeast Asia are growing, causing health issues due to poor sanitary conditions, and are also one of the major obstacles for the construction of sewerage systems and the purification of rivers as the land for sewerage is difficult to secure.

Associated with sewerage expansion is the problem of human resource development, both in number and capacity. Indeed the installation of wastewater treatment plants brings technologies that are often new to the countries where they are constructed and issues arise for their daily operation and maintenance as well as their administrative management. The most advanced countries in the region have an important role to play in this sector, not only in providing the technology but also in sharing the knowledge that can ensure a sustainable management of these systems.

Further consideration can be made on the approach and technologies to introduce in the countries in path to development. Should the approach and technologies that were applied in developed countries be adopted, which would likely require decades, or should the sanitation gap be filled using different approaches and technologies more suited to the needs and capacities of these countries?

In Metro Manila, Philippines, a three-pronged approach has been adopted by two private concessionaires to address wastewater management. As a first step, interceptor sewer systems are applied as a system to gather the wastewater discharged from septic tanks into drains before discharged to rivers, and to convey it to wastewater treatment plants, while septage management service is provided to the customers who are not connected to the separate sewer system. With this approach, the initial investment cost is reduced to an affordable level for the users by saving the expensive installation cost of the sewer network required for house connection.

In Ho Chi Minh City, Vietnam, and Kitakyushu City, Japan, the sewerage system has been introduced as a core part of the urban planning and the river banks, which were occupied by population living in slums or low income populations, were transformed into highways, promenades and municipal parks where the citizens gather thanks to the clean-up of the rivers and the successful implementation of the resettlement programs.

2.1.4 On-site sanitation and septage management

(1) On-site sanitation

On-site sanitation systems, particularly septic tanks, are the prevailing wastewater treatment facilities used in the developing countries of the Asia-Pacific region. The BOD removal rate of septic tanks, even if they are properly maintained, is estimated between 30 to 60%, which is less efficient than aerobic treatment systems enabling a BOD removal rate of 90% or more, which, however, is not affordable for ordinary citizens in these countries. A majority of septic tanks treats only black water and grey water is discharged without treatment. As the construction of sewerage system requires high financial resources and time, these septic tanks will remain as the major sanitation and wastewater management systems for many years to come in the rural, peri-urban and even urban areas of these countries.

The following table shows the percentage of the population served by septic tanks. In the countries where sewerage coverage is low, the percentage of the population served by septic tanks tends to be high in urban areas.

Table 1. Septic tank coverage rate in the selected countries and cities

Country	Year	Area	Coverage Rate (%)
Indonesia	2011	National Average	60
		Jakarta	93
Philippines	2010	Manila	71
Malaysia	2010	National Average	21
Viet Nam	2008	National Average	41
		Urban Area	79
India	2011	National Average	22
		Urban Area	38

(Source: WEPA, World Bank)

In some Asian countries such as Indonesia where rapid urbanization has occurred, even in urban areas, there are populations that do not have access to improved sanitation facilities. Some urban areas are too densely populated for individual treatment. Centralized sewage treatment systems are too costly and not affordable, particularly for low income residents, and, development will require many years. Such situation makes community wastewater treatment a practical solution.

One of the good examples as such is 'SANIMAS', a movement in Indonesia which encourages people's participation in wastewater management and promotes the eradication of open defecation through community-based sanitation, while providing an improved alternative to septic tanks. Although SANIMAS - a system using a wastewater treatment technology with anaerobic baffled reactor - is limited in wastewater treatment performance, it can fulfill the goal of community sanitation as an effort to raise wastewater treatment efficiency if a partial use of aerobic treatment is added, as demonstrated by the initiative of Yayasan Dian Desa (Indonesian NGO) and APEX (Asian People's Exchange; a Japanese NGO).

Additionally, together with economic development, governments and citizens take more interest in the improvement of the living and water environment through domestic wastewater measures. This creates a strong demand for the introduction of highly efficient on-site wastewater treatment systems. As an example, Packaged Aerated Wastewater Treatment Plants (PAWTPs, called 'Johkasou' in Japan) have been installed in rural communities in China, resulting in a great improvement of their living and water environments.

(2) Septage management

Any on-site sanitation system - septic tanks, their improved alternatives or more advanced systems - requires proper septage management. Septage management consists of two main aspects: 1) the collection and transport of sludge, and 2) the treatment and/or disposal, plus recycling/reuse in some cases. To ensure proper septage management, it is essential to establish institutional, financial and regulatory systems that enable the proper maintenance of on-site facilities, particularly regular desludging, which is a necessary condition before envisaging a transition to more advanced on-site wastewater treatment technologies.

Unfortunately, the current picture is far from being ideal in most countries of the region. The removal of sludge from septic tanks is not carried out on a regular basis and numerous surveys conducted in developing countries have indicated that the majority of households had either never desludged their systems or did not know when they were last desludged. In fact, septic tanks are rarely emptied or only tended to when blockage or failure occurs. As a result, septic tanks cease to function as wastewater treatment facilities to become pollution sources. Septage Management is therefore a critical problem to tackle in the Asia-Pacific region as well as in other regions.

The following table shows the situation of the preparedness (soft and hard) for septage management. Only few countries have developed the required capacity (soft and hard) for septage management.

Table 2. Preparedness of capacity (soft and hard) for septage management in the selected countries

Country	Regulations, rules or manuals for septage management	Development of sludge treatment facilities	Remarks
Indonesia	No guideline	Jakarta (2), Surabaya (1), Bandung (1), Yogyakarta (1)	Regular desludging is being piloted in Jakarta and other cities
Philippines	FSM manual (2004)	Manila (2)	Manila water
Malaysia	Regular desludging (2010)	National (40)	JSC Report (2011)
Viet Nam	No guideline	Hanoi (1), Hai Phong (1), Ho Chi Minh (1)	World Bank
India	FSM guideline (2012)		Septage management plans are being prepared for a few cities

If there is a market for the desludging of fecal waste, it is by and large unregulated and flourishes with vacuum pump operators emptying septic tanks for a fee and then dumping this waste, although there are multiple efforts to (a) regulate the work of these operators and (b) to ensure that the waste is then emptied at a wastewater treatment plant and not dumped in streams/ponds or vacant plots. Furthermore, the collection of fecal sludge from on-site systems is also often inefficient, partly because of the difficulty and time required to access these systems or to reach the treatment/disposal site, which can lead to delays and encourage inadequate practices to increase profitability such as the illegal dumping of sludge into the environment.

Septage management for on-site sanitation systems is an unresolved problem for developing countries in the Asia-Pacific region and for most of the countries around the world. Septic tanks, considered as 'improved sanitation facilities', have enabled many countries to achieve their MDG sanitation target. However, the MDG sanitation target was an initiative evaluating the percentage of access to sanitation facilities, but did not take into consideration the management state of wastewater treatment facilities and, thus, the quality level of their discharged effluent. This is a problem that is now being addressed by the SDG sanitation target.

Septage management is a substantial issue that has received international attention in recent years but still remains an unanswered challenge in many countries of the Asia-Pacific region. There are, however, several examples in the region that have shown an effort to improve septage management with on-site facilities, at municipal or community level, and have achieved to some extent good results, such as Manila City in the Philippines and Haiphong City in Vietnam. Other good initiatives include the work of Arghyam, an Indian NGO which has conducted activities for the improvement of septage management in two states in India: Tamil Nadu and Orisha.

2.1.5 Securing human resources for sanitation and wastewater management

On 12 September 2016, IWA issued a statement entitled '*Five solutions to avoid a water sector human resources crisis*', in which is declared that, to deliver the promises of the SDGS by 2030 a massive effort will be required. Perhaps more than anything, it will require people – newly trained, or re-trained, professionals to administrate, manage and deliver water-related services.

Indeed, the people shouldering sanitation and wastewater management in the Asia-Pacific are insufficient in number and capacity, which hampers the development of wastewater management in many areas of the region, such as Southeast Asia. This shortage of human resources is a common issue for wastewater management, either with off-site or on-site wastewater treatment systems, and even more for sludge management.

In the area of off-site sanitation, the management of sewerage systems in many countries is assigned to municipal governments, but in the majority of the developing countries in Asia and the Pacific, even in large cities such as the capital cities, the human resources enable to manage complex sewerage systems are insufficient. The situation is even more serious in medium and small-sized cities, which have virtually none of the required human resources for this purpose.

In the area of on-site sanitation and more specifically septage management services, the removal, collection and transport of the sludge accumulated in septic tanks, pit latrines and other on-site wastewater facilities – modern and traditional ones -, are often conducted by private operators belonging to the informal sector. They are not well regulated or trained, and the service quality is generally poor, resulting in the poor performance of on-site wastewater management systems.

Managing sewerage system requires a wide range of knowledge and technologies. The development of wastewater treatment plants requires knowledge on civil, construction, mechanical, electrical and chemical engineering. Their operation and maintenance requires knowledge chemical engineering and wastewater treatment technologies and processes. It is very difficult or not cost-effective for local governments to keep the required numbers of engineers to cover all these areas within their administration.

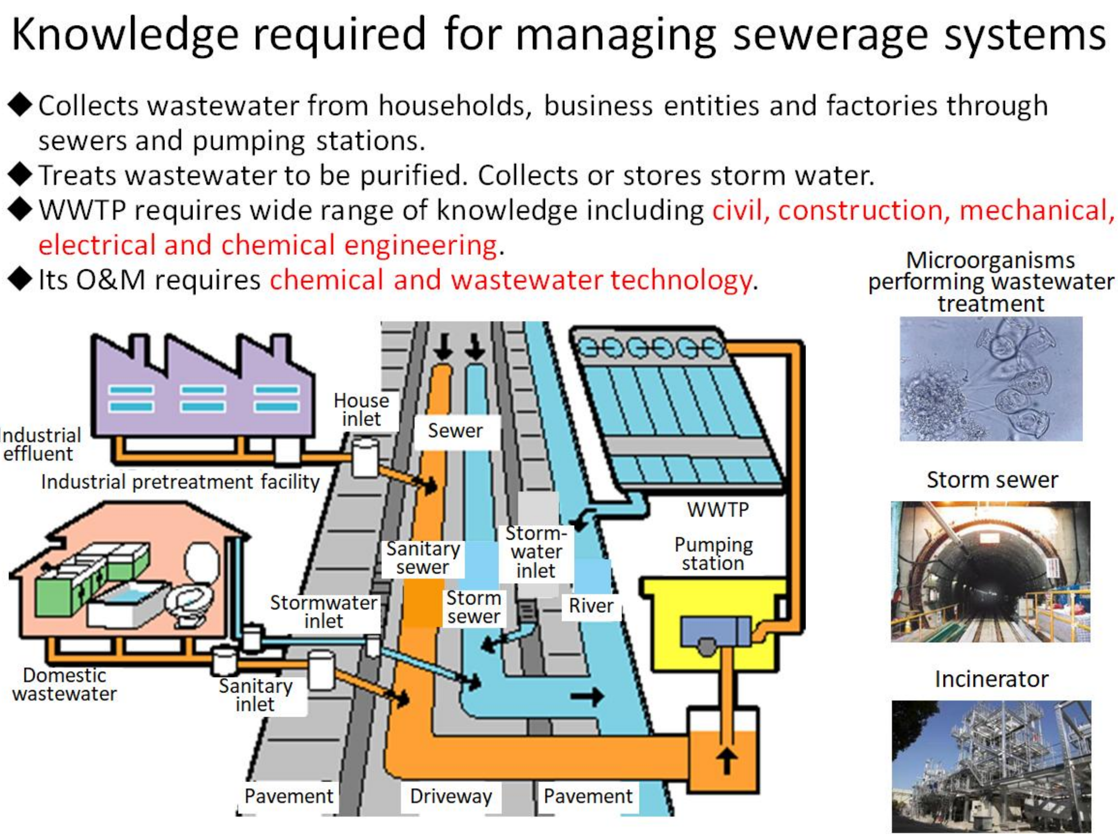


Figure 10. Knowledge required for managing sewerage systems
(Source: Japan Sewage Works Agency-JS)

The most difficult part with on-site sanitation systems is operation and maintenance (O&M). The O&M of on-site sanitation systems is more difficult than that of off-site systems, which are operated and managed by public or private utilities composed of professional engineers and technicians. In the case of on-site sanitation systems, O&M must be done by the owners or users, which is a very difficult and even dangerous task for ordinary citizens. Therefore, management systems in which the O&M of on-site sanitation systems is outsourced to professional operators (engineers and technicians) need to be established. This requires complex legal, administrative and financial arrangements.

In Japan, at the time of sewerage expansion in the 1970s, the shortage of human resources enable to manage such systems in every municipality was considered as a possible bottleneck for the rapid expansion of a nation-wide sewerage network. In 1972, the Japan Sewage Works Agency (JS) was established by the Japan Sewage Works Agency Act as a pool organization in charge of developing human resources for off-site sanitation. Further to this role, this organization has also provided planning and technical support for the construction of sewerage systems and help medium and small scale municipalities to plan for their wastewater management.

For on-site wastewater management in Japan, the training and qualification of the private operators involved in the O&M of on-site wastewater treatment facilities have been done by the public sector. When the diffusion of Packaged Aerated Wastewater Treatment Plants (PAWTPs, so-called Johkasou in Japan) started, the Japanese government established a training and national certification system to convert the people in charge of the collection and transport of night-soil/black water from vault toilets into technicians and engineers for the O&M of PAWTPs. This system solved the shortfall in human resources and established a social environment that enabled the sustainable development of PAWTPs in Japan.

Differently to the approach taken in Japan (that is, providing support via the public sector), there are countries that have addressed the shortage of human resources using the vitality of the private sector. In Manila, Philippines, water services including piped water supply and wastewater management were privatized in 1997 with the establishment of two private operators, Maynilad Water Services and Manila Water Company, which from this date have developed, operated and managed the sewerage system of this city.

In Malaysia, in 1994, Indah Water Konsortium (IWK) – a private operator – was awarded the concession for nationwide sewerage services which, prior to that, was under the responsibility of local authorities. Since then, IWK has taken over these services from local authorities in all areas except the states of Kelantan, Sabah, Sarawak and the Majlis Perbandaran Johor Bahru. In June 2000, as a testimony of the Government's commitment to ensure that proper and efficient sewerage systems are successfully installed and maintained, the Government, through the Ministry of Finance, took over the entire equity in IWK from its previous private owners. In addition to sewerage services, this now state-owned company is, as well as the two above-mentioned private operators in Manila, providing professional septage management services.

2.1.6 Institutional and regulatory frameworks

In order to achieve integrated sanitation for all and sustainable wastewater management, stakeholders – ranging from ordinary citizens to businesses – and policy makers need to create an enabling environment which includes policy, laws, regulations and financial resources, as well as institutions in charge of administrating the sector and making sure laws and regulations are applied in the ground. The lack of such comprehensive approach is probably the reason why in many Asian developing countries the situation and improvement of sanitation and wastewater management are far behind the development of other sectors. This is particularly true with septage management, an unregulated sector for a vast majority of countries in the Asia-Pacific region, despite the fact that on-site sanitation systems are by far the prevailing wastewater treatment systems used in the region.

There are, nonetheless, exceptions such as Malaysia. The Government of Malaysia's aim was always geared towards promoting sanitation and hygiene in order to protect public health, environment and water resource. As a result, three major reforms took place where governance transition was seen from Local Authorities to Sewerage Services Department to the present Suruhanjaya Perkhidmatan Air Negara (SPAN). Water Services Industry is divided into water treatment, water supply and sewerage services. In 2006, Water Services Industry Act (Act 655) was enacted where SPAN regulates all matters pertaining to water and sewerage services within Peninsular Malaysia and Federal Territory of Labuan. In extremely insignificant percentage, there are isolated cases whereby the sanitation needs are looked after by Ministry of Health (MOH) in very rural areas but regulation is still under the purview of SPAN.

Currently in Malaysia, constrain in provision of financial aid by the government has over a period of time caused development of sewerage infrastructure to be borne by developers. Therefore, the existing infrastructures were mainly built to serve a particular development and not a specific geographical area. As a result, high numbers of sewerage assets have been developed with various types of systems that have wide ranges of performances and quality. Only a small amount of treatment plants have been constructed to serve a larger catchment. To date, almost 91% of the existing sewerage treatment plants serve a population equivalent of 10,000 and lesser. With the current tariff structure, these facilities are a burden for public operators as smaller facilities drain out more cost for operations and maintenance.

As for sludge management, SPAN is currently in the midst of finalizing a legal framework for scheduled desludging of septic tanks namely “Desludging Rules” where the responsibility of providing this service falls under the obligation of a Service Licensee. Premise owners are obligated to ensure emptying of septic tanks are done and sufficient access to desludge is provided.

2.1.7 Sanitation in rural areas

The diversity of the Asia Pacific region makes any discussion on rural sanitation issues in a homogeneous manner both difficult and irrelevant.

Attention so far has predominantly been on eliminating open defecation. In the Asia Pacific this is a problem that is most acute in South Asia and within South Asia in a few states in India which because of their large populations have a disproportionate impact on overall aggregated numbers. There are several reasons for this, some cultural and some behavioral.

However, intense campaigns against open defecation such as the Swatch Bharat Mission in India have resulted in the construction of a large number of toilets propelled by a target driven approach. In the course of the next five years, it is expected that the open defecation problem will reduce in scale but other associated problems will need focused attention.

The first is the issue of uneven quality in toilet construction, particularly in the design of collection pits. So far this has not been an issue of discussion in international forums. But it is on the pollution of groundwater and also on other water bodies through infiltration processes. There are not many research studies on this subject but the few there are show the presence of fecal coliform in aquifers close to human settlements. Therefore, safe toilet design and the training of craftsmen is an area which will require a partnership approach between civil society organizations with their last mile reach and local governments in rural areas. Safe toilet design can also be an opportunity for local private sector initiatives to play their part.

The second is the issue of safe disposal of sludge. Although the collection of decomposed fecal matter will be slower in rural areas because of the more scattered nature of habitations when compared to urban areas it will become a more serious problem in the future. So far disposal of sludge has often been individual habitation based but attention needs to be given to a more organized and safe way of sludge disposal and treatment in rural areas as well. This would require not just regular and regulated removal of sludge but also methods of safe disposal, particularly where sub surface structures are fractured and pathways to pollution more open. This is an issue which affects coastal areas, the plains and mountain habitations.

The third area, which is prevalent in some parts of the Asia Pacific region but not in others, is the development of markets for decomposed sludge which can be used as fertilizer. The declining deposits and growing demand for phosphates makes the use of human waste based fertilizer more ecologically essential and therefore the need for safe collection and disposal to be addressed with a sense of urgency.

2.1.8 Circular economy (wastewater reuse and sludge recycling)

The SDG 6.3 target includes 'halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally'.

The reuse of treated wastewater is possible only if wastewater is properly treated at the preliminary treatment stage. Therefore, not many countries are reusing the wastewater treated in sewerage systems. On the other hand, when a wastewater treatment plant is built, the proper disposal of the excess sludge always becomes an urgent issue, and the proper recycling of the excess sludge is one of the options for the efficient sludge disposal. This also applies for the sludge from on-site systems which is collected from septic tanks and other on-site wastewater treatment facilities, once the O&M for these facilities is improved.

In the Asia-Pacific region, only a few numbers of industrial countries are one step ahead in the recycling of treated wastewater. One of the examples is the wastewater recycling system in Singapore. In Japan, the recycling of sludge is conducted with both off-site (sewerage) and on-site systems throughout the country.

2.2 key messages

(1) The Asia-Pacific region has problems related to both sanitation and wastewater management. On the one hand, there is a large proportion of its population without access to basic sanitation, particularly in rural areas, but, for some countries, this problem is not limited to rural areas and can also be found in some parts of urban areas. On the other hand, the pollution of the water environment is worsening in the rivers, lakes and coastal waters of a great majority of countries, which is particularly threatening the sustainable and healthy development of their urban economy. Countries in the Asia-Pacific region need to increase their efforts to achieve the uncompleted tasks carried over from the MDGs to SDG 6.2, 'By 2030, achieve access to adequate and equitable sanitation and hygiene for all, and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations', and to mainstream wastewater management in order to tackle the new challenges of SDG 6.3, 'By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated waste water and substantially increasing recycling and safe reuse globally'.

(2) This is a daunting task for many countries in the Asia-Pacific region. In order to improve sanitation access and reduce water pollution, it is essential to increase investments in wastewater management for both off-site and on-site sanitation, including septage management. However, many countries are under serious financial constraints. The low willingness to pay for sanitation and wastewater/septage management is another constraint. Legal and regulatory systems to eradicate water pollution must be established and enforced, but such systems are at the preliminary stage in many countries. Institutional arrangements and human resource development are also essential. The insufficiency of human resources for sanitation and wastewater management is particularly an acute issue for many countries, which is a critical obstacle for the improvement of the water environment. Behavioral change is essential, particularly to end open defecation and increase the acceptance of sewer house connection and septage management, which is not an easy job for many countries. We should also pay attention to the fact that, in all large scale efforts, more often than not, the poorest are left behind. Nonetheless, it should be noted that in all the success stories mentioned in (3) below, the poorest are not forgotten.

(3) Although the picture ahead of us looks gloomy, there are a few success cases in the Asia-Pacific region. Although the number of these success cases is limited and remains exceptional undertakings, the experience of these cases is worth being shared among other concerned parties in the region. There are many initiatives in Asia and the Pacific for sharing the experiences among officials, utilities and practitioners in the area of both sanitation and wastewater management. The Asia-Pacific Water Forum will continue to encourage these initiatives.

2.3 Case studies

2.3.1 Off-site systems

(1) MWSS/Manila Water Company

MWSS (Metropolitan Waterworks and Sewerage System)/Manila Water Company have implemented integrated wastewater management through sewerage development and septage management, including services to the poor.

Water supply and wastewater management services in Metro Manila, Philippines, were privatized in 1997. Under the concession agreement, Manila Water Company, Inc. (MWCI) is given full responsibility for operating, maintaining and managing the water supply and sewerage systems in the East Zone of Metro Manila. The West Zone concession was awarded to Maynilad Water Services, Inc.

Background

Prior to the privatization of the operations of the public water utility in Metro Manila, very little sewage collection and treatment was accomplished. Most of the sewer infrastructure in the City of Manila was built by the American colonial authority before World War II. When the city expanded into the then suburbs, most private land developers did not lay down wastewater infrastructure. The government housing estates laid down sewer lines but there were no adequate treatment facilities provided. Most households had septic tanks installed onsite in response to a government drive to address public health, but were largely inadequately designed and managed.

Waterborne epidemics were then somewhat controlled due to the existence of septic tanks and the pre-treatment of black water (flushed in toilets), but the environmental damage was unabated due to unmanaged gray water (kitchen, shower laundry) and commercial wastes.
The priority of the public water utility then was to address the water supply crisis, not sewerage and sanitation. There was not enough funding available for MWSS to expand water and wastewater services.

Public Private Partnership

In 1995, the Philippine Congress passed the National Water Crisis Act and allowed the president of the country to enter into agreements with the private sector to improve the delivery of water services to the public. The privatization of the operations of MWSS was the biggest privatization exercise in the water sector in the world at the time.

The objective of the PPP was to address three key issues in the operations of the public water utility: the slow speed of public procurement, the weak productivity of the workforce, and the lack of funding for capital works. It was viewed at the time that the private sector was more agile, driven and had easier access to funds.

Metro Manila was divided into two zones and concessions were awarded to two private companies after a public bidding. Manila Water won the concession for the East Zone, covering 23 cities and municipalities. Currently it serves a population of 6.7 million people. It has since turned around the operations of the water utility and through improvements in employee culture and management of systems losses (non-revenue water) it has increased water supply coverage to nearly all constituents, even the urban poor. Despite threats of climate change and having just a single major water source, there is currently no water crisis or water stress in the East Zone of the city.

Wastewater Service Expansion Strategy

The ideal end-point is to have all the homes and businesses connected to a sewer network, but this will entail a lot of up-front investments in treatment plants and sewer lines, and will take a long time. Therefore, Manila Water adopted a three-step strategy to expand wastewater service.

The first step is to take advantage of existing household-based septic tanks which already pre-treat sewage. To ensure that these individual septic tanks operate properly, i.e. optimizing hydraulic retention time, Manila Water needs to remove the accumulated solids every 5 to 7 years, and ensure that those solids are treated appropriately. Manila Water was among the first companies in the Philippines to actually construct septage treatment plants that complied with effluent regulations. With the total number of water service connections currently at around 1,009,000, Manila Company therefore needs to desludge between 150,000 to 200,000 septic tanks annually in order to meet the 5-7 year target for septic tanks.

Manila Water will continue to implement a desludging program as long as septic tanks exist in the concession area. However the impact for environmental improvement is still quite limited. To tackle this issue, sewage treatment plants are continuously being built.

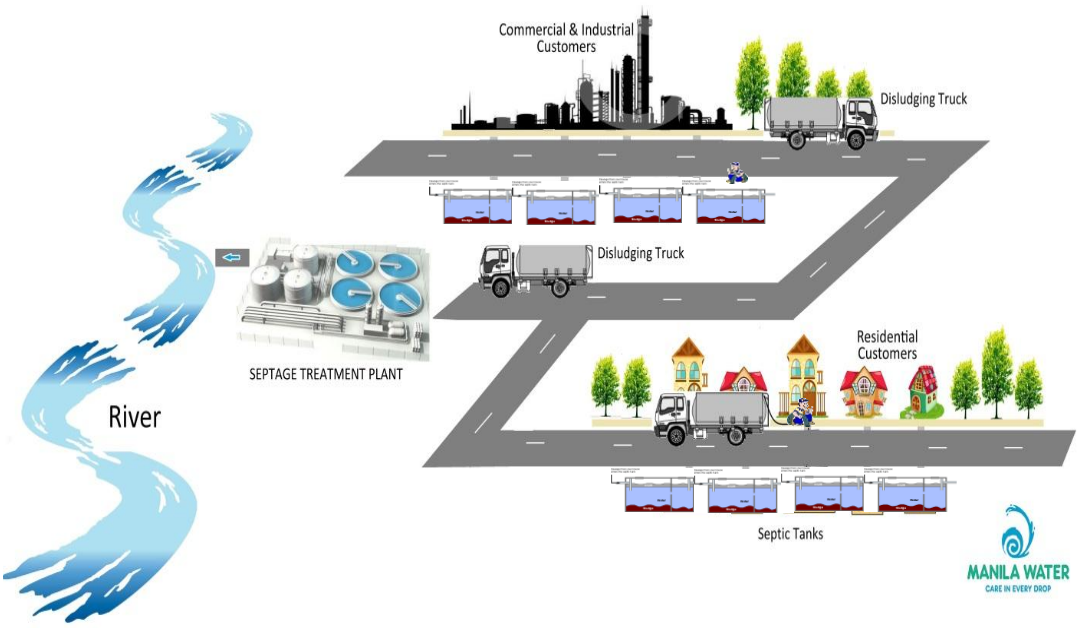


Figure 11. Household septic tank desludging
(Source: Manila Water Company)

As an interim plan, Manila Water and its public water utility partner (MWSS) adopted the Combined Sewer Drainage approach, where partially treated black water from septic tanks, along with untreated gray water from showers, kitchens and laundry, are discharged by households to existing stormwater canals. Manila Water installed interceptor boxes at the canal outfalls and divert dry weather flows to the sewage treatment plants. It is only during periods of heavy rainfall that there will be overflows into the rivers. (Due to space constraints, the company does not have storage basins for the 'first flush' of the rainy season.)

Manila Water Company's priority is to build the sewage treatment facilities, using storm canals as a conveyance mechanism, but they will eventually expand the sewer network to connect all households directly to treatment plants. That will be the third step to build the separate sewer system as the ideal solution.

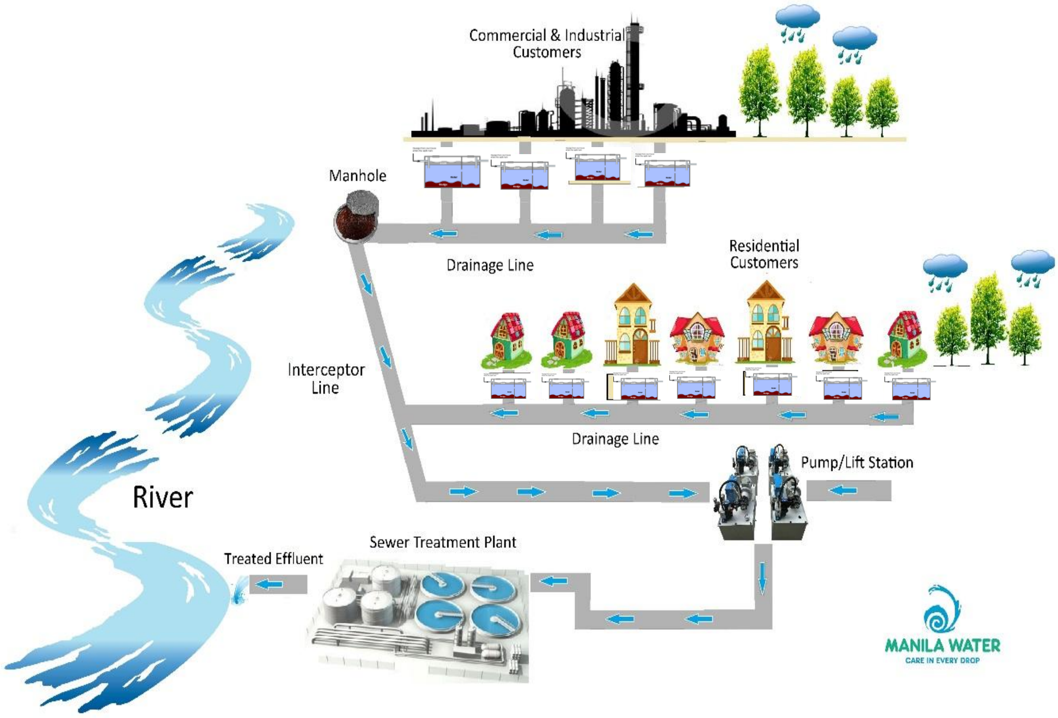


Figure 12: Combined sewer drainage system with septic tank desludging
(Source: Manila Water Company)

Current Status and Plans

To date, Manila Water in Metro Manila's East Zone has completed and is operating nearly 40 sewage treatment plants with a combined treatment capacity of 312 million liters per day. It is due to finish its biggest STP in 2018, with a capacity of up to 100 MLD.

In 2016, Manila Water diverted 6,264 tons of BOD (organic pollution) from the waterways of Metro Manila and the Laguna Lake region. Enterprise-wide, Manila Water removed 9,003 tons of BOD from the waters of the Philippines.

The organic pollution removal is equivalent to 39,461 tons CO_2 in the East Zone concession. Enterprise-wide, the carbon offset was 56,722 tons in 2016.

The LLDA (Laguna Lake Development Authority) Pilot Ecosystems Account reports 81,000 tons of BOD loading in 2014 for the entire Laguna de Bay Region. 70,000 tons of that originate from households.

Manila Water has a pipeline of sewerage projects until the end of the concession in 2037, targeting 100% coverage, in compliance with the Concession Agreement with MWSS, and a 2008 Supreme Court 'continuing mandamus' on the cleanup of Manila Bay. These capital investments will be implemented with approval of the MWSS regulator, reviewed every 5 years and with tariff adjustments. Upon completion, a total capacity of 1.26 billion liters per day capacity is expected to be installed.

Funding and Cost Recovery

The Concession Agreement with MWSS has clear service obligations and Manila Water is being measured through key performance indicators and business efficiency measures. There is a target of 100% sewer coverage by the end of concession in 2037, and all investments need to be recovered by the concessionaire through the water bill. All costs are passed on to the consumer. There is currently no subsidy contributed by the national government.

The heart of the concession agreement with MWSS is that in order to meet Manila Water's service obligations, the company will have to invest in new infrastructure (CAPEX Program) and operating the facilities will entail operating costs (OPEX), both of which will need to be recovered, with an appropriate rate of return approved by the regulator, through the water bill charged to the consumers. This is the full cost recovery model which incorporates the 'polluters pay principle'. The tariff tables are uniformly implemented across the concession area. All the customers (residential, business) are to pay 20% of water charge as environmental charge. Business customers are to pay 30% of water charge as sewerage charge, if their premises are connected to a sewer, in addition to the environmental charge.

In 2010, when the sewerage target of 55% by the original end of concession in 2022 was revised to 100% by a Supreme Court continuing mandamus, the MWSS utility decided to extend the concession by an additional 15 years, ending in 2037, in order for the concessionaires to attain the 100% target and mitigate the impact on the tariff.

Execution Challenges

Since Manila Water started expanding wastewater services to its consumers, it has encountered challenges in execution.

1. Although the Clean Water Act of 2004 mandates local government units to provide the land for sewage treatment plants, most of them did not have any. The company was forced to be creative, e.g. building facilities under basketball courts or parking lots, but as the projects became larger, it was forced to purchase land but it led to high project costs.
2. The environmental regulator recently issued a new set of very stringent effluent standards which incorporated nutrient removal, but the existing facilities do not have the space to have additional process tanks in order to comply. There are also issues with inconsistent regulatory practices across regional offices of the environmental regulator.
3. Manila Company foresees that if all water utilities will be forced to construct and operate sewage treatment plants, the company may have a shortage of capable contractors and wastewater professionals who can operate them. This is actually an opportunity not just for businesses but also young people, as there are not a lot of wastewater professionals around.
4. Investing in sewerage entails high CAPEX and OPEX compared to water supply. All these costs are passed on to consumers through the water bill. People have to be willing to pay the price for addressing the pollution they make.

Developing Public Support

In order to enhance public support and willingness to pay, Manila Water has opened its facilities to members of the public for them to witness how the company does its work. The Lakbayan Water Trail Tour is an award winning program which allows the guests to appreciate the water value chain from water source to sewage effluent.

At the same time, the company tries to engage them to pledge their own commitment to the environment by stating their personal stake or 'toka toka' which can be anything from committing to desludge their septic tanks, manage their solid waste properly, connect their houses to a sewer line when available, or simply start their own environmental campaigns in their neighborhoods. This helps develop an environmental responsibility mindset among the company's institutional partners and the customers themselves.

Summary

- Manila Water's Public Private Partnership contracts have clear service obligations and targets, and allow full cost recovery of expenditures through the water tariff.
- Approaches for expansion of used water services will evolve in time: from septic tank management, to combined sewers, to separate sewers.
- Involvement of key partners such as regulators and community leaders are essential for changing mindsets.

Practical Recommendations (the following views are necessarily not those of Manila Water Company)

- **Plan for the very long term, but build modular.**
  Wastewater infrastructure is not built for current demand, but for the future. The time horizon for planning may be as short as 10 years, or as long as a hundred years, but asset owners should ensure land banking early on because of population growth and urban sprawl. Although more efficient technologies develop through time, having enough space for retrofits and buffer zone are a good idea.

  Land acquisition for the very long term is a must, but due to funding constraints, it may be necessary to build only what is necessary to address medium term demand, say 5-10 years, but there should be enough space left for other modules during expansion.

- **Wastewater asset owners and operators should ensure that their facilities have enough space for retrofits or additional unit processes to cope with changing effluent limits and new parameters.**
  In the few decades that cities have been setting up wastewater infrastructure, the limits set in effluent standards have always been in flux due to changes in water quality targets. Initially, only organic pollution (BOD) removal was the objective, then after a few decades nutrients were included in the required contaminants to be removed. There is a trend that in the future, even trace contaminants may have to be addressed in conventional sewage treatment plants.

- **Need for constant collaboration between the water utility (wastewater infrastructure asset owner and operator) and the environmental regulator**
  Performance specifications of wastewater facilities are largely dictated by water quality improvement targets which can change from time to time. Changes in regulatory requirements need to be in phase with asset renewal activities and vice- versa.

Water utilities and environmental regulators also need to agree on facility retrofit protocols when compliance with effluent limits are at risk.

- **Pollution removal performance should be based on mass loading instead of concentration-based limits**
  The government environmental regulator in the Philippines, since pollution control laws were enacted, had set concentration based limits on effluents, say 50 mg/L BOD, irrespective of population and economic growth, but expecting water bodies to eventually recover. It is a matter of fact that as populations and economies grow, the total mass of pollutants discharged to a water body actually increases while the water body does not change in size.
  It would be beneficial for a water utility to understand its role and partly own the outcomes for water quality recovery initiatives if it quantifies its pollution diversion contribution through tons of pollution removed or diverted instead of percent compliance with effluent limits. It also allows for occasional concentration limit exceedances due to the variable nature of raw sewage. A focus on a utility's portfolio performance rather than individual facility performance allows everybody to appreciate the overall outcome, and gives insight on whether environmental policies and asset management plans are working.

- **Avoid the imposition of pre-treatment standards to commercial customers, but charge according to wastewater strength.**
  A government water utility, which practices a full cost recovery approach and cross-subsidies from commercial to domestic and wealthy to poor customers in the setting of tariffs, is naturally averse to setting up wastewater infrastructure that passes on the cost recovery burden to customers. Thus, it will insist that businesses pre-treat their high strength commercial wastewater 'down' to domestic wastewater quality so that the facilities built will not be overdesigned.
  However, many businesses are small and medium enterprises do not have onsite space for pre-treatment, and have no core competencies to operate a tiny sewage treatment plant. It is also very difficult to regulate individual business owners (either by the utility or the government environment regulator) as it would require a massive manpower complement. It is recommended that the utility simply accepts all types of wastewater in its sewer lines, except those with hazardous components, and charge the customer according to strength. It also removes the burden on the government environmental regulator to perform 'retail regulation' on thousands of regulatees.

(2) Kitakyushu City

The city of Kitakyushu is an industrial city in Western Japan, with a population of 1 million. The city has a long coastal line of 210 km and abundant nature with 40% of the city area covered by forest. The gross domestic product of the city is approximately \3.5 trillion (approximately $31.6 billion) with many heavy industrial groups, such as iron foundries, located in the coastal area. In the 1960s, the pollution at Dokai Bay, which is located in the middle of an industrial area, became so serious that its marine life became completely extinct. The area was called the Sea of Death. The water quality of the Murasakigawa River, which flows through the center of Kitakyushu, was extremely polluted in 1967 with a BOD value of 58 mg/l (around 1 mg/l currently). This was due to the city's rapid industrialization and urbanization as well as the lack of wastewater treatment facilities. As a result, residents disliked approaching the river.

Technology options

- Around 99.8% of the population is connected to the public sewerage system.
- On-site sanitation systems - mainly Packaged Aerated Wastewater Treatment Plants (PAWTPs), so-called Johkasou in Japan – cover the remaining population (0.2%) in areas where sewerage construction is difficult.
- For a rapid and relatively cheap manifestation of sewerage benefits, (i.e., water quality improvement and flood damage reduction) the combined sewer system was introduced in the 1960s in almost all of the central city areas.
- At the final stage of sewerage implementation, the combined sewer system, which covers an area of 3,422 hectares, represents 20% of the whole wastewater treated area while the separate sewer system has been installed in the remaining 80%.
- Since 2003 and the revision of the Sewerage Law Enforcement Ordinance, Kitakyushu City has continuously kept improving the combined system while gradually shifting toward the use of separate sewer systems and the construction of stormwater reservoirs for flood control during heavy precipitation events.
- Small-scale sewerage zones were planned in suburban areas with low population density. Separated from the urban area, the wastewater unit load and the minimum diameter of the sewer pipes were determined based on past records of supplied drinking water. Sewer pipelines include many manholes equipped with a pump, which enabled reducing the pipe cost.
- The city has five wastewater treatment plants (WWTPs). These plants use the conventional activated sludge process and have a total capacity of 621,000 m^3/day (as of 2015).

Institutional and management arrangements

- Kitakyushu City's Water and Sewer Bureau manages sewage works. Although the Water Bureau and Sewer Bureau merged in April 2012, their special accounts (for public business including water supply and sewage works) remained separated.
- The sewerage utility account is independent from the general account of the city.
- The financial regulations of the Local Public Enterprise Act are applied since 1985 and a corporate accounting method has been adopted.
- Since the 1970s, the operations at the central control center of the WWTPs are outsourced to private companies through contracts renewed annually.
- In the 1950s, a group of women (women's associations in the city) provide the stimulus to start a movement demanding action against pollution. This led to the initiation of antipollution activities. Various citizen organizations conducted environmental research, river cleanup campaigns, and collection of cans and bottles thrown along the roadsides.
- In 1968, Kitakyushu City created the Countermeasure Convention of Murasakigawa River as a special organization to tackle water pollution issues. This was followed by a resettlement plan for the informal settlers located along the river. This included consultations with residents to be relocated in building plots and apartments provided by the city, which proved to be successful in paving the way for the redevelopment and revival of the river.
- The private sector took part in the restoration project of the Murasakigawa River as early as the planning stage. It was involved in promoting the redeveloped waterfront by hosting various competitions and events in the area.

Financing arrangements

- In Japan, the implementation of sewage works is placed under the responsibility of local governments.

- The Sewerage Finance Research Committee was created, consisting of experts and knowledgeable persons from central and local governments. The role of the committee was to determine the financial principles appropriate for sewage works according to socioeconomic conditions (decision of subsidy rules with transparency).
- The central government provides subsidies at fixed rates, which vary depending on the type of facilities.
- The current subsidy rate is 55% for eligible WWTPs, and 50% for sewer lines.
- The funding of unsubsidized facilities is provided through local bonds while the remaining cost is transferred from the general account of local governments. Residents also pay partly for the capital cost through beneficiary contribution.
- The total capital investment cost for the sewerage facilities in Kitakyushu exceeded JPY 600 billion (approximately $5.4 billion) over the past 40 years. This cost is shared among municipal bonds (65% of total cost), subsidies from the central government (26%), beneficiary contribution (3%), and the general account of the city (6%) according to the fundamental principle of sewerage financing established by the Sewerage Finance Research Committee.
- At the time of bond repayment by the local government, the law had authorized about 50% redemption with the national tax revenue allocated to local governments for this purpose.
- Generally, sewer user charges are calculated by adding the basic charge and the charge from the amount of water supplied. In the case of Kitakyushu, for a family that uses $20m^3$/month, the sewer user charge is JPY 4,415 (approximately $39.86) for 2 months. This is equivalent to JPY $110/m^3$ (approximately $0.99). This amount is cheaper than in many cities of Europe.

Project outcomes

- As with many cities of Japan in the 1960s, the bay and rivers of Kitakyushu were extremely polluted, a situation comparable to the conditions currently found in cities of developing countries. Pollution was greatly reduced because of the investment made by private factories in wastewater treatment facilities for industrial effluent, as well as the significant public investment made to develop the sewerage system. Figure 13 illustrates these changes and/or improvement to air and water quality.
- Continuous efforts made by the city of Kitakyushu, residents, and the private sector also enabled sewerage progress.
- Kitakyushu was the first city in Japan that was able to improve its water environment.
- Improvement of the water environment in cities around Japan did not only support the country's economic development, but also allowed all sorts of environmental engineering development by both the public and private sectors. The developed technologies supplied outside Japan enabled environmental improvement in other countries as well. This provided significant returns in the investment required for sewerage.

Positive outcomes of sewage works in Kitakyushu include:

(i) The development of a legal and financial support system from the central government was a powerful incentive for sewerage implementation.

(ii) The determination of a business scheme well-suited to the characteristics of the city enabled effective project cost reductions.

(iii) The combined sewer system was adopted in areas with urgent needs.

(iv) A monitoring system was established to assess water quality in the major discharge points receiving industrial wastewater from factories.

(v) The strong will of the city authorities represented by the mayor and supported by the residents was a powerful driving force for sewerage projects.

<u>Reference:</u> ADB, “Sanitation and Sustainable Development in Japan”, 2016

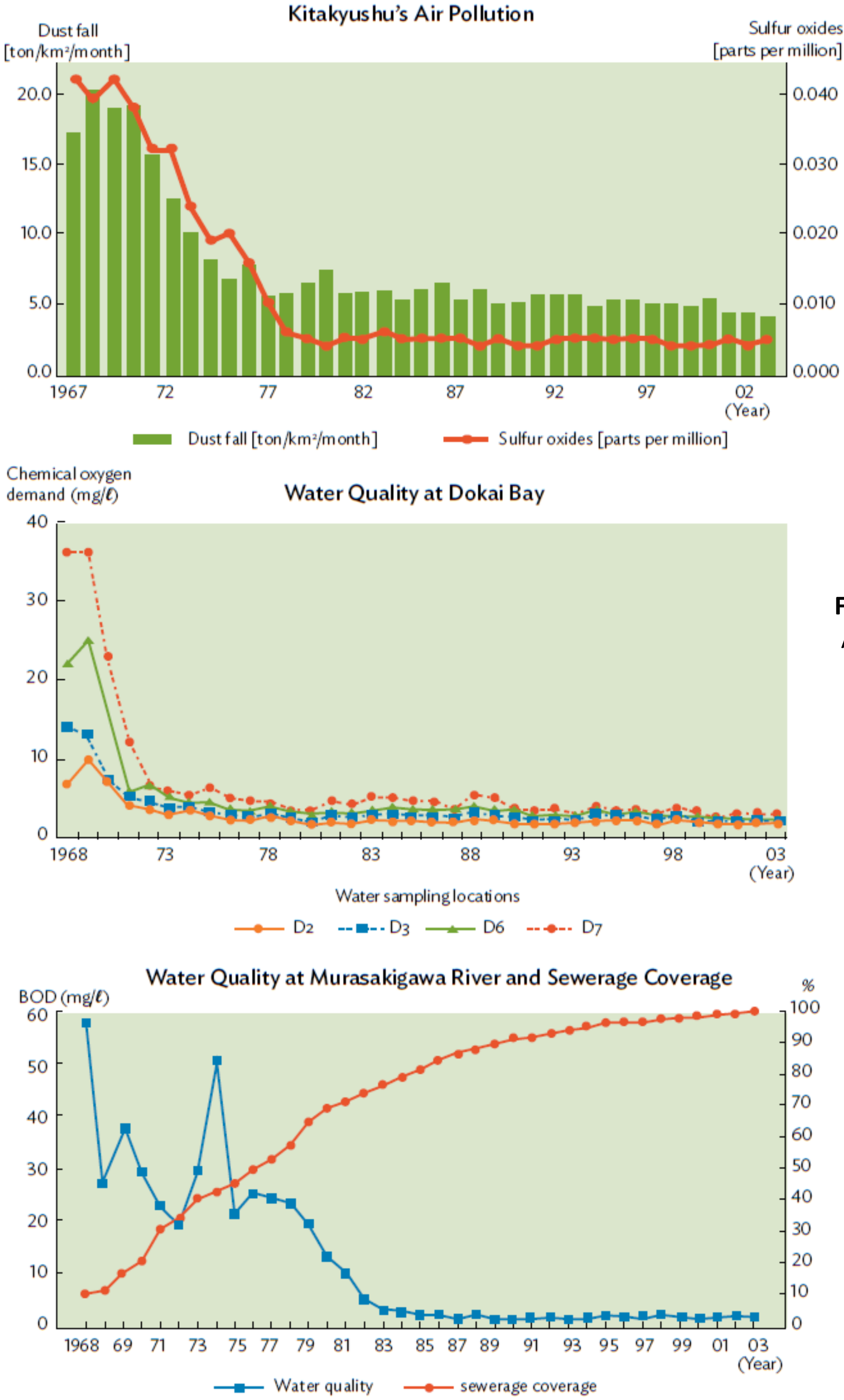


Figure 13. Changes in the Air and Water Quality at Dokai Bay and Murasakigawa River (Source: JSC 2013)

(3) Ho Chi Minh City: improvement of the water environment by the integrated development of the sewerage system, drainage system and the relocation of the slums

Recent rapid urbanization along with economic growth and industrialization has caused severe environmental deterioration in Vietnam. The urban infrastructure such as roads, electricity and water supply networks have been smoothly developing while the development of sewerage systems is not catching up with urbanization.

In Vietnam, based on the revised sewerage development policy (Prime Minister's Decision NO. 589, April 2016), the percentage of sewerage coverage should reach 50% by 2025 in the city center of Class-2 cities and above, while the percentage of sewerage coverage should reach 20% in the city center of Class-5 cities and above. By 2050, the percentage of sewerage coverage should reach 100% in the city center of Class-5 cities and above.

During these 10 years, the Vietnamese Government made a lot of efforts and financial investments on the sewerage and drainage sectors. As of June 2016, about 41 centralized wastewater treatment plants (WWTPs) were in operation in urban centers of Class-3 cities and above, with a total capacity of 960,000 m^3/d, accounting for nearly 17% of the total urban domestic wastewater.

About 50 other WWTPs are currently being designed or constructed and expect to be completed by 2020, which will be accounting for 35% of the urban domestic wastewater. However, this means that over 60% of the urban domestic wastewater will remain untreated even after 2020. The development of sewerage systems needs to be accelerated, especially in smaller cities such as Class-2 and 3 cities. To realize these projects smoothly and effectively, the enhancement of the management capacity in these cities are essential. (Refer to "Proposal of Establishment of Vietnam Sewerage Center (VSC) under Administration of Technical Infrastructure (ATI), Ministry of Construction (Draft)", August, 2017)

In Vietnam, Ho Chi Minh City (HCMC) is one of the largest cities with a population exceeding 8 million people within a city area of 2,094 km^2. The population density is about 3,900 people/km^2. HCMC is one of the rapidly developing cities in Vietnam with economy growth. The annual GDP growth rate between 1990 and 1998 was 12%. The deterioration of urban infrastructure such as water supply, sewerage/drainage systems and solid waste treatment facilities, and the delay of the associated infrastructure development have caused severe impacts and problems on the urban environment such as the increase of water pollution in rivers and canal/water ways, air pollution, solid waste volume and floods during the rainy season.

The development of sewerage and drainage system in HCMC has started in the 1870s by the French colonial government. HCMC was later supported by the USA to expand the sewerage and drainage service areas. However, due to rapid urbanization and the existing system deterioration, the total sewerage capacity did not catch up with the increasing urban population. Moreover, there was no wastewater treatment plant. Therefore, the collected wastewater was discharged into Saigon River and their branch rivers without treatment, causing severe water pollution in the canal and waterway inside the city. This water pollution probably had its worse effects to the health of the people located along the rivers and waterways.

To tackle water pollution in HCMC, an ODA project from the Japan International Cooperation Agency (JICA) started in March 2001. This project consisted of the 5 following components:

A) Repairing the canal waterway, including the resettlement of the inhabitant in slum areas beside the canal for land acquisition and canal bank works

B) Construction works of pumping drainage systems, including pumping stations and drainage pipelines

C) Construction works of interceptor trunk sewers and wastewater relay pumping stations

D) Improvement works of existing combined sewer lines

E) Construction works of wastewater treatment plant (capacity: 141,100m^3/d)

The project was completed in October 2012. The initial completion date was February 2006; therefore the project was completed with almost 80 months delay. After completion, several improvement points were made as follows:

A) No inundation in the project area was reported after the project completion. Before the project, inundation used to happen every year

B) Actual wastewater inflow is 90% of the WWTP capacity. Actual effluent water quality is BOD - 16 mg/L (project target: BOD 50 mg/L)

C) The improvement of the water quality in the canal waterways was more than expected. The water quality of the worst polluted canal was improved from BOD 89 mg/L in 2000 to BOD 24 mg/L (high water time), BOD 30 mg/L (low water time) in 2016 (project target: BOD 40 mg/L)

D) 2,573 households including 2,000 households in the slums beside the canals were successfully relocated in accordance with the Resettlement Action Plan (RAP) prepared by the Government. Among them, 1,737 households received compensation payments and moved to other locations by themselves. 800 households moved to the apartments prepared by the municipal government. These were provided with a low interest housing loan with 10 years maturity to purchase the room in their apartment. All the procedures were in accordance with the decree for resettlement issued by the central and municipal governments.

E) The landscape beside the canal waterways was drastically improved. The river banks which were occupied by slums were transformed to highways, promenades and municipal parks.

The total project cost was JPY 29 billion including 4.7 billion from Vietnam Government's own budget.


<u>Figure 14</u>. Canal waterway before and after project
(Source: Oriental Consultants Co., Ltd.)

2.3.2 On-site systems

(4) Community Sanitation in Indonesia (SANIMAS and PUSTEKLIM/APEX)

In spite of recent economic growth of Indonesia, the country is still facing serious water pollution problems as well as poor sanitary conditions. In order to improve the problems, proper treatment of domestic wastewater is indispensable. As individual treatment such as septic tank is not suitable for densely populated area and centralized sewerage systems are too costly, communal wastewater treatment is now becoming more and more important as a practical solution.

Since the issuing of the "Development of Community-based Water Supply and Environmental Services" as a national policy in 2003, the Indonesian government has been making efforts for the development and diffusion of community-based sanitation improvement systems called SANIMAS (Sanitasi Berbasis Masyarakt). The pilot initiatives in 2003-2004 were followed by up-scaling initiatives in 2006-2009. Then, in 2010, a special allocated fund for community-based environmental sanitation was launched as the major financial resource for SANIMAS projects, which is still used to date. In 2010 also, the sanitation development acceleration program phase 1 (2010-2014) started, followed by phase II (2015-2019). In spite of these efforts, still 32% (82 million people) of the total population were lacking access to basic sanitation and 12% (30 million people) were defecating in the open in 2015.

Figure 15. SANIMAS system in Yogyakarta
(Source: JSC)

The process that has been usually used in Indonesia so far for communal wastewater treatment is the anaerobic process such as what is found in septic tanks and anaerobic baffled reactors. The anaerobic process is advantageous as energy consumption is low and operation is easy. However, the quality of the treated water is unsatisfactory. Compared with the anaerobic process, the treated water quality of the aerobic process is much better. However, the disadvantage of the aerobic process is its large energy consumption. Considering the plus and minus of the said two processes, the development effort of wastewater treatment technologies appropriate to Asian countries by PUSTEKLIM (Wastewater Treatment Appropriate Technology Center, cooperatively established and managed by APEX-Asian's People Exchange and the Dian Desa Foundation) has been focusing on combining the anaerobic and aerobic treatment processes. Through this combination, a wastewater treatment system achieving high treated water quality and low energy consumption is expected to be developed.

In the combination system, the important question is what kind of aerobic process should be used. Activated sludge process seems not suitable for communal wastewater treatment as it is energy consuming. In addition, operating the activated sludge process is not easy as it requires recycle ratio control of sludge for keeping stable MLSS and also requires experience to overcome troubles such as bulking. Therefore, PUSTEKLIM has focused on Rotating Biological Contactor (RBC) as it is energy saving as well as a process easy to operate.

However, ordinary RBCs available in developed countries are too costly and difficult to produce in these countries. Therefore, PUSTEKLIM firstly tried to develop a new RBC type with palm fiber contactors, as the fiber is locally available and cheap. As a result, the efficiency of the palm fiber RBC proved comparable to that of conventional RBC in developed countries. However, it had been elucidated that palm fiber RBC has several disadvantages too, such as a reduction of efficiency if the microorganism layer on the contactors becomes thick and an insufficient durability.

Following these findings, and considering various factors related to the efficiency of RBC, PUSTEKLIM came with the concept of RBC with Three-Dimensional Lattice contactors (Figure 16 and 17). Different from the ordinary RBC using flat or corrugated plates as contactors, this new RBC uses lattice with projections at every cross point. The contactors are arranged in a way that if many contactors are assembled, crystal-like structure appears, resulting in the largest surface area on which microorganisms will be attached. Besides, as many projections hit the surface of the water when the contactors enter into the water, oxygen providing capacity is very high. Together with other factors which enhance the efficiency, it has been elucidated that a RBC with Three-Dimensional Lattice contactors is about 4 times more efficient than an ordinary RBC.

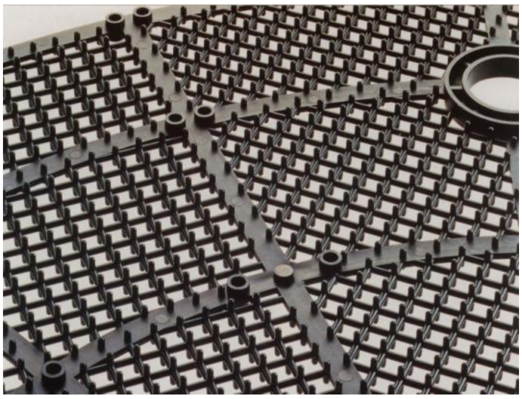


Figure 16. Three-dimensional lattice contactors (Source: PUSTEKLIM)

Figure 17. RBC with three-dimensional lattice contactors (Source: PUSTEKLIM)

As a result, a combination system using anaerobic and aerobic processes, as well as a RBC with Three-Dimensional Lattice contactors has been developed as one of the appropriate technologies for communal wastewater treatment in Asian countries, as it is low cost, easy to operate and maintain, energy saving, space saving and provides high treated water quality.

Then, the construction of a model system using the technology began after meeting with a local government. It was followed by the selection of a location for the installation and a meeting with people from the community (Figure 18). After obtaining the agreement of the community people, technical survey, design, and construction were conducted. Before the system was handed over to the community, training for the operation and maintenance was conducted (Figure 19) as the system would be operated and maintained by the community people themselves. As of 2016, 10 model systems have been constructed (Figure 20, 21 and 22) and operated by communities at their own expense. Among them, the oldest ones have been operated for as long as 8 years.

Figure 18. Meeting with community people (Source: PUSTEKLIM)

Figure 19. Training for operation and maintenance (Source: PUSTEKLIM)

The construction cost of the system with a capacity of 70-80 households is around USD 26,000-30,000 including the piping cost. This cost is comparable to or even lower than that of a conventional anaerobic system as the construction gets much more compact. The operation cost of the system is around USD 30-45 per month including electricity, wages for the operator and oil/grease, which is covered by the community people’s contribution ranging from IDR 6,000 to 18,000 (USD 0.45-1.32) per family as a monthly charge, which does not include the desludging cost. Usually, the desludging work is conducted by the operator using underwater pump. In some communities, the sludge generated from the system is dehydrated by sand drying beds and recycled as compost. The required land area for the system is one-third compared with an ordinary system with anaerobic treatment only. The BOD of the effluent of the model systems has been in a range of 20-50 mg/l (Figure 23).

Figure 20. Model system in Kricak Kidul Dist., Yogyakarta City (Source: PUSTEKLIM)

Figure 21. Model system in Landungsari Dist., Pekalongan City (Source: PUSTEKLIM)

Figure 22. Model system in Karangwaru Dist., Yogyakarta City (Source: PUSTEKLIM)

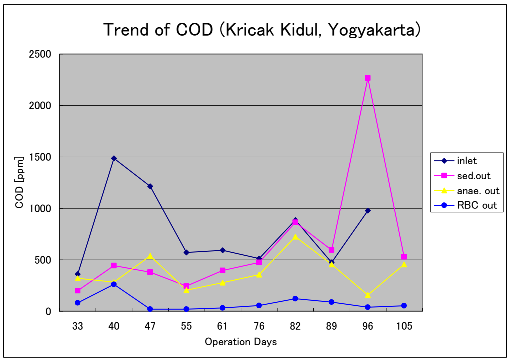


Figure 23. Monitoring results of model system, Kricak Kidul Dist., Yogyakarta City (Source: PUSTEKLIM)

Based on the results of the monitoring and evaluation of the model systems, the technology has been formally recognized as one of the qualified communal wastewater treatment systems with appreciation for its use by the Indonesian central government in 2017. In the same year, in addition to the said 10 model systems, 12 systems were newly constructed. Other than Indonesia, the same system using RBC with Three-Dimensional Lattice is now rapidly diffusing in China, adding several hundred thousand people every year to those whose wastewater are treated by this system.

(5) Rural Wastewater Treatment by Packaged Aerated Wastewater Treatment Plants (PAWTPs – Johkasou in Japan) in Changshu, China

Background

Changshu is located in the southern part of the Jiangsu Province, China. Changshu is the first prefectural city to promote integrated urban-rural wastewater management. From 2008, the city started to comprehensively promote rural wastewater treatment through integrated financing, integrated planning, integrated construction and operation over the whole city.

Benefiting from effective government financial planning, organization and management, facility construction and operation of the rural wastewater treatment is on the leading level in China. However, the input-output performance of rural wastewater treatment in Changshu has still a large gap comparing with more advanced countries due to a lack of experience in planning, construction and management, as well as a low-level of technology for decentralized wastewater treatment. This led the government to worry about rural wastewater treatment: on the one hand, sewerage system is too expensive to cover all rural areas; on the other hand, the performance of the existing decentralized wastewater treatment technology is doubtful. Consequently, a demonstration project was launched to introduce the Japanese PAWTP system in Changshu.

Demonstration project

The demonstration project was carried out in a small village called Fengqiangjing. There are 102 families and about 500 residents living in the village. The houses were built along a small river, with a little space behind and in front the house.

A 5-PE PAWTP, which has a 1m³/day capacity and was designed for BOD and nitrogen removal, was selected to treat the domestic wastewater from households. The designed influent and effluent quality of the selected type of PAWTP are showed in Table 3.

Table 3. PAWTP specifications

	Influent	Effluent
BOD_5	<=200 mg/L	<=20 mg/L
SS	<=160 mg/L	<=15 mg/L
T-N	<=45 mg/L	<=20 mg/L

In accordance with the location of the houses, the number of family members and the water consumption, 55 PAWTPs were designed and installed in the village: 48 PAWTPs were installed for 96 families, 6 PAWTPs for 6 families and one PAWTP for a public toilet. A grease trap was installed at the outlet of the kitchen to remove grease and prevent excessive oil flowing into the PAWTP. All the domestic wastewater from houses is treated by the PAWTPs and the effluent discharged into the river nearby after disinfection.

A private company was given the responsibility of operation and maintenance (O&M). O&M was conducted once every 4 months, and the main work contents are: (1) normal inspection; (2) disinfectant adding; (3) replacement of the diaphragm of blower, once every 2 years; (4) desludging, once a year.

The demonstration project was run for 1 year, and the effluent from PAWTPs was found to have met the water quality requirements. The project had good effects on improving the housing and public sanitation as well as the river water quality in the village. The villagers have a tradition of washing vegetables in the river, and they mentioned that the river water quality had improved significantly after the installation of PAWTPs.

Figure 24. Village of Fengqiangjing

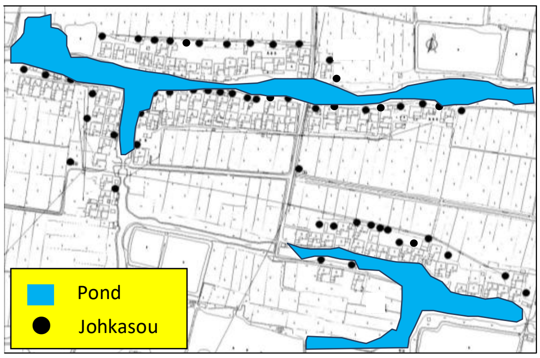


Figure 25. Distribution of installed PAWTPs

Figure 26. Installation of a PAWTP

Figure 27. A PAWTP after installation

(Source: JECES)

(6) Septage Management by Manila Water Company

Water supply service and wastewater management services in Metro Manila, Philippines, were privatized in 1997. Under the concession agreement, Manila Water Company (MWCI) was given the full responsibility for operating, maintaining and managing the water supply and sewerage systems in the East Zone of Metro Manila.

To address wastewater management, MWCI applies a three-pronged approach. As a first step, MWCI has built interceptor sewer systems to collect from drains the wastewater discharged from septic tanks before its discharge to rivers. Wastewater is then conveyed to wastewater treatment plants (WWTPs).

Figure 28. WWTP in Manila
(Source: ADB CASE STUDY NOTES 'Septage Management')

For the residential customers who are not connected to the separate sewer system, MWCI provides a free desludging service. The desludging of septic tanks is conducted over a 5 to 7-year interval period. The same environmental charge (currently 20% of the water charge) is charged to all the customers (residential, business), regardless whether or not they are connected to the sewer network. Further to the environmental charge, the business customers need to pay the sewer charge if they are connected to the separate sewer network.

(7) SADCO (Haiphong, Vietnam): the most successful case for septage management in the developing countries of the Asia-Pacific region

In Haiphong City, an international port city in the northern part of Vietnam which is experiencing rapid industrialization and urbanization, 1.9 million people are relying on septic tanks and pit latrines for sanitation. Septage management in Haiphong City is conducted by the Haiphong Sewerage and Drainage Company (SADCO) and four private companies. SADCO is in charge of the collection and transport of the sludge from household septic tanks and the operation and maintenance (O&M) of the sludge treatment plant. Sludge collection is conducted on a regular basis every three years.

SADCO has divided the cities into regions. When the septic tanks of one region are emptied (within a year), the company moves to the next region the following year. To enable faster septic tank emptying, a special type of access cover is provided.

(Source: PAS 'Faecal Sludge and Sullage Management in Urban Maharashtra' Policy Brief)

Figure 29. Worker installing a plastic cover to the access hole after septage emptying in Haiphong City (Source: 'URBAN DOMESTIC WASTEWATER MANAGEMENT IN VIETNAM', Water Environment Partnership in Asia)

The cost for septage management is recovered by the wastewater charge, which is 20% of the water charge. Desludging is conducted for 160,000 households, using the septic tank database supported by GIS system and with the help of neighborhood associations.

The average desludging interval in Haiphong City is reported to be 4.4 years, which is higher than Hanoi City (6.2 years) where the regular desludging system has not been introduced.

The treatment method for the collected sludge consists of the following steps: solid-liquid separation in a sedimentation tank, passage to a stabilization pond and sludge drying beds.

(8) Fecal Sludge Management in India – A case study of Dhenkanal, Odisha State, India
Fecal sludge management in India

India is rapidly urbanizing country in South Asia at a rate of 2.8% from 2001 to 2011. At the same time, most Indians do not have access to safe sanitation. In urban India, 33% of population is connected to the sewer, 38% use septic tanks, 11% uses pit and other latrines. Fecal sludge management (also called 'septage management'), which consists of the safe removal and disposal of the sludge accumulated in on-site sanitation systems, is a new challenge with the launch of the Swachh Bharat Mission that aims to achieve a clean and 'Open Defecation Free India' by 2019. Until a few years ago, sludge was not managed properly and there was no dedicated sludge treatment plant in the entire country. In 2013, the Ministry of Urban Development (MoUD) published the 'Advisory note on Septage Management in Urban India'. In 2017, the 'National policy on fecal sludge and septage management (FSSM)' was established and, currently, five states are in the process of a developing septage management strategy. Septage management plans are being developed and to be piloted in more than 10 cities.

An Arghyam initiative

Arghyam, established in 2005, is an Indian public charitable foundation addressing the issues of water and sanitation by identifying key niche areas as peri-urban areas that are poorly managed and have limited access to avail facilities provided by the Government. These areas basically form significant barriers to the provision of safe, reliable and accessible water and sanitation in urban contexts. The Class II (50,000-99,000) & III (20,000-49,000) from the MoUD's classified regions have been chosen because these are the locations where policy is fuzzy, capacity is weak and political attention is often directed elsewhere.

Recognizing the complexity of the urban terrain and development in India, Arghyam, in its urban program initiated pilot projects and research studies in fecal sludge management as one of the theme to build practice and knowledge that will be used to scale up the work and disseminate the knowledge to policy makers and practitioners. Some of the key issues identified in safe fecal sludge management are as follows:

- Lack of investment;
- Lack of institutional responsibility;
- Facilitation of Government schemes/programs;
- Groundwater sanitation nexus;
- Urban growth dynamics; and
- Community participation is highly ignored.

Arghyam, is therefore, working to close the loop while addressing these gaps in the most vulnerable towns; one of which being Dhenkanal, a small town in Odisha State in India. The project established a multi-partners approach that included Bill & Melinda Gates Foundation, Arghyam as funding organizations; Practical Action Foundation as implementing partner, Centre for Policy Research as knowledge & advocacy partner and CDD as technical partner.

Project Nirmal - Piloting appropriate and sustainable sanitation service delivery in Dhenkanal Town, Odisha, India

The project aims to demonstrate sustainable sanitation service delivery by implementing a fecal sludge treatment plant for Dhenkanal Municipality leading to increased coverage of households through enabling institutional and financial arrangements and increased private sector participation. The project ensures a strong link to the market, not just for collection, transportation, treatment and disposal, but also for reuse. To facilitate these initiatives and to ensure sustainability and replicability, the project focuses on building the capacity of existing institutions at the state level for the effective capacity building of urban planners, Urban Local Body staff and

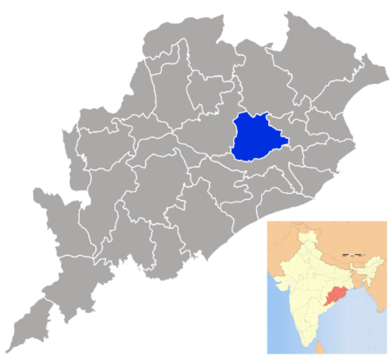


Figure 30. Location map of Dhenkanal Municipality (Source: Arghyam)

line department officials (Odisha Water Supply and Sewerage Board) through creating a cadre of state level master trainers in each of the specialized areas who would in turn train stakeholders across the state.

Current status of the project:

Completed	Ongoing
▪ Situational Assessment and market mapping of the Town ▪ City Sanitation Plan ▪ Detailed Project Report of the FSTP	▪ Implementation of the FSTP ▪ Handholding and capacity building of the Municipal Staff

Technology

The following technologies were selected because of low operation and maintenance cost, simple operation, minimal skills requirement, and no electricity requirement. But, land availability is a prerequisite.

Sludge: As per census 2011, the total population of the Municipality is 67,414 and 14908 households. The technology adopted is designed for its full capacity in 2030 for a projected population of 1,10,015. Anaerobic digestion and sludge drying is chosen for the fecal sludge treatment. The treatment plant is subdivided into three parallel decentralized units of 9 cubic meters (m^3) per day each within the FSTP site with a total capacity of 27 m^3 per day to treat fecal sludge. In total, there are 3 screens and grit chamber, 3 stabilization reactors with 36 sludge drying beds (12 for each stabilization tank). The treated dried sludge can be then used as soil conditioner in the agricultural fields.

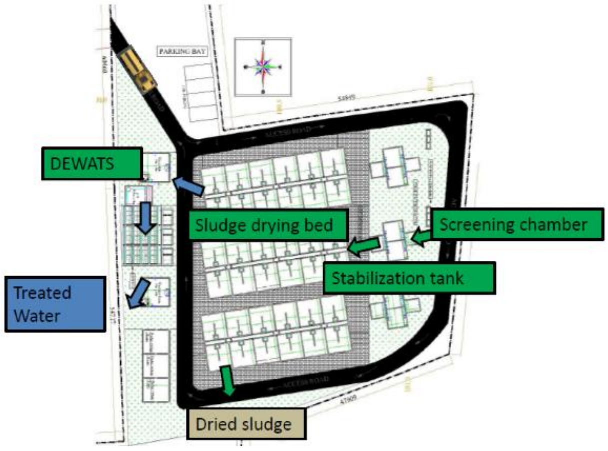


Figure 31. Layout of fecal sludge treatment plant in Dhenkanal (Source: Arghyam)

Wastewater: The percolate goes into DEWATS modules for further treatment. There are 3 parallel streams of 9 m^3 each as full design load is not anticipated for initial few years. As a result, there are 3 anaerobic baffled reactors and 3 anaerobic filters. The partially treated effluent will be pumped through a Sand & Carbon Filter for final treatment to match the BOD disposal standards of 10 mg/l and collected in a common treated effluent collection tank. About 4 m^3 treated water is proposed to be collected for use within the plant and the rest will overflow into agricultural fields nearby.

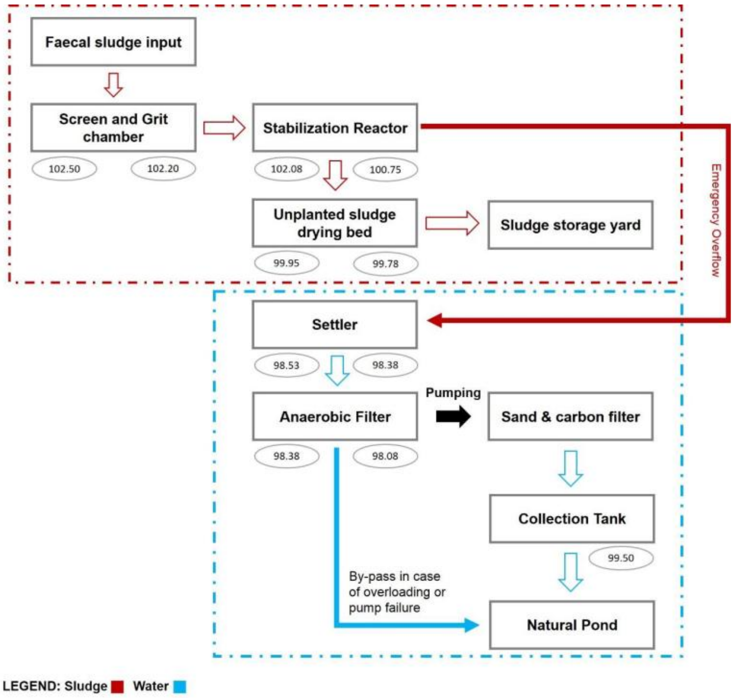


Figure 32. Flow chart of fecal sludge treatment plant in Dhenkanal (Source: Arghyam)

Capacity building

Capacity building needs an assessment study that was undertaken in Dhenkanal with a focus on FSM, to profile and assess the existing institutional structure and capacities that influence the extent and level of services being provided. About 10 key modules on sanitation were prepared for the Government of Odisha to plan the capacity building programs for all the ULBs in the State. The topics of the modules are Sanitation and its relevance; National and state sanitation scenario; Institutional and policy framework for wastewater management; Urban wastewater management systems; Introduction to fecal sludge management; Containment and handling of fecal sludge; Treatment and reuse/disposal; Financial management; Administration and Enforcement and FSM planning.

Institutional arrangement

The city-wide FSM service delivery in Dhenkanal requires two sets of service providers, i.e. **emptying & transportation**; and **treatment & reuse**. Currently, the informal sweepers are still dominating as the main service provider, although there is a regulation on banning manual emptying. The municipality is in the process of constructing treatment facilities and have 3 cesspool trucks granted from the Department of Urban Development and Housing (DUDH), Government of Odisha, with an order to engage private enterprises for emptying and transportation services. However, if the emptying and transportation service are leased out to private enterprises, the livelihood of the informal emptier will be in threat. Therefore, the current informal sweepers would work with the private enterprises as paid employee. Depending upon the level of municipal staff availability and technical know-how on the treatment process management, it is appropriate to lease out the treatment facility to the private enterprise through a service contract. The municipality could run the treatment function considering the long term municipal capacity building and service delivery. The current private cesspool operator and solid waste service providers could be tapped-in as service providers.

Financial strategy and arrangement

Strategy: The funding of the capital cost is provided by the Bill and Melinda Gates Foundation along with the Arghyam Foundation. The plant will be operated by the implementing agency (Practical Action Foundation, India) for a period of one year from the commissioning with donor fund and then will be transferred to the Municipality which will be responsible for operating and maintaining the plant.

Financial arrangement: The current level of demand for the delivering of city-wide FSM service is very low. Therefore, to initiate a standard FSM service and simultaneously ensure private sector participation, "on-demand emptying" will be initiated. Once a sufficient level of demand is achieved, "scheduled emptying" could be initiated. With demand driven FSM service delivery, a preliminary financial analysis revealed that emptying and transportation service is profitable from the beginning. Therefore, it is possible for the cost of the service to meet the revenue earned from the service tariff, while the treatment and reuse functions are not financially viable for the initial few years. These functions will require external financial assistance. Since the treatment facilities are being constructed with the project assistance, the municipality can therefore facilitate the running of the treatment function. The municipality could lease out the cesspool trucks to the private operator and utilize the lease money for infrequent maintenance of the trucks whereas additional money could be utilized for the functioning of the FSTP.

Social aspects: Public awareness, women's involvement

FSM being the new concept in the state/district/city, awareness on this subject among the various stakeholders including the general public was critical for the project. Therefore, a comprehensive Information, Education & Communication (IEC) and Behavior Change Communication (BCC) strategy has been developed and endorsed by the Dhenkanal Municipality and the State Government, which resulted in the launch of an awareness program at the city level in a systematic manner. The strategy intends to achieve the following broad objectives:

- To reduce the resistance of people living near the fecal sludge treatment plant (FSTP) site
- To increase awareness within the community and other stakeholders on FSM, particularly on safe containment, collection, transportation and disposal of fecal sludge
- To ensure the construction of appropriate toilets and tanks/pits by the households/institutions and to ensure timely desludging of the septic tanks/pits of the toilets in the city
- To address negative behavior patterns among the service providers pertaining to the collection, transportation and disposal of fecal sludge, particularly on the adoption of a proper collection method, the use of safety gears during collection, the use of proper

medium for safe transportation and prevention of disposal in water bodies/open spaces/drains

- To augment the understanding about the end-use of treated fecal sludge within the community and with other governments and private entities.
- To enhance understanding and capacity of the urban local body as well as the private service providers for the provision of FSM services, operation and maintenance.

Figure 33. IEC activities in the project locations

Figure 34. Banner at Dhenkanal Municipality displaying FSM good practices

(Source: Arghyam)

For effective participations of the city dwellers and the key officials, five major platforms have been facilitated at city, district and state levels as mentioned below:

- 18 Slum Sanitation Committees constituted
- 23 Ward Sanitation Committees constituted
- City Sanitation Task Force (CSTF) formed under the chairmanship of the Municipal Chairperson
- District Coordination Committees (DCC) formed under the chairmanship of the District Collector
- Project Steering Committee (PSC) formed under the chairmanship of the Commissioner-cum Secretary to Government, Housing and Urban Development Department, Government of Odisha

The slum and ward level meetings mainly focused on community mobilization towards identifying the sanitation/FSM issues at community level, creating demand to address these issues, institutionalizing the community monitoring processes and basically building bridge between communities and ULBs. Women participation is institutionalized in these platforms through their representation. In Slum Sanitation Committee, the representation is more than 50%.

Figure 35. Slum sanitation committee meeting (Source: Arghyam)

Outcomes and impacts: sustainability, challenges

- **Both the State Government and ULBs demonstrated commitment to urban sanitation service delivery in small cities**: A MoU was signed with the State Government addressing support and a vision of success for the project. The Dhenkanal Municipality passed the Council Resolution committing itself to support the pilot project and provide land for the project implementation.
- **The technical capacity of the State and ULB augmented during the grant period for effective sanitation service delivery:** The Project Management Unit was established both at the state and city levels for effective sanitation service delivery.
- **Small cities introduced to data-based planning tools:** A baseline survey in the pilot town was conducted and GIS maps developed.
- **Community level demand generation for city-wide sustainable sanitation solutions:** The IEC strategy and Sanitation Communication Report were developed and Community engagement structures (Committees) were set-up and made functional for increasing community level demand generation.
- **Urban sanitation training programs institutionalized in regular state training for urban cadre:** A capacity building needs assessment report was developed and training modules were developed.
- **The international exposure visit** of the State Government officials to Indah Water Konsortium, Malaysia resulted in principle in approving an investment plan for septage management. The national exposure visit of the political representatives resulted in changing attitude and support towards Fecal Sludge Treatment Plants.
- **Community level awareness programs** resulted in changing attitude and behavior of the slum dwellers towards keeping their environment clean and also increased their negotiating skill for fulfilling their demands.

Challenges

- **Lack of awareness & preparedness at city and community level:** Since FSM is the new concept in the state, the lack of knowledge, capacity and resources available at the city and community levels become stumbling block to achieve the desired success.
- Despite the fact that there is a commitment of the State Government (and the Urban Local Body) to advance FSM, systemic shortcomings slow down the adoption and spread of good FSM practices, such as:
  - **Lack of timely support from Government to implement the program:** The delay in the approval process in the State Government and district level administrations affects the timeline of the planned activities of the project. For example, the district administration in Dhenkanal took more than a year to allot a land for the project.
  - **Allotment of land for FSTPs**: The identification and selection of suitable lands is a long process due to the existing Government norms and procedures. The involvement of several departments (revenue, forest, urban etc.) in the selection of lands and the procedure followed at every level is time consuming.

- **Change in Bureaucracy**: The frequent transfer of Government officials at the state, district and city levels has a major impact on the project implementation. In the first year of the project, one Deputy Secretary and two Joint Secretaries have been transferred at the state level. The District Collector was transferred, four Executive Officers got replaced and Divisional Forest Officer, Dhenkanal got transferred. This requires tremendous efforts to update the new officials on the project.
- **Political dynamics at the city level**: The lack of majority of the ruling party in the Municipal Council and internal opposition to the Chairperson affected the project deliverables in time.

Key messages

- Appropriate engagement of stakeholders in various project intervention processes would create better results
- Mass awareness is required to institutionalize the FSM concept at state level
- Process for land allotment to the project should be started from the beginning of the project implementation in view of the lengthy governmental procedure and process
- Land availability and allotment is a critical requirement for a successful implementation

2.3.3 Human resource development

Cases on the development of human resources for sanitation and wastewater management through the establishment of professional organizations and systems for the training and qualification of technicians/engineers

(1) Japan Sewage works Agency (JS) as a pool of human resources for nationwide sewerage system development

The Japan Sewage Works Agency or JS (originally named: the Japan Sewage Center) was established by the Japan Sewerage Works Agency Act in 1972. In Article 1, the purpose of this agency is described as follows:

"JS shall construct, operate and maintain the main sewer system facilities based on requests from local governments. JS shall promote the improvement of sewer systems by offering technical assistance relating to sewage works, training sewage engineers and pursuing research and technology development on water pollution control for possible practical applications. The objectives of JS are to contribute to the improvement of the living environment and to the preservation of water quality in public water areas by the means of the above stated activities."

The Japan Sewerage Works Agency Act, Article 26 shows the following operations to achieve the objectives stated in Article 1:

"1. Based on requests from local governments, JS shall construct wastewater treatment plants (WWTPs), their connecting trunk sewers and pumping stations. (As shown in the following figure, JS has constructed 70% of the municipal WWTPs in Japan.)

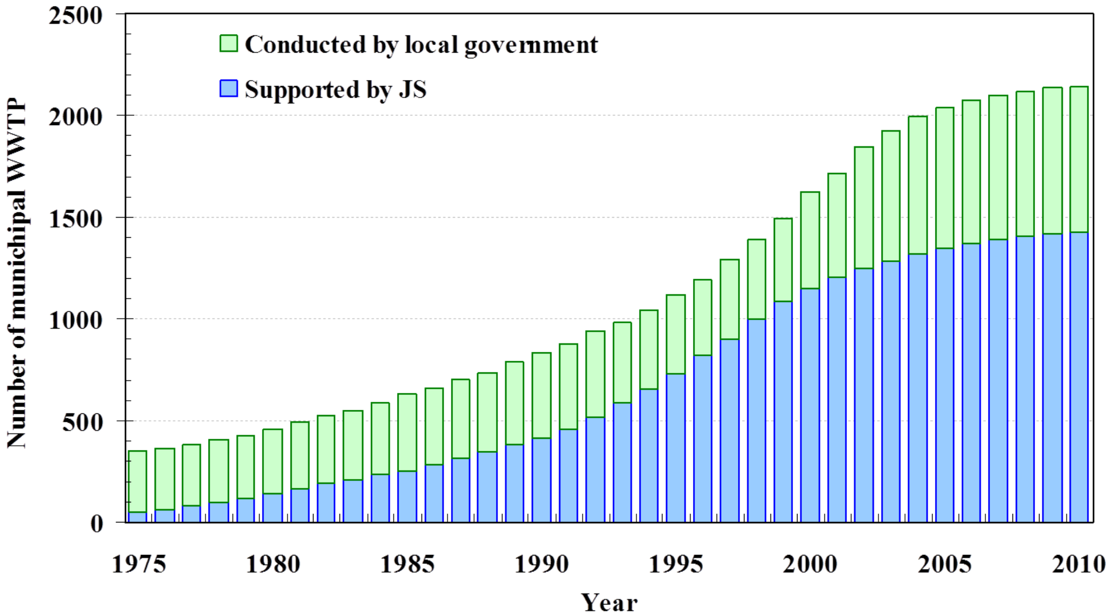


Figure 36. Number of municipal WWTPs supported by JS in Japan
(Source: Japan Sewage Works Agency-JS)

2. Based on requests from local governments, JS shall design sewer systems, supervise and control sewage works, and operate and maintain WWTPs and pumping stations.
3. Based on requests from local governments, JS shall provide technical assistance for sewer system planning, undertaking projects, and operation and maintenance of sewerage facilities.
4. JS shall train and develop sewerage engineers and certify supervisory personnel for designing, supervising, and controlling sewage works, and operation and maintenance of WWTPs.
5. JS shall encourage sewerage technological development, research studies, experiments and the dissemination of their results."

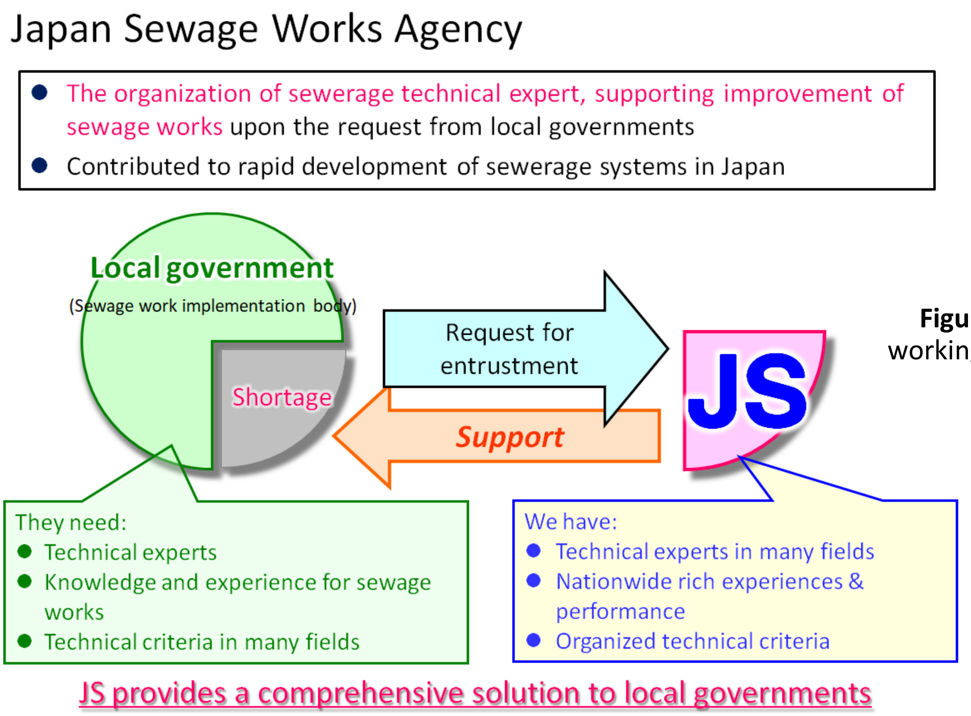


Figure 37. Outline of JS working framework in Japan
(Source: JS)

JS's training programs started at the same time as the Japan Sewage Center established in 1972 to develop sewerage experts in local governments. As of July 2016, more than 70,000 trainees have completed the programs. Since sewage works requires a wide range of specialized knowledge, such as local administration, civil engineering, architecture, machinery, electricity, chemistry, and biology, it is very important to secure human resources with such expert knowledge for local communities.

JS provides six training courses in Planning, Sewerage Management, Design, Construction Supervision, Operation and Maintenance, and International Projects as well as technical subjects in each course. JS training programs accept 1,700 trainees per year in JS's lodging facilities located in Toda city in the prefecture of Saitama. These trainees consist mainly of officials from local governments in charge of sewage works. JS is proud to contribute to the improvement of sewerage technologies and the development of sewerage experts as the sole training organization in this field. JS will keep encouraging training programs for local governments or open JS's training programs to the private sector in order to meet client's needs.

(2) Japanese experience on training technicians for on-site sanitation and wastewater management

The spread of Johkasou (Packaged Aerated Wastewater Treatment Plant or PAWTP) in the 1960s resulted in a huge shortage of PAWTP technicians, such as installation workers, O&M operators, desludging workers and inspectors. To meet the demand for PAWTP technicians and establish as permanent measure an education system for PAWTP technicians, Japan PAWTP Education Center, the precursor of the Japan Education Center of Environmental Sanitation (JECES), was founded in 1966 with the support of administrations and PAWTP related organizations for PAWTP business. From then, a technical training system for on-site wastewater treatment based on the Waste Disposal and Public Cleansing Act was established. It has since developed along with the PAWTP industry.

When JECES started in 1966, two training courses were launched: a 'A course' for operation and maintenance (O&M) technicians, and a 'B course' for desludging technicians. Another course for PAWTP installation workers was launched in 1972, followed by a course for PAWTP inspectors in 1980.

The technicians trained through these courses were formalized by the PAWTP Act later and were certified as PAWTP Installation Workers, PAWTP Operators, PAWTP Desludging Technicians and PAWTP Inspectors, respectively.

When the PAWTP Act was enacted in 1983, a new course for PAWTP Technical Supervisors, which is legally required for the management of PAWTPs larger than 500PE, was created.

In 1984 and 1985, the national examination for PAWTP Operators and PAWTP Installation Workers started. These two certifications can be obtained by passing the examination or by receiving the training course.

Figure 38. Training course at JECES (Source: JECES)

JECES has been appointed under the PAWTP

Act as the agency responsible for the training courses and the agency for the examinations. Through the training courses and examinations, more than 3,000 PAWTP technicians newly join the PAWTP business every year.

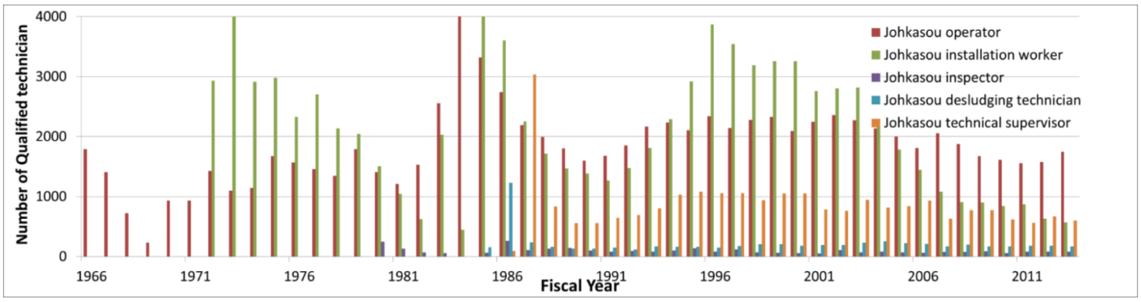


Figure 39. Number of qualified technicians for Johkasou installation and O&M in Japan (Source: JECES)

Certified technician/vender	Registrant/ number of venders	Business content	Legal basis
PAWTP Operator	80,042	Operation & maintenance	PAWPT Act
PAWTP Installation Worker	86,595	Installation/ construction	
PAWTP Technical Supervisor	29,794	Management of johkasou with 501 PE or more	Ordinance of PAWTP Act
PAWTP Desludging Technician	16,021	Desludging	
PAWTP Desludging Worker (Workers in the field)	13,560 app.20,000	Desludging under the guidance of Johkasou Desludging Technician	
Specified Inspection Agency (Registered PAWTP Inspector)	65 (1,280)	Johkasou inspection and water quality examination	
PAWTP maintenance vendor	12,435	O/M	PAWPT Act
PAWTP desludging vendor	5,291	Desludging	
PAWTP Installation vendor	28,356	Installation/construction	

(as of March 31, 2016)

Figure 40. Number of qualified technicians for Johkasou installation and O&M in Japan, and associated legal duties (Source: JECES)

2.3.4 Circular economy

(1) PUB, Singapore

Singapore is advanced in sewage works. The land area is very small and limited but with a population of around 5 million and a very high population density. Singapore is considered water-scarce, due to the limited land for the collection and storage of rainwater, the high evaporation rate and the lack of groundwater resources. To overcome this, PUB, Singapore's National Water Agency, was compelled to not only develop local water sources and increase reservoir storage capacity but also to look for innovative ways to diversify the sources of freshwater.

PUB is responsible for water, drainage and wastewater works. PUB has constructed the sewer network around the island city-state and wastewater treatment plants (WWTPs). Additionally, PUB has established a system for the reuse of treated wastewater.

NEWater of Singapore

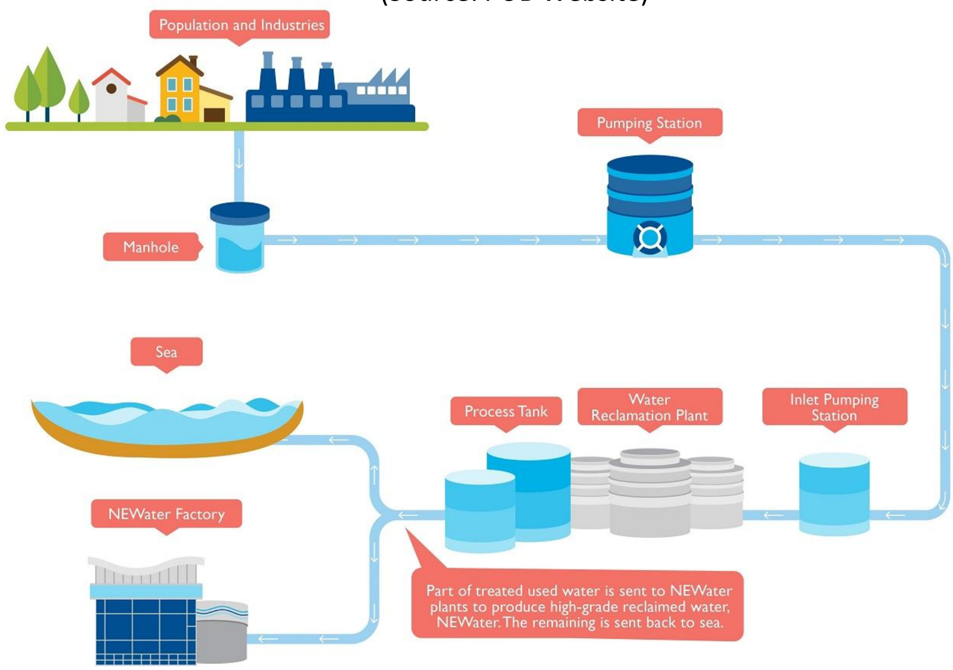
Singapore has been encouraging advanced treatment of wastewater and its reuse and already started using reclaimed water in February 2003. The water named *NEWater* is high-grade reclaimed water produced through a regular treatment in a WWTP followed by the additional three-step purification process.

PUB commissioned its first demonstration plant in 2000 and initiated an in-depth study on the suitability of NEWater for industrial use. An international expert committee reported that NEWater's quality was consistently safe and high, and well within the WHO and USEPA's requirements for drinking water. However, NEWater is not used for direct potable use. Today, five NEWater plants are in operation to meet up to 40% of Singapore's water needs. By 2060, NEWater is expected to meet up to 55% of Singapore's future water demand.

Most of the NEWater is directly supplied for industrial needs, including cooling water for air-conditioners and ultra pure water for the semiconductor fabrication plants. A small portion of it is added to reservoirs to blend with raw water before undergoing treatment through the conventional water treatment process for indirect potable use. *Indirect Potable Use* has a good record of 20 years in U.S.A. and some advantages. It can reduce the uncomfortable feeling that may arise with the process of reusing (treated) wastewater by mixing it with the reservoir water and supplement minerals that are lost through the treatment processes.

The *NEWater Visitor Centre* was opened in 2003 to enhance the understanding of NEWater. The center provides an exhibition of NEWater production process and an educational opportunity, especially for children, to learn about the safety of NEWater and water-saving.

Figure 41. USED WATER NETWORK
(Source: PUB Website)



(2) Sewage sludge utilization in Japan

As Figure 40 shows, nearly 80% of sewage sludge was recycled before the Great East Japan Earthquake in 2011. After the temporary increase in landfill uses caused by the earthquake, the rate of sludge recycling is getting increased again. Sewage sludge is recycled as construction materials, agriculture uses, and energy fuels. Building materials including cement are the most recycled elements. In "*Basic Plan for the Promotion of Biomass Utilization 2009*, the government of Japan set the goal to recycle 85% of sewage sludge by 2020 with the promotion of energy recycling including the production of biogas from sewage sludge.

Sewage sludge includes minerals recyclable as construction materials in the shape of incineration ash or slug. To encourage sludge recycling as building materials, the government of Japan modified/issued *Manual for Sewage Sludge Recycling as Construction Materials* in June 2001. The manual mentions about the physical/chemical properties of the incineration of ash/slug, the product standards of construction materials and their production methods, quality/safety management, and provides examples of products utilization. The manual also deals with a marketing strategy essential for the product distribution.

There are evaluation indexes for agriculture use, hygiene, safety, the effectiveness/handiness of fertilizers. One solution to meet the indexes is the aerobic fermentation or composting of dewatered sludge. Fermentation stabilizes the organic matter of sewage sludge, and the heat of fermentation inactivates pathogenic organisms with the high temperature.

Methane gas produced through anaerobic digestion process is high energetic. The energy can be used for gas power generation, heating digesters, and as a supplemental fuel of incinerators. However, an annual fluctuation of temperatures unsteadies gas demand. While in winter a heating digester requires additional digestion gas, it becomes excessive in summer. To enhance the usability of digestion gas as an energy resource, the excess gas needs to be stored and its supply stabilized through the year. When converting digestion gas to electric energy for recycling, the conversion efficiency and environmental impact should be considered.

Nowadays, sewage sludge recycling is a social demand in Japan and requires a further development of the recycling technology. At the same time, further understanding is needed for the components, properties, and features of sewage sludge. Considerations should also be given to social conditions for the adoption of the right recycling technologies matching sludge properties.

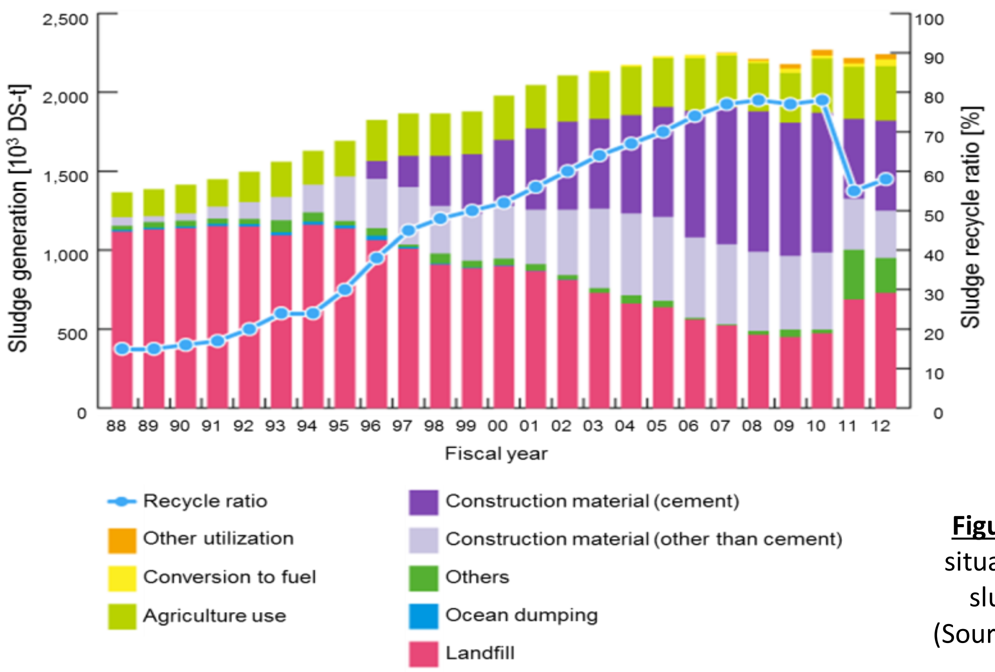


Figure 42. Current situation of sewage sludge in Japan (Source: MLIT, Japan)

2.4 Lessons learned from the case studies

(1) Sewerage system development supported by a good resettlement policy can contribute to the clean-up of rivers and a better life for all the citizens including low income populations.

(2) A combination of sewerage development based on the interceptor sewer system and septage management can provide affordable sanitation and wastewater management solutions in developing countries.

(3) Any on-site facility cannot function as a wastewater treatment facility and becomes a pollution source without a regular removal of sludge. Septage management is the key for the successful implementation of decentralized wastewater management.

(4) For successful sanitation and wastewater management, a substantial number of professional human resources who engage in the actual work of managing sewerage systems, operating and maintaining on-site facilities and conducting septage management are required. It is essential to create systems that promote, regulate and recognize these people socially.

(5) The creation of a circular economy is possible only if wastewater is properly treated and sludge properly collected. Sludge reuse and recycling must be pursued as a proper way of disposing of the increasing volume of sludge resulting from the development of sewerage systems and the establishment of improved septage management.

2.5 Actions and Sub-actions, and measures

Countries in the Asia-Pacific region are urged to mainstream wastewater management in their national development agenda together with continuous efforts for sanitation improvement. Since huge knowledge gaps exist in wastewater management among Asian and Pacific countries, creating the venue for knowledge and experience sharing is essential. The establishment of the Asia Wastewater Management Partnership (AWaP) proposed at the 3rd Asia-Pacific Water Summit will be an important step forward for the creation of such venue for knowledge sharing.

Promotion of knowledge and experience sharing through partnership: the Asia Wastewater Management Partnership (AWaP)

1. Background and Objective

In September 2015, the Sustainable Development Goals (SDGs) were adopted during the United Nations Sustainable Development Summit. Among these goals, the Target 6.3 on water quality and wastewater set the objective to halve the proportion of untreated wastewater by 2030. However, the current situation of wastewater management and the water environment in Asia is rather alarming with an increasing pollution load from municipal wastewater due to a rapid population growth in urban areas and a very low percentage of the population covered by wastewater treatment systems, particularly sewerage systems.

To support the activities of Asian countries towards achieving the SDG 6 targets, particularly Target 6.3, was held on 28 July 2016 in Nagoya, Japan, the conference on '*Watershed Management for Controlling Municipal Wastewater in Southeast Asia*'. During this event, the participating countries shared information about their current situation and issues related to the water environment and management of wastewater, and discussed the future developments of policy and infrastructure in the region. All the participating countries agreed on the necessity of promoting wastewater treatment in order to achieve the SDG 6 targets and, for this purpose, to share information and conduct continual discussions.

Based on the results of the conference and to promote the mainstreaming of wastewater management in the region, the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) of Japan and the Ministry of the Environment (MOE) of Japan agreed to create the Asia Wastewater Management Partnership (AWaP). MLIT formally proposed its establishment at the session entitled '*Improving Sanitation and Wastewater Management'*, which took place during the 3rd Asia-Pacific Water Summit in Yangon, Myanmar (11-12 December 2017). On the day following the summit was held the '*Preparation Workshop on the Asia Wastewater Management Partnership (AWaP)*', aiming for a common understanding on the problems to tackle for achieving the SDG 6 targets in addition to exchanging views on the concept of the partnership and its action plan. The six participating countries – Cambodia, Indonesia, Myanmar, Philippines, Vietnam, and Japan – agreed to partner for AWaP and work together to promote the diffusion of wastewater treatment and effective wastewater management in Asia.

2. Organizational Structure and Activities

As agreed during the Preparation Workshop in Myanmar, AWaP will be officially launched in summer 2018 with the holding of the first regular conference in Kitakyushu City, Japan. The partnership will consist of officials from central governments in charge of developing policy and infrastructure for wastewater management. The AWaP Secretariat will be managed and funded by Japan's MLIT and MOE, while the partnership will carry its activities with the expected collaboration and support of the Japan International Cooperation Agency (JICA), the Japan Sanitation Consortium (JSC), the Japan Global Center for Urban Sanitation (GCUS), and the Water Environment Partnership in Asia (WEPA). The collaboration with WEPA is particularly important as this organization has an significant network of 13 partner countries in Asia and substantial information on the water environment and policy in these countries, in addition to extensive knowledge on how to enhance water environment management.

The core activities of AWaP will consist of three main components:

1. Information sharing and networking:
   - holding of regular meetings with partner countries
   - discussion on the essential themes to focus on for maintreaming wastewater management, with a particular attention to awareness-raising, legislation, organizational and financial aspects, and technology
2. Provision of practical knowledge and know-how through an information platform:
   - building of a web-based platform to share practical knowledge on wastewater management in Asia
   - utilization of technical and legislative knowledge and information from JICA, MLIT and MOE projects
3. Execution of collaborative projects to tackle commonly shared issues:
   - launch of collaborative projects to address technical or legislative challenges commonly shared among partner countries leading to the preparation of guidelines and manuals.

2.6 Conclusion

In order to achieve all the tasks required to mainstream wastewater management, partnerships are essential to enable the sharing of knowledge, successful experience and good practices in sanitation and wastewater management. As illustrated by the case studies in this report, there are a few success cases in the Asia-Pacific region in sanitation and wastewater management. Although the number of these success cases is limited and remains exceptional undertakings, the experience of these cases is worth being shared with other concerned parties in the region. The acquisition of such knowledge can provide the tool for developing countries to tackle their sanitation and wastewater challenges in a shorter period of time than what has been required for developed countries. Therefore partnerships, existing ones for achieving the SDG sanitation targets and new ones such as the Asia Wastewater Management Partnership (AWaP) proposed by Japan, should be encouraged.

We are glad to report to the Regional Process Commission of the 8th World Water Forum that the proposed Asia Wastewater Management Partnership (AWaP) was a vehemently welcomed initiative by the participants of the 3rd Asia-Pacific Water Summit.

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