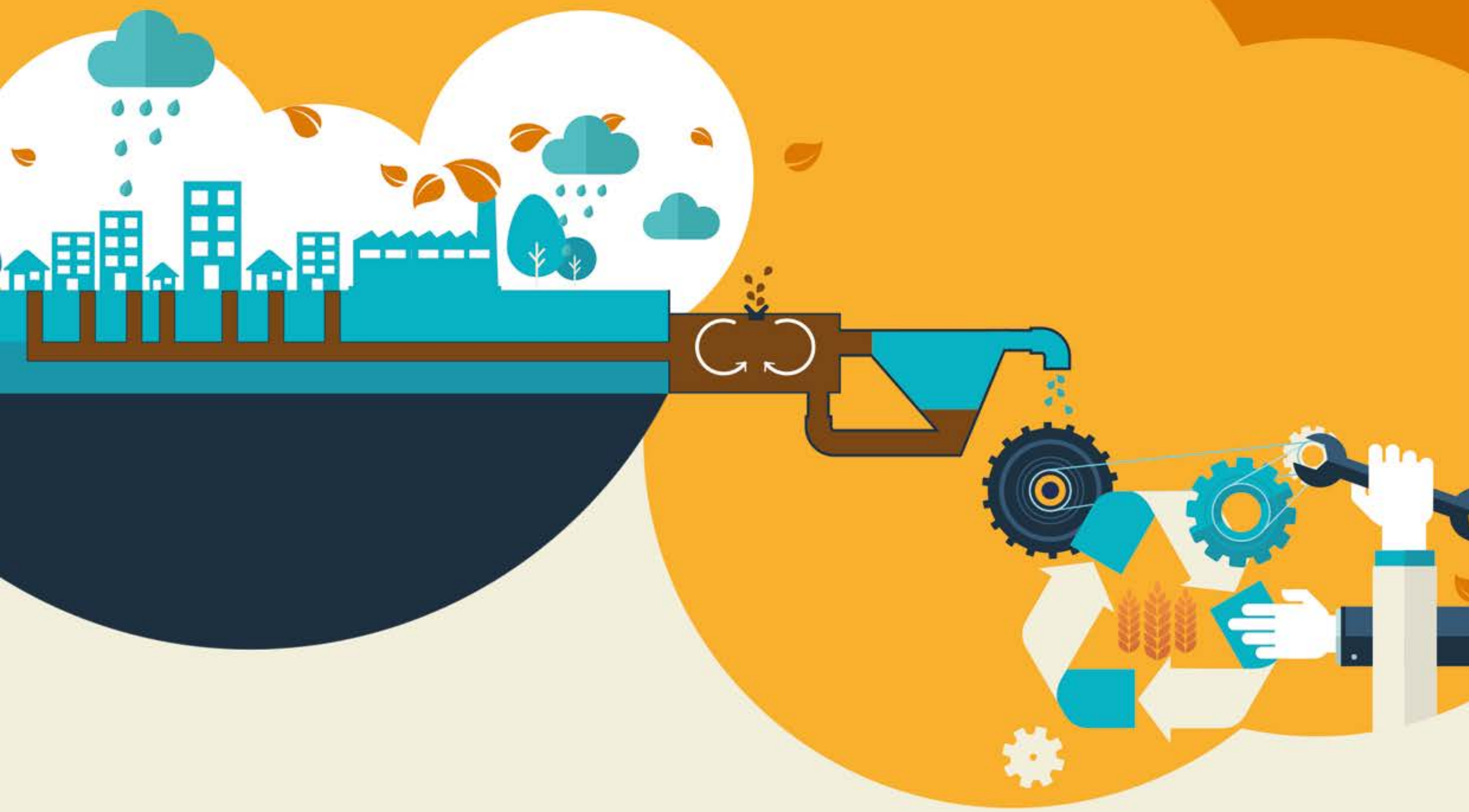
# Urban Wastewater Management

## Contributions for a post-2015 "Water" goal and for the 7th World Water Forum



**1- Collection, emptying and transport:**
a range of systems adapted to the type of housing

**2- Treatment:** rustic or technological? You must choose!

**3- Reuse of treated water and by-products:** confidence and moderation!

International workshop synthesis, 5-6-7th of November 2014, Colombes, France

Like the 5 other French river basins, the Seine Normandy river basin Agency is a public institution of the French ministry in charge of sustainable development. Its missions are to improve the knowledge of the water sector, aquatic environment, to finance the protection of water resource and control pollution.

The Seine Normandy river basin Agency is committed to restoring the function and biodiversity of the aquatic environment, protecting the groundwater catchments, controlling pollution in addition to promoting the integrated management of water resources and the democracy of water in the world.

**Website:** www.eau-seine-normandie.fr

SIAAP, Sanitation utility of Paris, evacuates and treats domestic wastewater, industrial effluent, stormwater and urban runoff produced by the 9 million people living in Paris urban areas. Once treated in one of the six SIAAP treatment plants, 2.5 million m$^3$ of water are returned to the Seine and Marne rivers.

Created as a public service in 1970, SIAAP became a local authority in 2000. Covering a 1,800 km$^2$ territory, good wastewater management needs specialized skills, forecasting operating systems and innovative treatment technologies. SIAAP is specifically involved in the protection of receiving water and in its territory sustainable development.

In the framework of the 1% Oudin legislation, SIAAP is actively committed to an international cooperation policy aiming to improve sustainable access to sanitation for people living in developing countries.

**Website:** www.siaap.fr

Created in 1905, ASTEE is the French scientific and technical association working on public services issues, in relation to environment and health. It brings together around 4 000 members, experts, researchers, scientists and practitioners as well as representatives of public and private organisations. The mission of ASTEE consists in carrying out in-depth reflections on the various methodological, technical and regulatory aspects linked to management of drinking water, sanitation and aquatic environments in France.

**Website:** www.astee.org

The French Water Partnership (FWP) is a non-profit organization established under the French Law of 1901. It was founded in 2007 on World Water Day.

It is a French platform for discussing and exchanging ideas that helps to place water at the top of the global political agenda. It also helps to share the collective know-how of French players throughout the world. The FWP now counts more than 120 members from the public and private water sectors.

The FWP consists of six panels made up of representatives from 1) the government and its public institutions; 2) NGOs, organizations and foundations; 3) regional authorities and parliamentarians; 4) economic players; 5) research and training establishments and 6) French and foreign private individuals. It carries out its activities in a collaborative manner, without any category of members taking priority over the others. Together they develop common, consensus-based messages and communicate them in European and international bodies and networks such as the United Nations, the European Union, the Union for the Mediterranean and at events such as the World Water Forum and the World Water Week in Stockholm.

**Website:** www.partenariat-francais-eau.fr

Created under the initiative of the French government in 1984, pS-Eau (Water Solidarity Network) is non-profit organization working towards universal access to water and sanitation. It is and coordinates an international multi stakeholder's network gathering together NGOs, local authorities, public institutions, research institutes, etc. with the aim to increase and enhance the actions being undertaken to improve access to water and sanitation in developing countries. Its main missions are 1/ to monitor scientific developments and improve understanding of the challenges facing the water and sanitation sector; 2/ to support French decentralized cooperation and non-governmental actors (local authorities, associations, etc.) in designing access to water and sanitation projects and improve the consistency of actions; 3/ to share information, discuss and campaign for universal access to water and sanitation, increase commitments and funding to the sector and facilitate debates on sector issues.

**Website:** www.pseau.org

# Edito

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Seine-Normandy
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(photo © AESN - S. Roudeix)

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(photo © SIAAP)

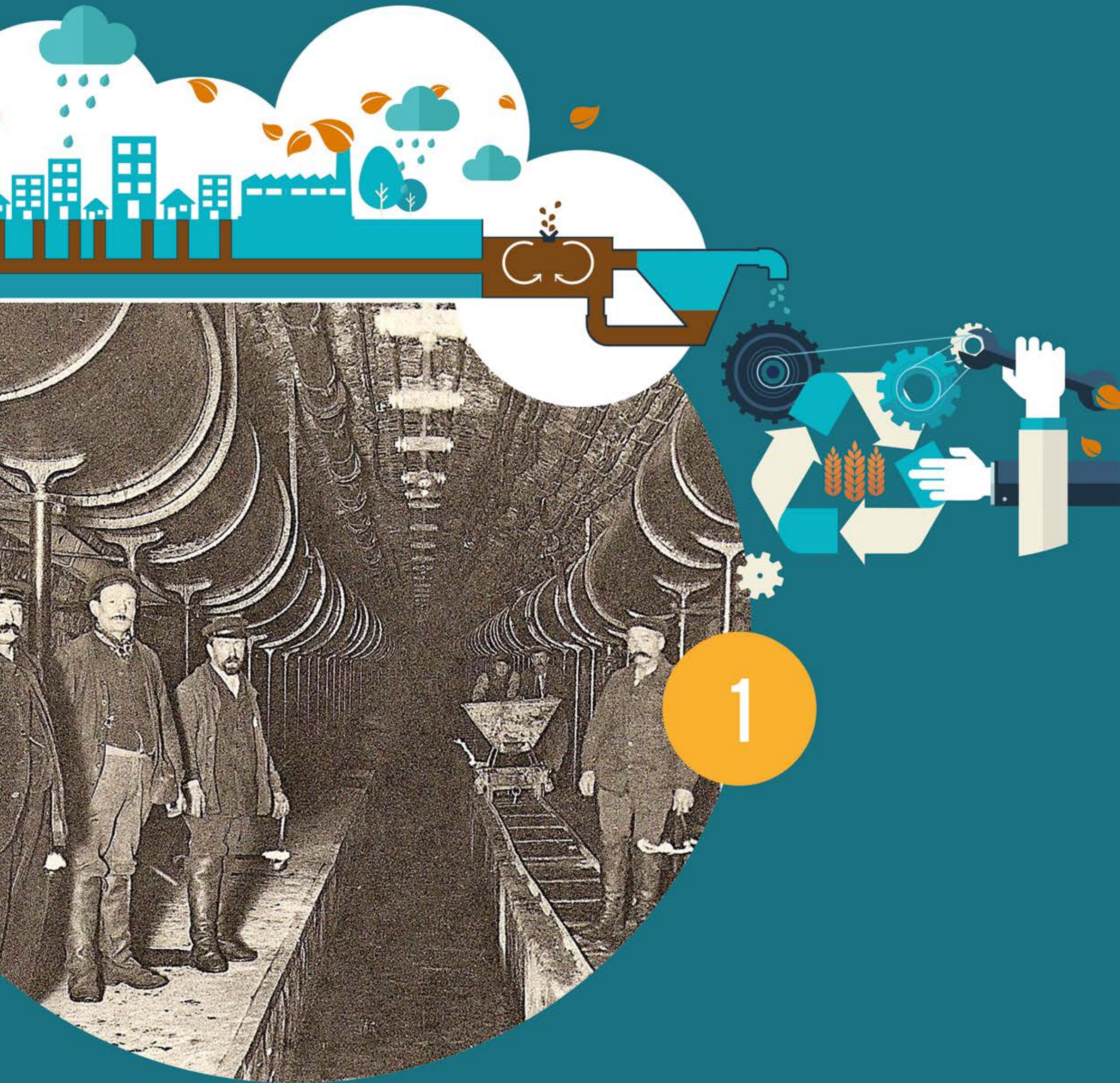
## MICHÈLE ROUSSEAU, SEINE-NORMANDY RIVER BASIN AGENCY DIRECTOR AND MAURICE OUZOULIAS, PRESIDENT OF THE SIAAP, SANITATION UTILITY OF PARIS

The international community is facing challenges for good sanitation that protects health and environment. Of course, important progress has been achieved since the 90s but it is still a long way from sanitation issues being taken in their entirety. We must insist on what takes place after the collection of waste water. Today, a new message must be brought to the international authorities so that the evacuation, treatment and reuse are properly managed.

It is a continuous and progressive process, a question of permanently improving the well-being of the population and the natural environment. In France, we have worried about the questions of sanitation for 120 years. But only in the last 50 years have we made real efforts to treat wastewater and protect the receiving environment.

Today we have a variety of solutions. The stake is not to yield to the temptation to stick to high intensity solutions using capital and technology in inappropriate contexts. There is no unique solution. Solutions must be adapted to the economic and social fabric upstream, and to the practices and in the environment downstream. Through their respective programs, the Seine Normandy River Basin Agency and the SIAAP promote this patchwork approach of the city and its sanitation.

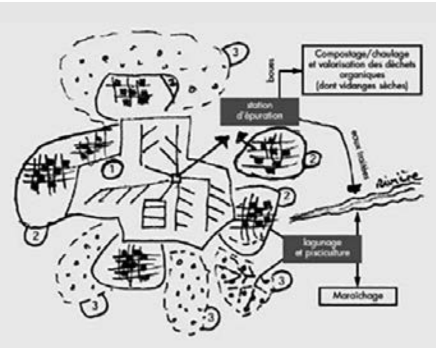
We have reasons to hope that our joint efforts will continue to influence the perspective of the next World Water Forum and the negotiation for the Unites Nations Millennium Development Goals.




# Collection, emptying and transport:
## a range of systems adapted to the type of housing

# Collection, emptying and transport: a range of systems adapted to the type of housing

**Collecting and disposing of wastewater and excreta is a key link in wastewater treatment.**

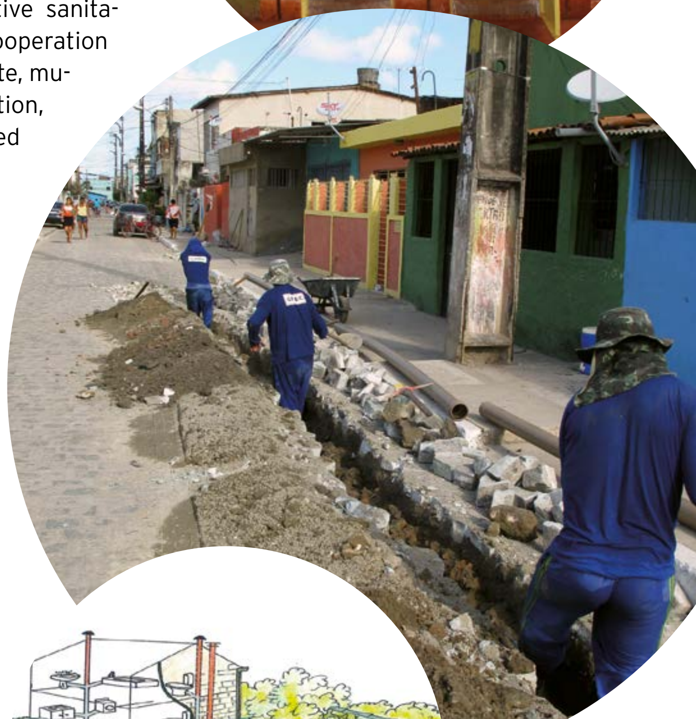


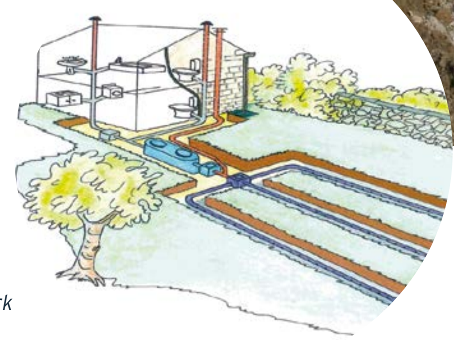

The issues and objectives related to collecting and disposing of wastewater differ according to local circumstances.

The choice of the system to be installed depends on the budget allocation for the project, the existing collection system (or lack of one), human resources available to manage the system and population density. On-site sanitation systems are a well-suited solution for sparsely populated areas or where the construction of sewerage networks is not economically viable or would pose technical problems (slopes, obstructions, etc.). There is, however, another form of collective sanitation called "non-conventional sewerage services" which can lend itself to intermediate contexts.
In addition, before embarking on any sanitation project, the sanitation zone must be defined, as Philippe Danois from the Seine Normandie Water Agency explains. Firstly, this makes it possible to choose the sanitation service (collective or on-site) best suited to each area based on urban planning and physical and socio-economic criteria. Secondly, it ensures that the network(s) are the right size and if a collective system is selected, the sewage treatment facilities too.

As such, following preliminary studies in Madagascar, the on-site option with a disposal management system for faecal sludge was selected to improve sanitary conditions when emptying latrines, transporting and processing sludge. In contrast to Hin Heup in Laos where water consumption levels per inhabitant are higher (75 l/d/pers), the GRET (a French Development NGO) opted for collective sanitation by building a small-diameter sewerage system and a DEWATS-type sewage treatment plant (decentralised wastewater treatment system).

In light of experiences such as these mentioned above, it transpires that installing an efficient collective sanitation system requires good cooperation between all stakeholders (State, municipalities and users). In addition, governance, a clearly divided responsibilities as well as support from local authorities and educating users (mains drainage doesn't mean anything goes!) are key elements when introducing wastewater collection networks.





*Urban patchwork*

# Lebanon:

## SIAAP cooperation activities to improve sanitation

**In Lebanon, where the sanitation sector is a real cause for concern, SIAAP has been undertaking cooperation activities since 2009 to assist municipalities.**

Lebanon has a population of 4.5 million, including 2 million Syrian refugees. The rate or urban development has been growing very quickly and the built-up areas have doubled in size in 30 years. Although it is a middle-income country, sewage management is lagging surprisingly far behind. Just 8% of domestic sewage is treated (compared to an average of 32% in the MENA countries (Middle East and North Africa) and all sewage from Northern Beirut is discharged directly into the Mediterranean Sea.

The sector is suffering from a vague legal and strategic framework, especially for the division of responsibilities between all those involved. Although a law passed in 1977 gave the municipalities the responsibility of collecting and transporting sewage, another passed in 2000 established water authorities and transferred these responsibilities to them, but did remove them from the municipalities. These water authorities now employ 1,600 agents with only 10 working on sanitation. The State, the water authorities and municipalities are delivering their projects separately without consultation or coordination. There are many networks without treatment plants at the outflows and most of the country's 15 sewage treatment plants are under-loaded due to a lack of collection and transportation.

Another problem in the way the sector operates is a lack of monitoring. Very little data has been collected by national institutions and they are sometimes contradictory.

Some innovative projects using consultation and a holistic approach of the sector have developed over the last few years and it would be interesting if these types of projects were to develop at a national level.

In this context, the SIAAP is undertaking initiatives to improve the sector. An initial project produced a working methodology to define wastewater management masterplans in the regions administered by 3 Federations in Southern Lebanon. This methodology was based on the involvement of all sanitation stakeholders in the regions concerned. Given the outcome of this initiative, the SIAAP, the Lebanese Committee of Mayors and the Technical Bureau of Lebanese Cities (Bureau of the UCLG in Lebanon) decided to roll-out this methodology to all Lebanese municipalities by implementing the ***"Support project to strengthen the capacities of Lebanese municipalities and local authority dialogue in the field of sanitation"***. The project began in 2013 and runs for three years. The data capitalisation stage was completed in May 2014 and numerous communication and information tools were employed as part of the project such as national seminars, local technical workshops, facilitated discussion groups, etc.

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# Municipal sanitation zoning in France

## The choice of sanitation system must take into account various criteria:

### Housing density:

In rural areas where homes are more dispersed, there is more space easily available for collective sewerage systems although installing such a network would require far too lengthy pipe connections per household. Conversely, in a very built-up area with high population density, the space available in building plots is often insufficient to install independent sanitation facilities whereas the density of homes makes a collective system perfectly appropriate.

### Soil type:

The purification capacity of land must be assessed by soil and permeability tests.

### Sensitivity of the receiving environment.

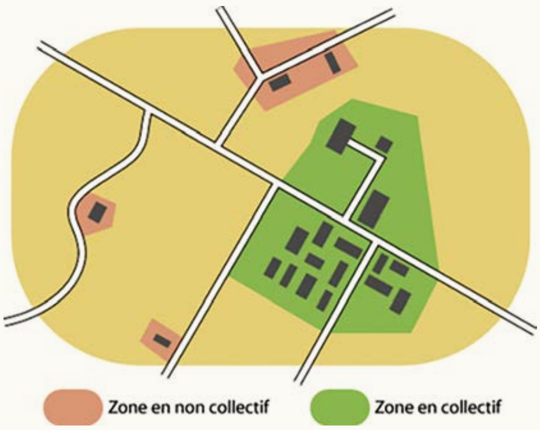
These different characteristics will have an effect on the cost of installing a public collection system. As such, if collective sanitation presents no environmental benefit and is excessively costly, it is better to opt for on-site sanitation.

When a municipality wants to add an extension to the network or a new sanitation facility, the size of the network or the sewage treatment plant must be determined. This involves stating what volume of effluents will be transited and subsequently the zones where homes will be connected up to the network together with those that will not. This is why, in France, sanitation zoning has been mandatory since the 1992 Water Law. In France, municipalities (or groupings of municipalities) are responsible for sanitation. They must define two types of zones based on their sanitation system:

- Firstly, there are collective sanitation zones, where municipalities are responsible for collecting domestic sewage and for storing it, purifying it then discharging or reusing all the wastewater collected.
- Secondly, there are on-site sanitation zones where municipalities are only responsible for checking sanitation systems and their maintenance (optional) to protect public health.

This demarcation exercise defines the sanitation zones and is subject to a public enquiry.

In an on-site sanitation zone, facilities are not connected to the public sewerage network. The difference between collective and on-site sanitation is therefore a legal matter and not a technical one. In collective sanitation, the municipality is the project owner while users themselves are responsible for on-site sanitation.

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# Madagascar :
## Operational implementation of a low-cost service to manage faecal sludge

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**Meeting sanitation needs in Madagascar is far from being achieved. The municipality of Ambositra, situated at the foot of mountains in the south of the country, is no exception. This town of 39,417 inhabitants has on-site sanitation, even in the town centre. In most cases, houses have simple, often unlined, pits (82%), or septic tanks (18%). Almost 600 pits are filled each year and they are emptied by manual emptying services that collect faecal sludge by hand without precautions (elevated health risks) and transfer them to a hole dug just a few metres away from the pit which leads to an accumulation of faecal sludge in the town centre.**

This is what forced the development of a project to manage faecal sludge in this muncipality. The project costs 35,000 Euros (over 15 months) and was funded by USAID as part of the WASHplus Project and delivered by the NGO, Practica, together with local partners such as the municipality of Ambositra and a building company and management service. The purpose was to introduce an improved emptying service which is both hygienic throughout the emptying chain, profitable in terms of financial viability, accessible to all and geared to local circumstances.

The system works as follows: when the latrine pit is full, the owner makes a telephone call or goes to the centre where they request a service assistant who visits the property to confirm the request by concluding a contract and making a survey of the site. Next, a team comes to the customer's address to remove and transport the faecal sludge to a site where it will be processed.

- A set of pumping tests were carried out when the sludge was removed, (Gulper pump, diaphragm pump, etc.) but blockages and clogging problems were encountered due to the consistency of faecal sludge and the presence of rubbish in pits. In the end, the pits were emptied through a combination of these tools together with other simple implements (buckets, pails and shovels) according to the nature of the sludge. Personal protective equipment was also used to limit health risks. The pit emptiers were given boots, gloves, masks, caps and overalls.

- The transport stage, when sludge is removed from the town, is a significant task for the service due to the logistical costs that have to be managed. A 1 $m^3$ trailer was tested at the beginning of the project followed by drums placed on the deck of a small truck. Trailer access in the narrow streets was however difficult although there were longer emptying, discharge and equipment cleaning times using drums rather than the trailer. Emptying times varied between 1-3 hr/$m^3$.

- The end of the processing chain is landfill. The choice focused on this technique for various reasons such as availability of land in the municipality where the water table was 20m deep with sludge being buried at a depth of 1.5m in a low-permeability lateritic soil. In addition, this fits well in terms of replicating and when we look at life-cycles and carbon emissions, a well-designed landfill site, requiring little work and imported material with local manpower to directly improve the soils, contributes to reforesting or to produce precious wood energy for the environment without the uncertainties of a compost industry. An investment of 2,000 Euros helped develop the site and protect drinking water facilities to guarantee water hygiene.

As concerns payment, a trial fee of 20 Euros/$m^3$ for emptied sludge was applied.

After operating for several months and with more than 80$m^3$ emptied, an appraisal made it possible to estimate that the emptying fee should be 28 Euros/$m^3$.

The positive outcome of this project is mainly due to the firm commitment of local stakeholders. Mr Ratsimba pointed out that as a result of this, the municipality introduced a decree banning traditional emptying methods.

One of the lessons learned during this experiment was that basic forms of technology are the best suited for starting-up a pit-emptying service.

In Madagascar, where no municipality is able to manage its sludge, the introduction of this type of service represents a huge step to develop a wider range of techniques for emptying pits. As such, this kind of project is tending to develop in other towns with the view to mainstreaming it throughout the country.

# Laos :

## Managing a small-diameter sewerage network with a decentralized treatment plant

**In 2010, the 2,000 residents of the small town of Hin Heup, in Laos, used on-site sanitation with a system of unregulated household latrines.**

In this context, the Gret, in partnership with the Laotian consultancy firm, WTA, began a 2.5 year pilot project in 2011 to install a small-diameter sewerage network and a decentralised sewage treatment plant. The challenge was huge given that there was no previous experience of this type of sewerage network in Laos.

The purpose was to support local and national authorities in defining and introducing the service. The first stage was to produce sanitation zones for the town, then to define technical solutions tailored to the space available, the urban development and local socio-economic conditions. Using this simplified masterplan, the option of non-conventional sanitation was selected for part of the town. The project then involved designing, building and commissioning this small-diameter sewerage network together with a decentralised treatment plant (anaerobic baffled reactor, sludge drying beds).

The management plan put in place was a form of delegated management by the district of Hin Heup (and contracting authority) with a local private sector operator based on a 15-year management contract. The operator's role is to run and maintain the sewerage system, to collect user fees and to be accountable to the local authorities which monitor the service and provide a conciliation role with users.

Another aspect of the project is to train the public authorities in undertaking project management for the service. This includes planning, financing, procurement, service management and monitoring, etc., accompanying the operator to take ownership of the service both technically and commercially and raise awareness and inform local residents about the sanitation service and good hygiene practice.

In assessing the outcome of this project, Frédéric Naulet emphasised the importance of being extremely thorough when conducting the technical sizing stage and to not under-estimate the financial aspects for the sanitation service (investment and operating costs), especially household connection costs. These up-front costs can represent a heavy burden and hinder households taking up the service. Also, no stage should be neglected, particularly initial surveys and analyses which make it possible to define appropriate solutions.

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# Non-conventional sewerage services

As previously explained, here are two main families of systems to meet household sanitation needs. These are on-site sanitation with individual systems built for each household and collective, conventional sewerage as has been developed in numerous urban centres. The limitations of these two forms of sanitation are however occasionally exposed and alternative approaches for collective sanitation have emerged. These options, called "non-conventional sewerage" are defined by the fact that they can overcome certain constraints of conventional sewerage systems (smaller pipe diameters, shallower pipe-laying depths, simplified connection methods, etc.) to reduce investment costs. In addition, these non-conventional sewerage systems often differ from their conventional counterparts by their scale (a district rather than an entire town) and by the allocation of responsibilities and the management method used. Given these features, non-conventional sewerage is a highly appropriate solution for specific urban contexts, but before embarking on installing such a system, it should be borne in mind that its management is complex and that a range of requirements have to be met.


With support from SIAAP, the Seine-Normandy River Basin Agency and the French Agency for Development (AFD), the pS-Eau studied various trials on non-conventional sewerage around the world. It subsequently produced a guide to help local decision-makers verify if non-conventional sewerage is an appropriate solution for their own circumstances and also to help coordinate their project in a coherent manner should they choose this option. It also provides a clear vision of likely management methods and necessary expertise.

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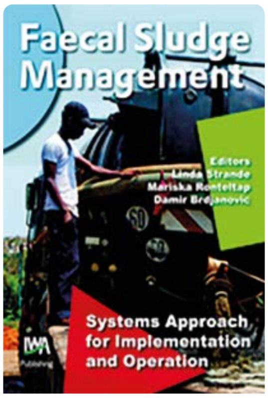
# Faecal Sludge Management: The new FSM Book

**Over a billion people in urban and peri-urban areas of Africa, Asia, and Latin America are served by on-site sanitation technologies. Until now, the management of faecal sludge resulting from these on-site technologies has been grossly neglected. Financial resources are often lacking, and on-site sanitation systems tend to be regarded as temporary solutions until sewer-based systems can be implemented. However, the reality is that onsite sanitation is here to stay, either as an intermediate or permanent standalone solution, or in combination with sewer-based systems. The appropriate and adequate management of faecal sludge deriving from on-site technologies is imperative for the protection of human and environmental health.**




Produced by Eawag-Sandec and partners, and published by IWA, this is the first book dedicated to faecal sludge management. It compiles the current state of knowledge of this rapidly evolving field, and presents an integrated approach that includes technology, management and planning. It addresses the planning and organization of the entire faecal sludge management service chain, from the collection and transport of sludge and treatment options, to the final end use or disposal of treated sludge. In addition to providing fundamentals and an overview of technologies, the book goes into details of operational, institutional and financial aspects, and provides guidance on how to plan a city-level faecal sludge management project with the involvement of all the stakeholders.

The book can be downloaded for free at:

**www.sandec.ch/FSM_book**

The Faecal Sludge Management book can also be ordered as a hardcopy at:

**http://www.iwapublishing.com**

Eawag-Sandec is currently searching for partners to fund the translation into French.

## An expert opinion:
# Stefan Reuter

### Improving sanitation: a challenge for the global agenda

In September 2015, Heads of State must agree on global targets for sustainable development. For Stefan Reuter, Director of the BORDA Association (Bremen Overseas Research and Development Association)*, the 7th World Water Forum in South Korea in April 2015 will be an excellent opportunity to work with Heads of State and various public and private sector stakeholders on sanitation-related issues.

Up to now, Millennium Development Goals were limited to access to sanitation without taking into account disposal or treatment. For Stefan Reuter, improving sanitation in developing countries must be done gradually. By introducing too stringent standards, States can discourage local grass-roots stakeholders from taking action. The "step-by-step" policy is the right solution in a sector where is still a lot to do!

**BORDA is a non-profit making association working in basic services, particularly sanitation.*

# Treatment:
## rustic or technological? You must choose!

# Treatment: rustic or technological? You must choose!

**Increasing urbanization together with new production and consumption trends in both industrialized and developing countries throw up new challenges for managing the water cycle. Treating wastewater from urban areas is part of this and everywhere it presents the dual challenge of protecting public health as well as the environment. The task is considerable since it is currently estimated that around 80% of sewage is discharged into the natural environment without any treatment whatever and this is over 90% for developing countries alone.**

Effective treatment systems tailored to regulatory, territorial, social, environmental and sanitary contexts are real guarantors of public health and environmental preservation. Together with the technical and financial capabilities of the authority responsible for this link, these systems must be set up before water is discharged into the receiving environment. These forms of treatment can use traditional tried-and-tested solutions or more innovative extensive or intensive systems, involving ecological engineering.

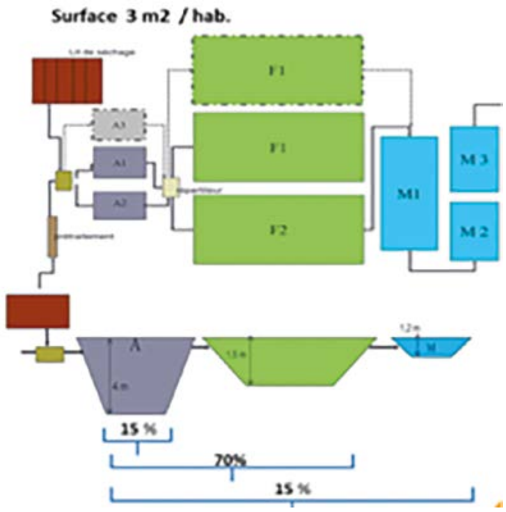
# Experimenting with stabilization ponds in **Morocco**: 10 years of practical experience

Since 2000, stabilization ponds are the most commonly used system in Morocco. At present, the Moroccan national masterplan has favoured this wastewater treatment technique for four main reasons:

- simplicity of use,
- performance in line with current wastewater discharge standards (which were still not very restrictive),
- reasonable investment and operating costs,
- a system seemingly geared to Morocco's weather conditions (sunlight and temperature).

Stabilization ponds were mainstreamed in all Moroccan regions and account for some fifty plants of the sixty commissioned between 2003 and 2014.

Stabilization pond treatment comprises a series of man-made basins. There are dozens of possible configurations around the world but the most common design in Morocco (70% of cases) involves 4-metre deep anaerobic ponds connected to 1.5-metre deep facultative ponds. In some cases, these are supplemented by 1.2-metre deep aerobic ponds (when bacteriological requirements impose them, especially for the reuse of purified wastewater for farming).




STEP BERRECHID – 100 000 EH
A + F + M

Stabilization pond plants built in Morocco vary in size. 75% of them are between 10,000 and 50,000 population-equivalent (PE) with the smallest being 4,000 PE and the biggest, 122,000 PE. The sizing method adopted uses empirical models taken from the work of Doctor D. D Mara and Doctor H. W Pearson (1998) and from biokinetic equations. The main size parameters are volumetric loading, surface loading and detention time.

Purification performance assessments were made over a 6-year period (2006 – 2012). Findings showed that hydraulic and organic loading rates were below the nominal capacities and that the principle size parameters such as volumetric and surface loadings were compliant. Some parameters such as DBO5 or DCO have non-compliant outflow values of 30% and 70% respectively. The performance range is still wide, from 37%-94% for DBO5.

Following analysis, it appears that algal blooms are one of the causes affecting purification rates. Some odour problems in the anaerobic ponds during digestion have also appeared in certain plants. Similarly, this system does not appear to cope with concentrated discharges. Finally, cleaning still represents a quite onerous task despite delayed sludge management (storage for 3-4 years).

Also, from late 2014 to 2015, trials with different pond configurations using various methods were carried out to control and limit algal production. These included, rock filters, floating baffles, sand filters, or plans for combining stabilization ponds with planted filters. The tendency is already to focus on transforming natural stabilisation ponds into aerated ponds (for large-sized plants or those with odour problems).

Stabilization ponds remain a useful solution given their competitive cost and simplicity of use. This system also provides good bacteriological performance.
The issue of managing algae still needs to be addressed although the local trend is to favour this technique for small and medium-sized communities. Feedback is expected in late 2015 to gauge the effectiveness of solutions tested and to possibly consider rolling this out to all existing stabilization pond plants.
Areas to improve this technique still have to be found through research and development for size parameters geared to the situation in Morocco.

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### Additional comments by French expert, Jean Duchemin (duchemin.jean@aesn.fr):

*"It is normal that anaerobic ponds develop odours at certain times when there is an imbalance in inputs like, for example, a sudden addition of organic effluents during inter-season changes in temperature. Ponds should be built a bit further away from settlements, or the whole treatment should be done in natural aerobic ponds.*

*To avoid strong algae concentrations in outflows from aerobic stabilization ponds, they should be left to grow (to absorb N and P in the effluent and to oxygenate it) then left to die back due to a lack of sustenance and settle. Each of these 2 phases requires about a month, so a total aerobic retention time of roughly 2 months is needed (i.e. 10m2 per PE which explains why this system is rarely used in Europe for conurbations above several tens of thousands of PE; detention time having been validated in France and elsewhere over the last 20 years after numerous monitoring activities on natural stabilization ponds) which is clearly greater, so it appears, than the size chosen in Morocco.*

*Rock filters are not very effective and micro-algae can clog up sand filters. Planted filters probably take up as much space as the proposed extension of aerobic ponds and require considerable plant maintenance. As for aerated ponds, these are as energy-intensive as activated sludge systems and require regular maintenance and sludge removal into settling ponds as well as having lower microbiological reduction rates than natural stabilization ponds."*

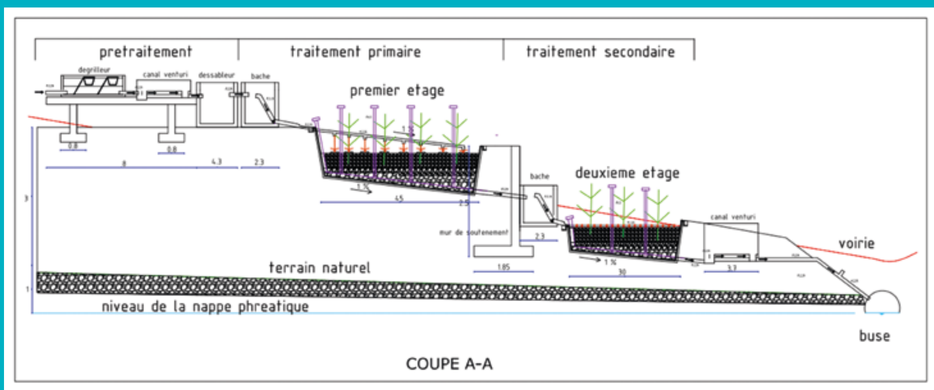
# Development of a wastewater treatment plant at Yaoundé

**Connection rates to collective sanitation in the town of Yaoundé are very low and account for around just 2% of the population. The five sewerage networks built in the 1980's are in a poor state and sometimes have no treatment plant. Collected wastewater is therefore directly discharged into the natural environment without any purification treatment.**

To illustrate this situation, here are a few problems identified on one of the networks (the Messa network):

- 22% of manholes are clogged up due to pipes being blocked by non-biodegradable objects located downstream from the network and 32% of manholes are inaccessible;
- Part of the pipes are broken, leading to periodic leaks;
- The pumping facility is out of order.

Faced with this situation, the Cameroonian government renovated three 1980's sewage treatment plants between 2010 and 2012. (Messa, Cité Vert and Biyem Ass). In addition, the Ecole Nationale Supérieure Polytechnique of Yaoundé came up with a technical and economic proposal to improve the Mendong network together with the development of a gravity-based treatment plant as part of the SPLASH Research Programme.

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# Durban :

## from installing decentralized wastewater treatment systems to energy saving

**In South Africa, the metropolitan municipality of eThekwini is using a low-cost global and sustainable approach to promote healthy communities. It also has a keen interest in resources provided by treated wastewater. This municipality is one of eight South African metropolitan municipalities, including the city of Durban and nearby towns.**

In this context, the German non-profit association, BORDA (Bremen Overseas Research and Development Association) is working with eThekwini Water and Sanitation Unit (EWS, one of eThekwini's municipal services) and the University of KwaZulu-Natal (UKZN) on the design and construction of a decentralised wastewater treatment system (commonly known as DEWATS).

This system's potential applies to sites where population density is too high to use individual sanitation solutions like latrines (due to public health concerns), or when connection to the public sewerage system is not economically feasible for technical (distance, topography) and hydraulic reasons (hydraulic capacity/ sewerage network load limits).

Downstream from a simplified sewerage network, the treatment unit comprises a first stage of settling which is easily achieved in warm and tropical climates. This is followed by an anaerobic digestion stage, finishing with a vertical or horizontal constructed wetland. This system reduces the organic load by 90%. The system is most commonly designed with gravity-based flow and, as such, no energy input is required. Although regular checks and maintenance are necessary, the DEWATS system is still user-friendly. As the system does not remove nitrogen or phosphorus compounds from wastewater, treated water contains nutrients which can be reused in irrigation.

The DEWATS system was trialled in the country's second largest industrial city which links a densely populated urban environment to more sparsely inhabited outskirts just a few metres from the ocean. The city's population rose rapidly and through a lack of resources over the last few years, there are atypical areas where several households share a septic tank. Elsewhere, around one hundred homes share non-conventional sewerage and even some immigrants go to public facilities to use the toilets. This situation was conducive to trialling the DEWATS system.

Progress has also been made in managing wastewater used in latrines (emptied every 5 years). This is then taken to plants where it dehydrated and pasteurised. The resulting products are used for burning or agriculture.

There are 80 000 urine diversion toilets installed in the municipality. Studies are underway to productively use both the urine and faecal material.

There are now more than 1,500 DEWATS systems of 1 to 1,000 $m^3$/day installed in whole districts, small and medium enterprises or institutions in Africa, Asia and Latin America.

In recognition of this technological innovation, BORDA won the "IWA Development Solutions" prize in 2011 while EWS was subsequently recognised as "the most progressive water utility in Africa" and won the prestigious "Stockholm Industry Water Award" in 2014.

Nevertheless, to improve knowledge (a lack of consumption data or reliable technical data), a more robust commitment is expected from national institutions so that they propose and pass laws and regulations and are more inclined to countenance these treatment systems. Finally, the challenge to accepting this type of project emphasises the complexity of the task which is not solely technical.

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# Half a century of urban wastewater treatment in France: a gradual move towards a reclamation plant

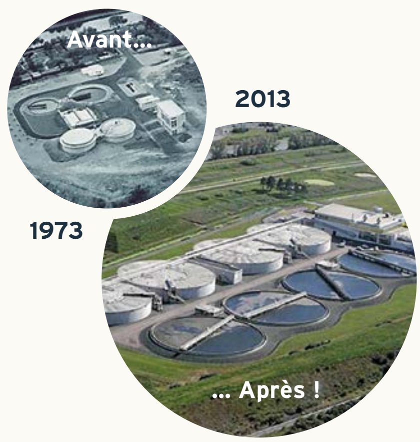
**In the beginning, effluents were often discharged into the natural environment with no prior treatment while later they were spread on land to fertilize. In the 20th century, with greater awareness about polluting the natural environment and the development of micro-biology, local authorities quickly realised that the natural self-purifying properties of micro-organisms (bacteria) in aquatic environments could be used to clean domestic wastewater. In 1914, the chemists, Adern and Locket from Manchester, presented a pond system in which wastewater was aerated to enable it to be broken down by micro-organisms present in the effluent and they submitted their first patent on "activated sludge".**
**In 1940, the Achères sewage treatment plant in Paris area was commissioned. Using activated sludge techniques, it inaugurated the first biological sewage treatment plant enabling a more thorough treatment. It was however not until the 1960's that the installation programme for sewage treatment plants really took off in France.**

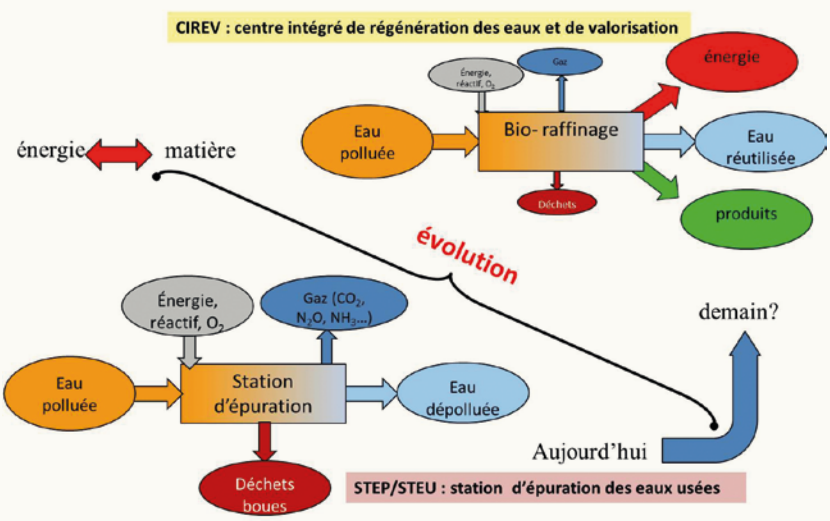
The first sewage treatment plants that appeared were designed to treat organic matter (DBO/DCO) then gradually, the nitrogen burden was taken into account, which was essentially in its ammoniac form as concerns urban wastewater. It was only recently that sewage plants included the elimination of phosphorous as this was the parameter that had to be controlled to avoid algal blooms in rivers (the phenomenon of eutrophication). Technically and economically speaking, biological treatment is the best-adapted method to treat contaminants in urban wastewater. When stringent requirements on discharges linked to fragile receiving environments apply, a physical and chemical treatment of phosphorous is often necessary.
Over time, the expansion of pollution parameters, reliability requirements as well as minimising impacts on the receiving environment during low-water periods consequently led to a rise in land expropriation for activated sludge systems which is the most commonly used technique. The effluent detention time in these kinds of sewage facilities built today has subsequently changed from a few hours for initial heavy-loaded activated sludge to practically 24 hours for low-loaded activated sludge. To address local constraints on available space and in particular, landscaping, compact systems are now offered such as membrane bioreactors and biofilters, etc.

Systems introduced in small sewerage treatment plants (of <2,000 population equivalent), which account for 80% of French plants, have suffered from changing fashions. Activated sludge systems were built in the 1970's, followed by stabilization ponds and sand filters. Today, this has resulted in a range of capabilities with the mainstreaming of reedbed filtration systems.

Among recent developments, the relatively frequent appearance of buffer zones between the sewage plant outlet and the discharge point into the receiving environment should also be noted. The role assigned to these dispersion zones has not always been clearly stated and their size has not been fixed. This is an area of biodiversity alternating between planted ditches, water bodies, wetlands, etc. which takes up space and requires regular maintenance.

Today, the design of sewage system is rapidly evolving to include the desire to make use of the energy potential from organic matter, to recover by-products, to minimise waste and to re-use treated water.

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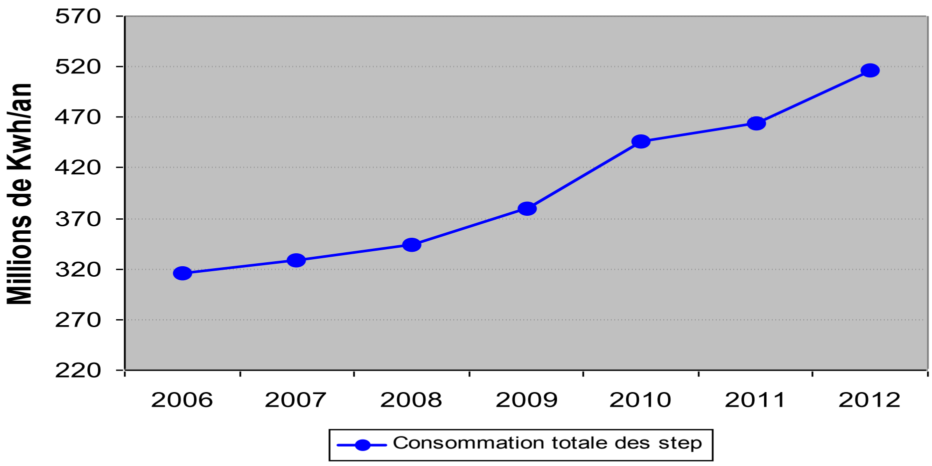
# Advocating for technical and energy optimization in sewage treatment plants

**This announcement is for all decision-makers (from the construction process through to commissioning) who want to manage energy requirements for their sewage treatment plants in this context of crisis.**

The preferred method is based on an overall analysis of data collected from self-monitoring a sample of more than 600 sewage treatment plants with a capacity in excess of 2,000 population-equivalent operated by the Lyonnaise des Eaux Company, in France. The purpose is to find the best compromise between purification and energy efficiency.

This analysis on energy consumption highlights a growing trend which mainly applies to the most recent sewage treatment plants. This rise is partly linked to the fact that new plants are more complex, more efficient and more energy-intensive than older plants.




In parallel, it can also be seen that total effluents received has not risen over recent years. Consequently, the energy ratio of plants is rising and adds to the energy bill for these new facilities. This rise in consumption can also be linked with the regular decrease in plant filling rates (received organic load/nominal load), which handicaps the operation of plants running almost permanently under-capacity.

To improve the situation and move towards the best compromise in technical and energy terms, recommendations have been put forward, most of which stem from observations in the field.

**For more details:**
**please see the article on this subject published TSM magazine, issue 1/2 - 2015 - 110th year**

These recommendations concern sewage treatment plants from project design right up to commissioning. Most of them can be applied to all plants, but especially for activated sludge systems that are operating when significantly or very significantly under-loaded for most of the year.

Among the twenty or so important recommendations proposed, there is:

- the importance of interconnections between facilities
- adapting the number of treatment lines or facilities to the real load that must be processed
- importance of a thickening stage when processing takes place on lowest weights of sludge, etc.

Monitoring these recommendations will enable better management of sewage treatment plants that are under-loaded for long periods.

# 3

# Reuse of treated water and by-products: confidence and moderation!

# Reuse of treated water and by-products: confidence and moderation!

**Over the last ten years there has been significant growth in the re-use of wastewater and recycling treated wastewater is now seen as a new and important resource. It contributes to preserving the environment and, more generally, to the integrated and sustainable management of water resources.**

There are many benefits from re-using wastewater, including:

- quantitative and qualitative health and environmental benefits such as preserving groundwater/recharging aquifers, particularly for protection against saltwater intrusions in coastal areas, respecting sensitive areas by not discharging in them, etc.;
- economic benefits such as a reliable source of constant-volume water detached from climate hazards/rising agricultural production in drought-prone areas.

While re-using water is simple in principle, it is nevertheless complicated to put into practice as can be seen by the difficulties encountered when setting up projects. The issue of social acceptance occasionally leads to excessive legal and regulatory precautions as agronomic, health and environmental risks must be avoided.

Apart from re-using water, there are many other resources that can be recycled or produced from sewage by-products. These include green energy (biogas) or organic fertilisers. In the current context of scarcer resources, reclamation has been optimised and its environmental impact is restricted through making these by-products more hygienic according to requirements (composting, for example) and limiting micro-contaminants at source. These processes therefore require informing users and raising their awareness.

# Giving water a new lease of life in **Australia**, but at what price?


**Due to current climate change and rising water needs, much of Australia has recently been dealing with a long period of drought (2000-09). It was almost inevitable that Australia had to review wastewater reuse. At the moment, wastewater is predominantly used, for irrigation, dual reticulation (gardens and toilets) and replenishing some aquifers used to supply fresh water.**

To ensure public health was not compromised and reassure the public that recycled water was safe, water treatment systems were chosen to limit residual pathogen-related infection risks to below background levels. Pathogen reduction levels, compared to levels in raw wastewater, are set based on the use of recycled water making it fit for the intended purpose. Pathogen reduction required is at least 100-1000 time (2-3 log10) by treatment and 10,000 to 100,000 (4-5 log10) by on-site controls (e.g. no public access) to irrigate crops that are not consumed in raw form. Even higher removal rates are required for crops consumed raw. In practice though, these levels are generally higher as the precaution of multiple barriers (primary, secondary treatments, membranes, UV, etc.) and high removal rates is practiced to err on the side of safety (be precautionary) and help achieve a high level of public acceptance. These treatment reduction thresholds require techniques such as UV lamps and/or ozonisation which are both very expensive to purchase and operate, where on-site control measures can usually be achieved at much lower costs.

Australia finds itself facing a problem with the economic viability of some of these treatment techniques in some recycled water schemes. For example, the treatment cost of recycled water for irrigation is too expensive compared with more traditional sources of irrigation water. Consequently, there is need to increase the price of recycled water, however, this limits the acceptance of recycled water for other reasons. Now that many areas of Australia are not so reliant on recycled water (although rainfall and runoff seems to be decreasing again in 2014) the balance between water supply security in the future (partly provided by recycled water) needs to be balanced with the ongoing costs of water recycling and protecting human health protection.

Research projects are currently underway to help restricting production costs and verifying treatment systems for recycled water. Water authorities are also seeking to provide, where possible, recycled water for low risk crops/uses, where the risk of human exposure to the water is minimal. However, community action groups worried by public health risks, combined with the fact the water authorities must ensure human health is not compromised, usually leads to the use of very high treatment standards in Australia (as described in the Australia Guidelines for Water Recycling).


Indeed, some Australian consumers may have a poor image of recycled water, viewing it as "toilet to tap" water. Doctor D. P. Stevens thinks these fears are unjustified and show a genuine lack of understanding about the water cycle and safety factor in treatment and onsite management of recycled water schemes. According to him, the health risks of this type of water must be put into context. «Treatment levels selected for many scheme developed in the 2000's were over precautionary and caused an increase in production costs for recycled water. Finally, to give these techniques a chance, the consumer must accept this type of water, trust water authorities and their treatment systems and understand that recycled water quality presents no concerns for their health".

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# A range of technologies to match quality and uses in **California**

For several decades now, Southern California has been suffering from acute water shortages which have forced it to import most of its water from neighbouring regions. This accounts for around 80% of its drinking water needs. To reduce this dependency, the public agency, West Basin Municipal Water District, which is tasked with supplying drinking water to the county of South West Los Angeles has embarked on an ambitious programme to re-use water. Among other things, it has financed the construction of a state-of-the-art plant to recycle water to:

- reduce dependence on external supplies (80% in 1990 to 66% in 2010);
- control saltwater intrusion;
- and have a quality water geared to every type of use (industry, irrigation, recharging drinking water aquifers, etc.).

The plant and its ancillary buildings have a production capacity of 240,000 $m^3$ of 5 different types of recycled water quality to cover various uses while avoiding discharging these volumes into Santa Monica Bay:

- 70% undergoes filtration and disinfection treatment and is used for irrigation, watering public and private gardens and supplying cooling towers in neighbouring refineries;
- 30% undergoes microfiltration and single or double reverse osmosis treatment. This is destined for indirect drinking water (recharging aquifers) and supplying boilers.

Costs vary according to quality. For the 3 least-demanding qualities, (which account for 70% of treated wastewater) recycled water costs less than drinking water. By contrast, for the two remaining qualities (where reverse osmosis technology is required which might appear extreme and energy-wasting to simply recharge aquifers), the cost of water produced is 2-2.5 times higher than for drinking water.

Although this project is economically viable, its success stems primarily from the involvement of all stakeholders such as public sector, industry, water producers as well as a balanced split of the costs and production of tailored quality water for every type of use.

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# Ecological sanitation in the "Ger" areas of **Oulan-Bator**

In Mongolia, there has been a considerable rural exodus and there are more and more people living in urban-fringe areas. However, access to water and to wastewater treatment services remains very low in the outskirts compared to the city-centre. In the capital, Ulan Bator, daily water consumption per inhabitant is more than 400 litres compared to 10 litres in the outskirts. City-centre homes are connected to the wastewater collection network while there is no such sanitation service in the outlying areas of the city. An" Action Against Hunger" NGO, project was undertaken to try to address inequalities in access to wastewater treatment services.

Replicating the city-centre model in the outskirts would not be environmentally sustainable, so the choice focused on dry toilets that could be emptied together with sludge composting. Opportunities in farming and restoring soils after mining activities have been considered.

Comfortable and well-insulated toilets have been built to encourage local residents to use them. The cost of emptying them has been set at 4 Euros.
The composting site is outside the city and its design was considered in relation to adapting to local weather constraints.

The composting platform is formed from two well-insulated containers joined together. As the insulation was insufficient, a Canadian well was built to recover geothermal heat from beneath the frozen earth. As a result, air was collected at the right temperature to trigger composting.
Those emptying the toilets can unload their trucks on the platform where sludge is mixed with sawdust and straw to prepare the compost which will then be processed at more than 60°C (natural aerobic fermentation) for more than 3 days to achieve optimal hygiene levels.
The temperature rises for several months and it is possible to increase compost volumes. During winter, the emptied sludge freezes and can therefore be stored for processing in the summer and by doing so, ensure the facility's long-term viability.

No legal texts or official directives have been established on the use of this compost and local people are still wary of accepting crops from fields that have been indirectly fertilized with human excreta. This solution can be substituted by other uses, especially restoring soils and for green spaces. The composition and agronomic value of the compost can also be displayed on the sacks and reference to its various components omitted while ensuring good levels of hygiene during the composting process (temperatures rise to in excess of 60° in the pile).

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# "And what if we sorted our wastewater too?"

In the Île de France (area surrounding Paris, in France), population projections indicate significant growth with more than one million additional inhabitants by 2030. This equates to a 10% rise in nitrogen and phosphorous-rich effluents that must be removed or recycled in the sewage treatment plants run by SIAAP.

Current treatment systems in the sewage plants cannot make the most of these elements. For nitrogen, the denitrification process in place only produces a nitrogen recycling rate of around 30% as most of the nitrogen is rendered volatile in the form of nitrogen gas. However, if urine, which is rich in urea, is separated at source from the rest of the effluents, the recycling rate could be in excess of 80%. In addition, processing water with the urine removed is simpler.

The development project for the Grand Paris area could mark an opportunity to build in the selective collection of urine beginning with the design of homes and thus reduce the quantity of nutrients discharged. Collecting urine from one million residents could help avoid a new tranche of sewage plants.

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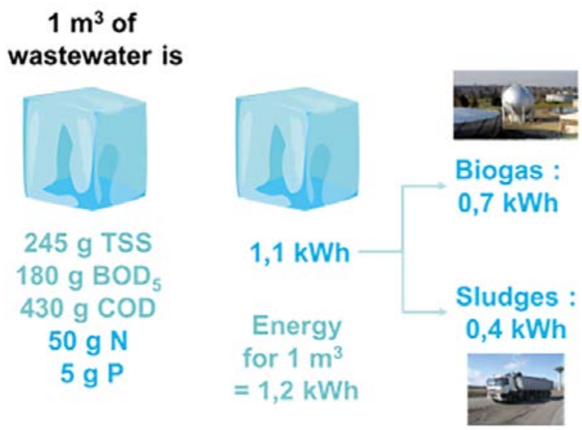
On a technical level, a system geared to store and transport this urine should therefore be introduced, thus giving back the collection workers their place. But this selective urine collection project must overcome sociological scrutiny to ensure that it meets the needs of potential populations and agricultural users.

In terms of energy, sewage plant sludge has significant potential and changes in regulations now make it possible to inject biogas into the public gas network which provides some interesting perspectives.



# Sustainable project management in water and sanitation sectors in the municipality of Bangangté, Cameroon

Since 2011, the municipality of Bangangté has been delivering a programme to improve conditions to access water and sanitation for the communities in its area. This targets improvements to public services for the population. This process is accompanied by a sector-based policy which is intended to embrace local initiatives and provide for transferring the promotion, financing and governance of water and sanitation systems to municipalities and urban groupings.

The sanitation component: fifteen ecological toilet blocks installed in schools and markets in the municipality. In parallel, public awareness activities to promote hygiene have been undertaken to ensure that good use is made of the toilets and that they are well-maintained.

Infrastructure management:
A Public Water (SPE) and Sanitation Service for the Municipality of Bangangté has been established. It is currently operating with 3 municipal officers who have been specially trained for these tasks.long-term future of the facilities:

- Environmental Education Councils in schools: CM1 and CM2 pupils supervised by teachers ensure that the toilets are regularly maintained and fertilise the fields with hygienized urine. Consumables are funded by the Parents Association.
- Market toilet managers: market managers collect fees (50 FCFA for the WC's and 25FCFA for urinals), maintain the toilets and provide consumables (water and soap to wash hands).

MODEAB's choice of partners to accompany and strengthen municipal project management is a guarantee of efficiency and sustainability for activities.

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# Social and political challenges to managing wastewater issues in the municipality of Xochimilco, Mexique

Xochimilco maintains significant links with the capital. It lies 28km south of the centre of Mexico City and has kept its urban and rural layout which was defined back in the 16th century. As such is achieved world heritage status in 1987, at the same time as the historic centre of Mexico City. While renovation efforts are clearly visible in the historic heart of the capital, they have barely begun in Xochimilco. This is down to negligence but also other priorities. In fact, the city is on a permanent 'drip-feed' of 1.6 $m^3/s$ of contaminated water to stop it dying in return for the 3.2 $m^3/s$ of water it transfers to the capital from its aquifers. In 2004, the situation was judged to be so bad that Xochimilco was threatened with being added to the world heritage in danger list. Now is the moment of truth. Fervent differences of interest expressed over the last few decades have erupted once more on the question of water. Living conditions in Xochimilco have been adversely affected by the overexploitation of aquifers, tapping the city's freshwater sources to supply Mexico City.

In addition to the 330 settlements and 21 illegal landfills in Xochimilco, there are political interests that take precedence over environmental necessities. Although the technical and technological means do exist, they are far exceeded by urban growth where building rights have become a political commodity. To make this project work, a change in water management and, above all, in the attitudes of the various stakeholders concerned must be achieved. More elaborate techniques could be used, but if political and social sectors do not take on board the issue of environmental sustainability, it will be a difficult task.



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## An expert opinion:

# Jean Duchemin, Sanitary Engineer, AESN

### What if we could safely re-use wastewater with the help of nature?

Technological advances in wastewater treatment enable some very elaborate refinements to improve wastewater quality prior to re-use. These are arranged to deal with genuine health risks according to uses just as much as the need to reassure the often reticent public about the origin of this water.

Sophisticated and intensive technology developed in the examples above is costly in terms of investment and maintenance as well as being energy wasting. It is therefore poorly adapted to rural areas or developing countries.

However more extensive, rustic and less energy-hungry refinements can be used as soon as enough space becomes available. These use microbiological and chemical natural self-purification methods by making use of the natural surroundings:

- Slow filtration on a sand bed, or dune filtration, after traditional biological treatment, e.g. like in Agon-Coutainville (Normandy, France), where filtrated water is used to irrigate a golf course, and avoids any direct discharge from the wastewater treatment plant to the neighbouring bathing and shellfish farming zone in the sea;
- Natural stabilization ponds such as those of Mont St Michel (feeding maize and pastures) or on the Island of Noirmoutier (potatoes growing), but also in Mexico, Morocco or the Far East to irrigate crops or recharge aquifers and other water bodies used for drinking water.

Finally, caution should be taken when developing an irrigated crop programme for an entire water catchment area. This especially so for areas with water deficits to preserve low water-level flows and the ecology in water courses which are normally receivers of treated water. To this end, a local basin-wide "water resources management plan", to maintain a harmonious co-existence between the different uses, would be useful.

**Re-use everything?**
**No! Not at all!**

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## Working group 1:
## **Collection, emptying and transport of wastewater**

Collection and evacuation, concerns wastewater and excreta as well as faecal sludge resulting from individual sanitation. The development of a sustainable urban collection/evacuation system requires the organisation of a variety of complementary technical solutions (pits, grids, vacuum trucks, etc.). Contributions may for instance analyse how this organisation requires taking into account territorial management, urbanization practices, financing models, governance, and the social acceptance of the means implemented.

***Urban sanitation is not only sewers !***

## Working group 2:
## **Treatment of wastewater and fecal sludge**

To ensure health safety and environmental preservation, effective treatment procedures must be implemented before wastewater is discharged into the environment. These procedures need to be adapted to the regulatory, territorial, environmental and health context, as well as to the available budget, of the involved authorities. Such treatments may call upon classic tried-and-tested solutions or on more innovative procedures, involving ecological engineering for example.

***National standards must take into account the particularity of the receiving body and include a progressive implementation approach***

## Working group 3:
## **Recovery and reuse of wastewater**

There has been a major increase in reuse of treated wastewater over the last 10 years. This solution, which, in some regions, enables significant reduction in the withdrawals of fresh water resources, is nevertheless subject to health and technical constraints depending on the uses given to this wastewater: agricultural irrigation, watering of parks and golf courses, water for industrial processes or refrigeration, cleaning, or aquifer recharge.
Apart from the reuse of water, numerous resources can or will be able to be recycled or produced from wastewater, including green energy, bioplastics and organic soil amendments. This is particularly interesting in our current context of resource scarcity, thus delivering solutions for the optimization of resources and the reduction of their environmental impacts, subject to preservation of the low water flow of rivers which would have naturally received these recycled waters : a "Water Resources Management Plan" can be very useful, at local and water-basin level.

***Wastewater reuse is useful in many context, but must always be chosen following an analysis of the various demands without neglecting the receiving water itself***


## **Tour of the "House of water and wastewater" of SIAAP**

The "House of water and wastewater" is the long-life learning school of SIAAP employees. Its goal is to strengthen the knowledge of SIAAP employees faced with changing technologies.

Educational tools have been created, allowing the trainees to work with scale models of industrial technologies and processes used in sewers and WWTP

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