



Fecal sludge market
structuring program

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Dakar tests the omni-processor



Social business
and sanitation,
A new tool



**Dr. Doulaye Koné,
Project Manager
at the Bill and
Melinda Gates
Foundation**
"We want to help
make sanitation a
market sector"



- **Receiving desludging services
with a phone call**
Now a reality in Dakar



Dossier



Collective sanitation and management of fecal sludge in Dakar

Access to adequate sanitation is a major component of poverty reduction because sanitation is more than ever related to health, social services, the environment, in short to development. **p 26**

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Sustainable access of the poor to adequate sanitation



Innovation

One of the main challenges of the project "Improvement of sanitation for households living in flood-prone and flooded areas in Pikine and Guédiawaye (Dakar, Senegal)," is the implementation of the sustainable business model known as "sustainable livelihoods business (SLB)." **p 17**

Reinvent The Toilet Fair the Promotion of Innovation

The New Delhi fair, held in March 2014, was co-organized by the Department of Biotechnology - Government of India - and the Bill & Melinda Gates Foundation, with the support of the Indian Ministry of Urban Development. **p 4**



Innovative technology for the value addition to fecal sludge



Bill & Melinda Gates Foundation has given ONAS the opportunity to test the first prototype of the omni-processor in Dakar. In fact, this facility will be installed in one of the fecal sludge treatment plants (FSTP) at the end of the year to be operational in early 2015. **p 33**

Focus

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Editorial

Believing in innovation



Following the scale-up of the call center and the first trends beginning to confirm a promising future with SMS text messages and calls with an increasing conversion rate of 8% for text messages, ONAS and its fecal sludge management program have already started working, with their financial partner, on the experimentation of the first omni-processor: an innovative treatment system of fecal sludge. It is a revolution, but above all, it is a big step towards the transformation of sanitation into a business sector.

This latest-generation machine with its reduced dimensions will be tested in Dakar in late 2014. It will allow the production of by-products from

sludge and even solid waste, such as approximately 1,000 megawatt hours of electricity per year, hot water and ash that can be used as fertilizer for agriculture or in the manufacture of breeze blocks for construction.

Firmly installed in a dynamic of innovation, the fecal sludge management program is preparing for an experiment in areas of Dakar that are inaccessible to conventional vacuum trucks, with the omni-Ingestor. This new truck is another invention being finalized with the support of the Bill and Melinda Gates Foundation; it will enable, with adequate equipment, work in narrow streets and the on-site treatment of desludging products in order to separate liquid from solid.

Before the arrival of bio-digesters to the new dumping site in Keur Massar, for the transformation of fecal sludge into biogas and the production of fertilizers for soil amendment, the negative impact of the imbalance in the fecal sludge value chain, characterized by difficulties in operating treatment plants, is already being solved.

Indeed, the delegation of the operation and management of the three existing plants in Dakar to the private sector, following a call for tender, has put an end to a series of management deficits.

ONAS is now beginning to see the positive impact of this delegation, having received payment for the license and payment of a monthly fee of 286,539 FCFA, i.e. 3,438,468 FCFA a year, from the three existing plants in Dakar. These amounts should definitely increase with all the actions foreseen in the program to increase the quantities of sludge emptied and to lower the cost of desludgings.

Add to this, last but not least, the introduction of new types of toilets in flood-prone areas and the renewal of the desludgers' fleet with the establishment of the guarantee fund of which initial funding is already available.

Bassirou SOW

Expert IEC/ PSMBV



Dr. Mbaye Mbéguéré



Une vue du Omni processor



Reinvent The Toilet Fair the Promotion of Innovation



After the first fair in Seattle in 2011 where the first prize was awarded to the California Institute of Technology for a new toilet powered by solar energy and producing hydrogen and electricity, researchers, politicians and experts in the fields of water and sanitation in over 45 nations agreed to meet again in New Delhi, India to take stock of the progress made and see the innovations underway.

The New Delhi fair, held in March 2014, was co-organized by the Department of Biotechnology – Government of India – and the Bill & Melinda Gates Foundation, with the support of the Indian Ministry of Urban Development. It was an opportunity for researchers who received grants from the Foundation to present their technological inventions that can change sanitation systems in developing countries. We have selected a few inventions that align with the goals of treatment and value addition developed by ONAS, and that contri-

bute to the growth of business from sanitation products. These include:

- The Omni Ingestor developed by Janicki in the U.S. and capable of transforming sludge into energy and enabling integrated waste management (see article elsewhere),
- The Biofil toilet system developed by a Ghanaian firm whose objective is to make feces completely disintegrate, with almost zero sludge production,
- The Loowatt which is a system that does not require water and is capable of producing energy and fertilizers.

It is worth noting that in 2011 already, the "Water, Sanitation and Hygiene" program of the Bill & Melinda Gates Foundation launched a major challenge called "Reinvent the Toilet" to offer sustainable sanitation solutions to the 2.5 billion people in the world who do not have access to safe drinking water and improved and affordable sanitation.

Grants were awarded to researchers from around the world – working on the basic engineering processes – for safe and sustainable management of human waste, on the basis of innovative approaches.

Through this program, the Bill and Melinda Gates Foundation are looking for the toilets of the future, a need "for public health and human dignity" because lack of access to latrines is "an economic and public health burden in poor communities." "Toilets are very important for public health and, when you think about it, for human dignity," writes Bill Gates on his website thegatesnotes.com. "The flush toilets we have in our rich countries are (...) impossible to use for 40% of the world population, because people often do not have access to water, sewers, electricity or waste treatment systems," he says.

The next toilet fair is expected to be held in China. The organization of these meetings is a very important initiative so that access to improved technologies remains permanently affordable for poor countries.

Dr. Mbaye Mbéguéré
PSMBV Coordinator

Second Steering Committee of the PSMBV

Satisfaction and continued efforts

The second meeting of the Steering Committee was an opportunity to encourage and congratulate the implementation of the Fecal Sludge Management Program (PSMBV). This meeting of the program's governing body aimed to assess the level of implementation of activities undertaken through this project that is important for the state, people and desludging professionals. Presided over by Mr. Aruna TRAORE, Technical Advisor to the Minister, the meeting presented the findings and recommendations with respect to various studies conducted under the program.

The second meeting of the Steering Committee of the PSMBV gathered technical and financial partners, local authorities and representatives of institutional stakeholders, communities and organizations of desludgers. Several presentations were made about the call center that is currently being tested, and whose improved efficiency and profitability are expected in the scale-up phase. This call center is a tool of the research component which is supposed to help lower the price of desludgings. To reach this goal, the call center should have an acceptable operating cost, and a level of efficiency that can create an environment capable of overseeing healthy competition among desludgers.

Concerning value addition to sludge through biogas, the committee noted that the reuse of the digestate, which greatly increases crop yields, should be treated more carefully.

With regard to the omni-processor (a tool for revolutionary energy production from solid waste with the exception of metal and glass), the first machine acquired as a gift from the Bill & Melinda Gates Foundation will greatly reduce the electricity costs of ONAS, even if the expenses related to the development of the host site and operating costs will be borne by ONAS. The omni-processor also produces ashes very rich in phosphorus that can be used in construction or in agriculture.

However, the arrival in Senegal of the Omni Ingestor that stores and processes the sludge while separating clear treated water and digestate in the truck will, in 2015, overcome the inaccessibility of some areas. This innovative truck will also contribute significantly to promoting hygienic desludging and lower the cost of collection.

Certification of desludging companies will, for its part, consist of the licensing and formalizing of desludging companies that meet all the criteria listed in the administrative decree on desludging.

The committee has also asked the coordinating unit of the program, in case they are unable to know the exact volume of a pit for a good pricing of desludgings, to make estimates of the volume during emptying, so that they can create a database.

The Steering Committee also recommended:

- Continue looking for proposals of adequate technologies for sanitation works in the flooded and flood-prone areas;
- Finalize the rehabilitation of three FSTPs of ONAS and effectively monitor the delegation;
- Rapidly implement the guarantee fund to renew the fleet of desludgers and reinforce communication;
- The Department of Sanitation (DS) should support the process of signing the decree on the certification of desludging companies, in accordance with the Sanitation Code;
- Improve the functioning of the call center for better, transparent competition between desludgers;
- Monitor desludgings monthly, in relation to the scaling of the call center;
- Develop all the possibilities for value addition to sludge, including soil fertilization.

Bassirou SOW
IEC Expert/PSMBV

Innovative Sanitation Technologies in Flooded Areas:

Two Prototypes Selected

The committee for the evaluation of examples of innovative sanitation technologies eventually selected two prototypes early May 2014. These prototypes could potentially be tested in a flood-prone area in Dakar. This is the result of a long process of five months that followed the launch of the International Competitive Bidding (ICB) process in December 2013. The first prototype is a toilet from China, proposed by Sunnybreeze Technology; the second is an invention of the Biofilcom Company in Ghana. Both firms have already presented their inventions at the Toilet Fair in Delhi, India, organized by the Bill and Melinda Gates Foundation in April 2014.

The most important decision in planning a sanitation program is undoubtedly the choice of technology (or technologies) to be promoted. The adoption of an inappropriate system may in fact lead to a waste of resources, and failure of a sanitation program can cause serious degradation of health and hygiene conditions in a community.

In attempting to address sanitation issues in flooded and flood-prone areas in the suburbs of Pikine and Guédiawaye, component 6 of the PSMBV embarked on a mission that has not yet been successful in finding a sanitation solution in Senegal and across Africa.

Hence the question: **Is sanitation in flooded and flood-prone areas a utopian dream?** With this question, one evaluates how risky it is to consider this goal as the central element of the component.

Furthermore, technological solutions for households in flooded or flood-prone

areas include two major (technical and socio-economic) obstacles that must be taken into account. Indeed, it is necessary to find technical solutions that can resist floods. From a socio-economic point of view, affordable sanitation would help the low-income populations of flood-prone areas to have access to sanitation through a financial model that is adapted to their situation.

Studies and analyses have helped answer a few questions. The research conducted included a geophysical study that showcased the natural and human environment in Pikine and Guédiawaye, as well as an analysis of soil and water looking at the physicochemical characteristics in the project area, and a market study on the topic of sanitation in addition to a socio-economic profile in Pikine and Guédiawaye.

The results of these studies helped set, for the first time in the sector, criteria that take into account the technical, economic, socio-cultural and environmental aspects. These have served as a guideline for the development of innovative sanitation technologies (IST), adapted to the

context of the target population. The development of these criteria was a major innovation in this project.

These criteria were used to develop the terms of reference of the international competitive bidding, inviting companies to propose innovative sanitation technologies (ISTs) that are adapted to flood-prone areas. For the selection of ISTs from those proposed, the project has established an evaluation committee composed of experts from Oxfam, the Directorate of Sanitation, ONAS (National Office of Sanitation in Senegal), WSA (Water and Sanitation for Africa) and the University of Dakar (soil laboratory of the Ecole Supérieure Polytechnique)

Dr Astou FALL
OXFAM



Sunnybreeze Toilet

Sunnybreeze Toilet

These two toilets will have to be tested before their final selection. To evaluate the technical characteristics and adaptability, Oxfam and ONAS will establish an evaluation committee to monitor these toilets during the upcoming rainy season. Good results will facilitate the scale-up process. Beyond all the technical considerations, this evaluation will focus particularly on the adoption of these toilets by target communities.

Submission of the first funding application files

After the third and final training session for emptiers on the guarantee fund mechanisms, a fund steering committee has been set up by the Director General of ONAS at the suggestion of the Program for Structuring the Fecal Sludge Market (PSFSM) Coordinator.

The steering committee's assignments include the following:

- Assessing the financial and economic viability of emptiers seeking a loan from the Sahel-Saharan Bank for Investment and Trade (BSIC) under the financing agreement signed with ONAS;
- Selecting the emptiers to be provided with funds;

- Ensuring compliance with emptiers' commitments made to BSIC;
- Assisting the emptiers in preparing their application files;
- Reporting to the ONAS Director General on the guarantee fund status;
- Authorizing the BSIC to use the guarantee fund in the event of failure to pay, after all remedies provided for in the agreement are exhausted.

The committee is composed as follows:

- PSFSM Coordinator;
- PSFSM Administrative and Financial manager;
- PSFSM Monitoring and Evaluation Expert;
- Representative of the Ministry of Water and Sanitation of Senegal;
- Representative of ONAS Administration and Finance Management;
- Representative of EDE consulting firm;
- Representative of the Association of Sanitation Stakeholders in Senegal (AAAS);
- Two representatives of BSIC.



Gaspard Diabigha BADJI

In addition, the committee may approach any relevant person or organization in performing its assignments.

The committee meets at least once a month at the invitation of its chairperson. However, it may hold extraordinary meetings when needed.

The committee has already held its first meeting, which has validated the first funding applications. The eighteen (18) validated application files have been sent to the BSIC, which is processing them.

The validated applications include three (3) joint-stock companies, one (1) Economic Interest Group (EIG), and fourteen (14) individual companies. After this stage, the requested funds will be disbursed by the BSIC and the beneficiaries will get emptying trucks, painted in the colors chosen by the guarantee fund steering committee.

Gaspard Diabigha BADJI
PSFSM Administrative and Financial Manager



All households in the Dakar region that are equipped with autonomous sanitation systems and are willing to empty their septic tanks can now call 77 33 96 96 and receive the service in a short period of time without leaving their house. After beta and pilot phases, the call center for mechanical desludging now, as of last February, covers the entire territory of the region of Dakar. Below is a progress report of the process which represents one of the major innovations of the Psmbv.

The establishment of the center has gone through several phases to enable the program team to follow its evolution, the desludgers to gradually participate in the call for tenders, and populations to take ownership. The 'beta' phase lasted a month and a half, and permitted a very small scale test of the functionality of the tools developed by the call centre, in a part of Ouest Foire that is not connected to the sewer system. It was followed by the pilot phase that was reduced from 9 to 5 months. This phase aimed to test the call center in a somewhat broader area of the project (Sicap Mbao) in order to measure its effect on the adoption of mechanical desludging.

Throughout the beta and pilot phases, a promotion campaign was conducted exclusively in the target areas using posters, banners and flyers in neighborhoods, with home visits and community meetings to inform residents and stimulate discussion about the call center in the neighborhoods.

During the implementation of the first two phases, there were difficulties in terms of technical limitations of the call center platform, which was undergoing gradual changes to monitor the management of tenders for desludging operators. There was a short delay. Also, the low participation rate of desludgers has been a hindrance during these early stages. Indeed, as with any other innovation, the desludgers were not very excited because they were concerned and puzzled about its effectiveness. In addition, most of them were already working as contractors, pumping rainwater in flooded areas during the preliminary phases.

Nevertheless, after the first two phases, 92 desludgings were made through the call center with an average price of 26,600 FCFA, a modal price of 30,000 FCFA, and an average participation of three desludgers per call for tender launched.

A telephone number for all of Dakar

After a test of the call center on the small to medium scale, the tool was ready to be launched across Dakar. Thus, on February 21, 2014, the call center was scaled up citywide with only one number: 77 333 96 96. This phase consists in the generalization of the services of the call center to the whole program area (Pikine and Guédiawaye), and by extension to the greater Dakar region. Lessons learned in previous phases are capitalized upon and applied to improve service performance. At the end of this phase, it is planned to define a trade policy to clarify operational guidelines and ensure adequate and sustainable service of the call center under the management of ONAS. This policy will address, inter alia, the needs for management of the customers' and desludgers' base, the customer/desludgers relationship, and determination of sustainable funding sources to ensure the correct operation of the call center.

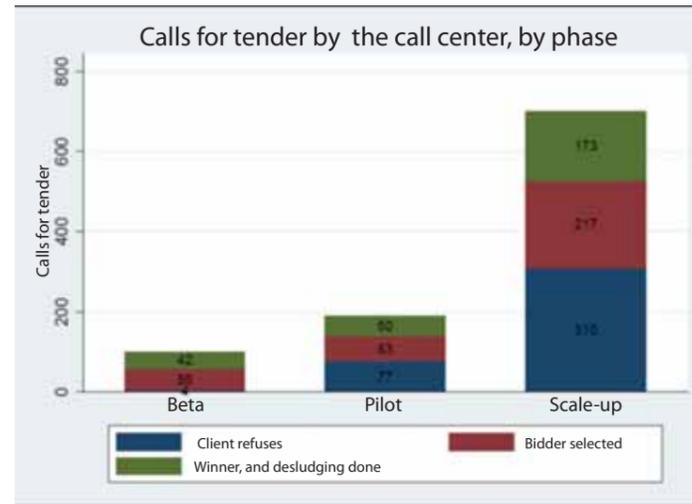
Project dynamic

Ordering desludging services on the phone in Dakar

Now a reality

To ensure proper management of the number of calls, which is expected to increase significantly during this phase, a second operator was recruited and trained in November 2013. Today, the technical features of the call center platform continue to evolve through an iterative process that is based on the comments of operators, a survey of scavengers, calls to customers for quality control, and customer consultations with partners. The turning point of this phase was the promotional campaign, conducted through multiple channels including SMS text messages sent to groups of households referenced by the program in 2012 through the Water and Sanitation for Africa (WSA) agency. Since the scale-up phase more than 43,500 promotion text messages have been sent and about 7.7% of them have led to calls from households, leading potentially to requests for desludging services. In addition to SMS text messages, information about the call center was shared during workshops organized by the program team in all municipalities to explain the project. Similarly, there has been a high level of promotion of the center through word-of-mouth among customers who have already desludged their pit thanks to the call center. This multi-level campaign will gradually boost the activity level of the call center.

The first trends visible since the scaling have been very encouraging. The number of calls to the center increased. This led to an increase in the number of calls for tender made by the center which resulted in an increase of over 73% of desludging requests and an increase of approximately 47% in the number of desludgings performed, as compared to the two previous phases.



The increase in the number of calls has helped to refine the understanding of the strengths and weaknesses of the system, and see its reinforced progression. The average price and the modal price of a desludging are falling, with 23,250 CFA for average price and 25,000 CFA for the modal price. An increasing trend in the participation of desludgers in bids was noted. In total, more than 95% of clients who completed their desludging through the call center say they are satisfied with the services offered, and over 90% praise the quality of service of the desludger.

However, although major strides have been made towards an effective and fluid system with increased participation, the scaling is facing a few challenges:

- An overload of the call center's line is noted during certain peak hours, between 9am and 11am.
- An inability to reach the center on the phone can discourage potential customers.
- Hours of opening and closing of the fecal sludge treatment plants (FSTP) limit operation to between 9am and 4pm (note that the hours of operation of FSTPs have now changed). So far, any bidding started after 3pm gets little attention from desludgers. Subsequently, huge efforts were made

to encourage greater participation of desludgers because, although some participate in each tender, others were late to get involved.

Perspectives and next steps

Through positive and promising trends since the establishment of the center, evidenced by the increasing number of calls received, the lower average price of desludgings, and increased participation of desludgers in bid-dings, the call center has a great future ahead of it. With the upcoming launch of the communication plan, it a greater usage of the call center is expected, thanks to commercials on the radio and on TV, a communication campaign in the field accompanied by the distribution of flyers in neighborhoods and in public meetings. Now the call center - this social and technological innovation designed by the PSMBV project to make mechanical desludging more accessible in Dakar-reaches another dimension.

Cheikh Samb
Innovations for Poverty Action

Participatory Monitoring and Evaluation (SEP) and Decision Making

A dynamic system to involve stakeholders

"Doing something badly is not a crime. Not learning from your previous mistakes because you do not monitor and evaluate is a crime."



The monitoring and evaluation system in place in the fecal sludge management program (Psmbv) aims to meet the needs related to the essential functions of the program. It is simply necessary to develop proper planning, to conduct proper monitoring of activities and results, and to measure the effects and impact of the program. These three basic structuring functions of the system's architecture and their implementation facilitate supervision, as well as interim and final evaluations. Thus, it helps to provide all relevant data for these very important phases.

The Operational and Participatory M&E System

The purpose of the monitoring and evaluation system in place under the Psmbv is to enable timely decision-making at the various levels of intervention. It serves to transmit information in order to meet the needs for internal management and supervision of all stakeholders and implementing partners of the program. It addresses two major concerns: (i) report the (physical) results from the implementation of its various components and activities;

ii) assess the impact or major changes instilled in the intervention area as compared to its main achievements. The main stakeholders involved in the program's monitoring and evaluation system intervene at various levels. Within this system, they perform one or more functions related to monitoring and evaluation: production, collection and aggregation of data; data processing and/or analysis; decision making.

Monitoring the program at different levels...

- In terms of results and performance of the program, the plan is:
 - to assess the relevance of strategies and mechanisms for implementation of the Psmbv;
 - to monitor the results and the level of achievement of performance and contractual indicators, as defined in the grant agreement, and to report that the program objectives are reached (or not).

• In terms of activities
The Coordination Unit, in collaboration with its project management assistant, organizes regular missions to monitor the activities of partners in the field. The type of monitoring/

supervision depends on the volume of activities in the field. It covers aspects related to the organization of work in the field, and the quality of implementation. It aims, among other objectives, to report on the effective implementation of activities in the field.

• In terms of finance
In collaboration with the administrative and financial officer using TOMPRO software, the level of use of the program budget is provided and enables a correlated analysis with the level of technical implementation. Financial monitoring is carried out on a semi-annual basis; each component manager is responsible for monitoring the use of its budget based on the budget lines approved by the Foundation.

• In terms of risks
Risk monitoring includes the entire process of monitoring, planning and risk management by the program team, as well as monitoring of the implementation of mitigation strategies. The specific risks identified will be monitored at all levels throughout the implementation, in collaboration with the implementing partners. The intended purpose is to increase the

Acteurs Principaux	Rôles et Responsabilités
Bill & Melinda Gates Foundation	<ul style="list-style-type: none"> • Capitalize program results • Facilitate the implementation of the program • Redirect the coordination unit to achieve results
Steering Committee (Ministries of Environment, Health, Water and Sanitation, etc.).	<ul style="list-style-type: none"> • Validate Monitoring & Evaluation Systems • Submit technical reports • Approve contractual indicators • Capitalize evaluation results • Formulate recommendations for improved program management • Submit the annual work plan of the program
Technical Committee	<ul style="list-style-type: none"> • Submit technical reports (studies, etc.). • Submit the quarterly work plan of the program • Formulate recommendations for improved program management
National Office of Sanitation (ONAS)	<ul style="list-style-type: none"> • Take ownership and replicate results • Make recommendations to the program • Capitalize program results • Develop a sustainability strategy of acquired results • Facilitate the implementation of the program
Program coordination unit (PCU)	<ul style="list-style-type: none"> • Coordinate the effective implementation of the system • Monitor the implementation of work plans validated with partners • Monitor the quality of data • Capitalize and disseminate results • Reorient implementing partners as necessary
Implementing Partners (IPA/WSA, EDE, Oxfam)	<ul style="list-style-type: none"> • Implement annual work plans of their component • Collect, aggregate, analyze and send data at the PCU according to the predefined template
Program beneficiaries (households and AAAS)	<ul style="list-style-type: none"> • Take ownership of program results • Actively participate in program activities

the probability and impact of positive events (hypotheses) but also to reduce the likelihood and impact of events that may adversely affect the program and the project. Generally, the identified risks are discussed in monthly coordination meetings, and decisions are taken to reduce their impact on the successful implementation of the program.

At various levels also, the performance of the program is evaluated

• **Baseline Study/Situational Study**
A baseline study was conducted in the specific program area (Pikine /

Guédiawaye) to collect information that can help measure expected changes promoted by the program. This situational study focused on a representative sample, whose size is determined by a scientifically proven method of estimation, selected in the area of intervention of the program. The results of the baseline study allow us to update the program objectives, and also to have references to measure performance by the program, etc.

• **Self-evaluation**
Self-evaluation has a dual function in the program. On the one hand, it

serves to stimulate critical thinking and capitalization among partners of the coordination unit as well as implementing partners; it helps monitor the current or past financial year, to assess the results, and to learn lessons and make suggestions. On the other hand, self-evaluation helps to report and share suggestions to improve performance, helps members of the steering committee and the technical committee, and if applicable local and governmental authorities. Self-evaluation helps to review the:

- Physical achievements obtained as compared to the annual projections;

- Financial resources used;
- Evaluation of the level of involvement of stakeholders at different levels;
- Problems or factors explaining the differences between the results obtained and the expected results
- Key actions to be included in the next Annual Work Plan.
- Midterm Evaluation/Final evaluation

Based on the same sample used in the baseline study, the interim evaluation was conducted to measure changes in the indicators of the program and make recommendations for better management of the program. An evaluation at the end of the program is also planned, consisting of conducting a baseline study 2 that fits the same technical principle as the baseline study 1. It will aim to not only determine the level of achievement of objectives, and evaluate performance and impact of the program, but also to capitalize on the lessons learned. This evaluation uses the same sampling method as the baseline study 1.

Monthly coordination meetings, a platform of exchange among the implementing partners

A monthly coordination meeting of the program is held on the last Thursday of each month. Its objective is to share experiences, review the objectives and achievements, assess progress in the program, discuss potential problems or challenges, and identify an action plan for activities in the coming month. After this meeting, a report is written on the status of activities for the month and the decisions and recommendations to follow over the next month.



Le comité de pilotage ici réuni joue un rôle important dans le suivi-évaluation

Activity reports prepared to capitalize program results

An annual report on the level of execution and the achievement of program results is written at the end of each year. The Coordination Unit is responsible for developing it in collaboration with implementing partners (WSA, IPA, Cabinet EDE, and Oxfam) based on the template provided by the Bill & Melinda Gates Foundation. In addition, the program coordination unit prepares an interim report to the attention of members of the technical committee and the steering committee. This report focuses on the progress of activities and program indicators.

Several sources of information to ensure the reliability and accuracy of data

The sources of information of the monitoring and evaluation system in place are varied. The call center is the main source of information for contractual indicators of the program. Regarding the delegation, a special structure has been established to collect a set of relevant indicators to measure the performance of the private sector and the impact of

delegation on the operation of fecal sludge treatment plants. Other studies in the areas of Pikine and Guédiawaye will refine the analysis of this data and triangulate information from different sources.

Technical reports are validated through a participatory process

After submission of the report by partners, the PCU takes some time (which varies depending on the complexity of the study and the size of the document) to read the report and make comments before submitting the report to the Technical Committee of the program for validation. If necessary, a workshop is organized where all stakeholders are invited to share their opinions as was the case for the call center, the market research, the situational study and the baseline study within the component on flood-prone areas.

Moustapha LO
M&E Expert of the PSMBV

The WSA agency in the PSMBV project

The pilot for research and organization

At the present stage of PSMBV, all available data in the sector of fecal sludge in Senegal were collected and analyzed. For the first time in West Africa, this allowed the establishment of a call center entirely dedicated to fecal sludge and the development of a certification process for desludging companies aiming to reorganize the desludging activity. This is thanks to the strong involvement of the WSA Agency and its commitment to its main objective of enabling sustainable and equitable access to drinking water, hygiene and sanitation for African populations through the “research” component of the program.

The Panafrican Agency Water and Sanitation for Africa (WSA) is involved in the market structuring program of the fecal sludge sector (known by its French acronym PSMBV) led by the National Office for Sanitation in Senegal, through its Centre for Research and Competencies (CRC) and its Office in Senegal in four major research components:

- Market analysis for fecal sludge in the program area (Pikine and Guédiawaye);
- Certification process of desludging companies in Senegal;

- Analysis of the laws and regulations governing the fecal sludge sector in Senegal;
- Innovation in Information Technologies

Market analysis of fecal sludge in the program area;

The objective of this component of the innovative initiative to modernize and make profitable the sector of sludge is to estimate the current supply and demand in the sanitation market in the project area (Pikine and Guédiawaye) in order to develop business models to reduce desludging costs. To do so, four specific objectives are to be reached:

- Make a comprehensive review of the existing supply and demand for sanitation services in areas affected by the project;
- Understand the current market and the issues of heterogeneity of demand and supply;
- Analyze financial data and prepare financial models;
- Estimate the size of the ideal business managing fecal sludge that can be profitable for service providers while remaining affordable for low-income households.



Dr. Bécaye Sidy DIOP

Necessary studies have been completed and, inter alia, significantly contributed to the design of the call center platform established under the PSMBV and dedicated to the market of fecal sludge (see section 2.4).

Analysis of the laws and regulations governing the fecal sludge sector in Senegal

This is a thorough review of the legislative and regulatory environment of the fecal sludge sector through:

- Identification of laws, regulations and policies relating to desludging, transportation, treatment and disposal of fecal sludge;
- Evaluation of these laws, regulations and policies to identify gaps;
- Development of environmentally and economically sustainable recommendations for the improvement of the legislative, regulatory and policy framework;
- Cost-benefit analysis of potential regulatory changes in the sector;
- And benchmarking to compare Senegalese laws, regulations and policies relating to fecal sludge with those implemented in other African countries.

- Cost-benefit analysis of potential regulatory changes in the sector;
- And benchmarking to compare Senegalese laws, regulations and policies relating to fecal sludge with those implemented in other African countries.

The report on laws and regulations is available and, among other outcomes, has served as the basis in developing the certification process for desludging companies (see section 2.3).

Certification of desludging companies in Senegal

This component involves the development and implementation of an inclusive and participatory process for the certification of desludging operators Senegal. In short, this is a license delivered to companies that meet the criteria defined by all stakeholders in the fecal sludge sector of the country.

Cross-analysis of discussions during the meetings held with these stakeholders and the results of the study on the legal and regulatory aspects led to the production of a report called “Report on certification.” This document will soon be validated by all stakeholders of the desludging sector during a national workshop: it will then constitute the new roadmap for all desludging operators.

Innovation in Information technology

Through this component, the PSMBV aims to provide the fecal sludge industry (desludging operators, regulators and households) with a tool to improve and optimize services, namely an MCSP platform (Multi-Channel Service Platform) coupled with a call center totally dedicated to fecal sludge. In other words, it is the modernization of the fecal sludge market through the use of Information and Communication Technology for simple contact between the household and the desludging operator. In the end, the call center aims to reduce the cost of desludging to give the poor access to mechanical desludging. The call center does so through encoura-

ging healthy competition between desludging operators.

This tool, developed in collaboration with Innovation for Poverty Action (IPA), has been operational since February 2014 and is open, for the moment, to people in the Region of Dakar.

The call center can be reached at 77 333 96 96.

Dr. Bécaye Sidy DIOP
EAA



Un focus group de WSA avec les opérateurs de vidange de Dakar

Panafrican Agency for Water and Sanitation in Africa (WSA)

A tool for African Emergence

The WSA Agency targets the poor living mainly in rural areas and peri-urban areas of large cities. It aims to sustainably meet their needs for drinking water and sanitation, thereby improving their socio-sanitary conditions and fighting against poverty. Its mission is therefore to promote sustainable and equitable access to drinking water, hygiene and sanitation for the benefit of African populations.

The WSA is structured into four main administrative and operational bodies as follows:

- The Council of Ministers is the supreme authority of WSA. It is composed of the ministers in charge of water and / or sanitation in member states;
- The technical Advisory Committee provides strategic and technical support to WSA. It is composed of experts from WSA's member states and other resources people appointed by the Council of Ministers;
- The Executive Secretariat, under the authority of the Council of Ministers, is the coordinating body of the various WSA operations. It is headed by the Executive Secretary appointed by the Council of Ministers;

- WSA country offices set up in each member state. The main function of the country offices is to take care of services agreed upon with the operational bodies, to implement programs and establish national and local strategic partnerships.

For the smooth and effective implementation of programs and specialized functions, WSA has established three specialized organs: the WSA Foundation, the Center for Research and Competencies, and the Group for Enterprise and Investment (GIE)

The WSA Foundation

The WSA Foundation is a charitable entity in charge of mobilizing and managing financial resources through grants and donations. It implements, inter alia, three main activities: fundraising, executing projects in favor of vulnerable populations, and strategic consulting, policy influence and advocacy.

Center for Research and Competencies (CRC)

It aims to develop innovative solutions and promote debate on issues of public interest in the sector.

Among other objectives, it is supposed to fill the gap related to the virtual absence of a research institution dedicated to Water And Sanitation Hygiene (WASH).

The main areas of intervention of the CRC are research and skills development, capacity building, knowledge management and sharing, as well as communication and information.

Group for Enterprise and Investment (GIE)

One of the objectives of WSA is to assist African governments in facing the challenges of water and sanitation through the exploration of innovative financing solutions: GIE is the tool set up to reach that goal.

GIE aims to create investment opportunities to establish efficient infrastructure in Africa for capacity building of people in the WASH sector to ensure water supply to the 390 million Africans who still use polluted water for drinking, and access to adequate sanitation for 687 million Africans including 250 million who still defecate in the open air.

Dr. Bécaye Sidy DIOP
EAA



Ousmane GUEYE

Sustainable access of the poor to adequate sanitation

Social business, a new tool

One of the main challenges of the project "Improvement of sanitation for households living in flood-prone and flooded areas in Pikine and Guédiawaye (Dakar, Senegal)," is the implementation of the sustainable business model known as "sustainable livelihoods business (SLB)." This sustainable business model, in our context, could mean "doing business with the poor in ways that benefit the poor and benefit the company."

While in Senegal, offering free or subsidized services has always been the instrument of promotion of sanitation works for the poor, this project differs from such an approach. It promotes "social business" as a new perspective for the poorest, to give them access to innovative sanitation technologies (IST). The objective is to encourage private companies (suppliers, financial institutions, distributors, etc.) to develop a partnership with households at the bottom of the pyramid for a "win-win" companionship. Outside of Senegal, this new approach to sanitation is being developed by several organizations in Africa and Asia under the concept of "Sanitation As A Business (SAAB)".

The basic principle here is that the market is the sole and principal regulator under a public-private partnership (PPP) where the rule is to reconcile the objectives of economic efficiency with the social purpose for the benefit of the poor. As such, the subsidy supported by the Bill and Melinda Gates Foundation (BMGF) does not cover investments

reconciling business and social impact (Olivier Kayser: 2010). The poor who constitute this market segment have one major concern - the security of their investments. The limited resources they have are devoted to essential products, necessary and indispensable for their survival and resilience needs. For this purpose, there are two non-negotiable demands:



in research of adequate and innovative sanitation technologies (IST), development of a business model, social marketing, or behavioral change. In general, the social business market aims to engage with various products and services nearly four billion people around the world who live on less than 2 dollars a day (World Bank: Hammond A L, Kramer W.J et al.: 2007). However, this important market can only be captured through adequate products and services, accompanied with hybrid strategies

quality and sustainability (Kayser. 0: 2010). Consequently, the willingness to pay for a product or service depends on the guarantee of security of investments because these investments cannot be made without several adjustments calling for several decisions, or even conflicting priorities in the family.

Ousmane GUEYE
Livelihoods Program Officer
OXFAM/WARO

Innovative Sanitation Technologies (IST) in Dakar's Suburbs :

A real need for populations living in flood-prone areas

The cities of Pikine and Guédiawaye have a total population of over 1,200,000 inhabitants, among whom 75%, or 920,000 people, live in flood-prone areas. This eco-geographical fragility (impermeable soil, water table, unstructured urban areas, etc.) causes, during the rainy season, the filling/overflow and collapse of toilets that leads people to defecate in neighbors' latrines or in vacant houses (during the day) and in plastic bags (at night). Often furrows, called drains, are dug and are connected to septic tanks that discharge directly into the streets and run hundreds of miles through the neighborhoods. Faced with this situation, the need for people to have improved living conditions was felt, but the means and the will to meet it require an increase in willingness to pay (WTP). The latter already exists but remains low because of the scarcity of resources and lack of purchasing power.

Doing business with the poor: many interrelated challenges...

Indeed, 70% of the population living in the flooded and flood-prone areas in Pikine and Guédiawaye are considered poor or very poor with huge living expenses that are superior to their monthly income (OXFAM:

42013). Over 44% of households are in debt, and 21% live in a situation of over-indebtedness (inability to repay their debts). (OXFAM 2013) Given this situation, a sustained effort is vital in order to increase self-resilience necessary to trigger demand (engagement) for acquisition of IST.



prototypes and mechanism of acquisition. Subsequently:

- The first challenge is the positive understanding of stakeholders promoting the market as the main regulator of the relationship between household/client/beneficiary and private companies in a development project contributing to the recovery of the dignity of the poor that are victims of floods every year.
- The second challenge is to give these poor households access to ISTs that are technically suitable for the area they live in, and that are affordable enough for their low purchasing power.
- The third challenge is to convince private companies (suppliers, distributors, financial institutions, etc.) that do not usually operate in the sanitation sector to invest in it.

- The fourth challenge is related to the development of a business model that satisfies all stakeholders in the value chain
- The fifth challenge is the establishment of the most appropriate financing mechanism for all segments of the market
- The sixth challenge is to convince people to uptake innovation in a time as short as the duration of the project (3 years).
- The seventh challenge is to demonstrate and convince people to make the correlation between the adoption of ISTs, the impact on the living environment, health and significant savings.

Appealing technology solutions and a market that is attractive for investment

Shortlisted prototypes determine the contours of new types of toilets. These are dry toilets (bio digester and micro-processor) with which the head of household will not pay for desludging services. In an environment where desludging expenses are significant, it is possible to save money with this prototype.

A first potential market estimated at nearly 5 billion CFA francs (\$ 10 million) could be generated by the population living in flood-prone areas in Dakar (OXFAM: 2013) and, by extension, in areas with similar characteristics at the national and sub-regional levels, this market could also be multiplied by five.

Mbaye Babacar Diagne and Moussa SECK
OXFAM



Through the extension program of the WWTP of Cambérène that is expected to start shortly, ONAS is trying, among other things, to promote biogas as fuel to produce more power and ensure energy independence of its facilities. This is another way, besides the site of biogas production from fecal sludge in the area of Tivaouane Peuhl, for ONAS to actively participate in environmental protection and sustainable development, using biogas.

The use of biotechnology has enabled, among other things, access to biogas and biofuel. Cogeneration, the subject discussed herein, results from these processes.

Biogas used as a fuel may produce heat or electricity, or both. This is called cogeneration.

The project ONAS submitted to the authorities of the Islamic Development Bank (IDB) and whose funding is acquired, aims to complete the wider project of the wastewater treatment plant in Cambérène.

Reduction of electricity costs :

ONAS counts on cogeneration

Its objective is to extend the treatment plant, including rehabilitation, deodorization, a strategy to reduce electricity costs, and the realization of the sea outfall.

The proposed technology includes the treatment of sludge by activating it at medium load, including major works to increase the capacity of processing up to the secondary level of 52,000 m³/d, and the tertiary level of 11,200 m³/d with a deodorizing pretreatment.

Sludge production by treatment of urban effluents

The treatment of urban waste water results in the production of excess sludge that is removed periodically. This sludge is from:

- raw effluents by natural sedimentation of substances in suspension at the primary settlement or by precipitation of colloidal and particulate materials after coagulation with iron or aluminum salt in the case of physicochemical treatment;
- biologically-treated effluents or part of the organic pollution is consumed by cultured bacteria which multiply to form an active biomass in the ventilation structures, the secondary sedimentation and filtration.

For the sludge treatment industry, the plan is to provide the Cambérène WWTP with all facilities (digesters, mechanical dewatering system, and thickeners) required to properly treat sludge from water treatment arriving

at the WWTP.

Biomethanization

Biomethanization is the biological process that produces methane from organic waste. Methane is rich in energy: 35 MJ/m³ (10 kWh/m³). The percentage of methane may vary from 40 to over 80%, the rest being mainly CO₂ (20-60%), H₂S (about 1%) and water vapor.

There are also plans to build works to add value to byproducts in the Cambérène WWTP, especially methane which will be drawn from the sludge digestion and will be converted into electricity to provide, in the long term, 50% of the electricity the plant needs.

Uses of biogas

The methane from biogas is used as energy source in many applications. Some of them are widely developed, and industrial and commercial supply is firmly established. These include:

- the production of heat in the form of hot water or steam,
- the production of hot air to dry sludge,
- the production of electricity using an engine or gas turbine,
- the combined production of electricity and heat from cogeneration.

The electricity can be used locally or sold, integrating the public network.

The heat produced is typically used on site for the purpose of heating the digester and ancillary rooms during

winter (in the summer, the remaining heat is generally not made use of). In the case of the proposed extension of the WWTP in Cambérène, the climate is very favorable; use of the heat generated will be very limited. There are two types of co-generators: the fuel/gas motor for small installations and the gas engine for larger installations. The devices that use biogas are:

- Burners, stoves, water heaters, refrigerators, ovens and boilers,
- Diesel or gasoline engines, generators, motors specially designed for biogas, co-generation engines (producing electrical and thermal energy)
- Steam boiler for the production of electricity by turbines.

The operation of the WWTP is currently characterized by very high operating costs due to the saturation of the plant on the one hand, and especially high consumption of electrical energy supplied by SENELEC on the second hand.

Strategy for reducing electricity consumption in the current situation is based on a single 300 KVA generator that uses part of the biogas produced by the digesters as fuel to provide 20% of the energy needs of the WWTP. The capacity of this generator is far from meeting the needs of the two existing biological units that alone consume more than 65% of the electricity needs of the WWTP in Cambérène.

Environmental Protection

The production and use of biogas have a positive impact on the environment. Indeed, biogas frequently replaces fossil fuels, which contributes to reducing greenhouse gas emissions, partly responsible for climate changes. Use of biomass, which is continuously renewable, leads to a cycle. The emission of CO2 is controlled and stabilized.

Bioenergy is a renewable energy that is very developed across the Rhine region. German industry is a world leader in the field of bioenergy. ONAS has a great interest in benchmarking in Germany whose business skills in the design, construction, commissioning and maintenance of biogas plants are unanimously recognized.

Moussa Alioune BA
Sanitary Engineer
Technical Advisor of the
Director General of ONAS

Station d'épuration de Cambérène



RANAS Research Technology :

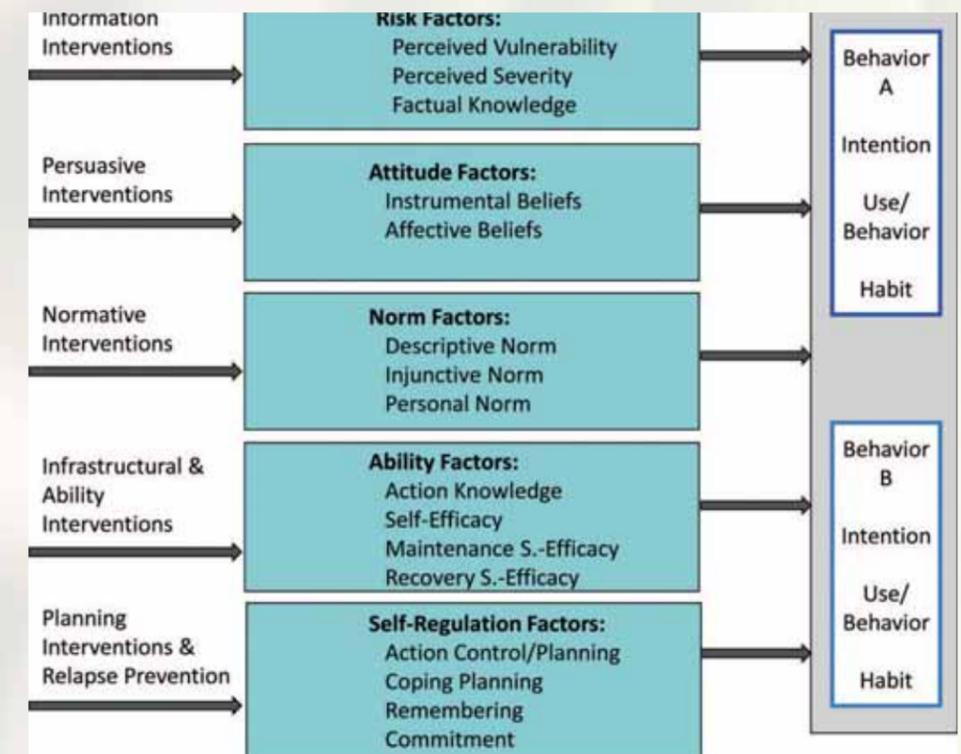
A New Approach to Behavioral Change



Dr Astou FALL

The model is based on five blocks of psychological factors called Risk, Attitudes, Norms, Abilities and Self-Regulation, hence the name RANAS. The model was developed in 2012 by Professor Hans-Joachim Mosler from the Swiss Federal Institute of Aquatic Science and Technology (Eawag). This model involved research specialists in public health, particularly in the field of sanitation, who consider that taking social engineering into account is necessary, in addition to technical aspects, to reach a change in behavior. This is also the reason why the 6th component of PSMBV project is conducting research on behavioral change related to handwashing with soap at key times, in 800 of the most vulnerable households located in Pikine and Guédiawaye.

The RANAS model, based on psychosocial work, explains that for a behavior to be adopted and practiced by an individual, there are 5 blocks of psychological factors involved, targeting the behavior in question, that must have a positive value. A specific behavior questionnaire helps measure the value of these 5 factor blocks. Once the factors are measured, the model provides change interventions that target specific behavioral factors with a low value. The value of the factors is determined by means of statistical analysis.



The RANAS Model of Behavioral Change (Mosler, 2012)

Results of the study on behavioral determinants of the populations in Pikine and Guédiawaye in terms of hygiene and sanitation: Baseline Study, conducted in July, August, and September 2013

One of the topics of the behavioral study conducted in collaboration with the Swiss research institute focuses on practices and behaviors related to handwashing with soap and water at key times. Critical psychological factors with low value are very likely to evolve. They will serve as a lever to design behavioral change interventions geared towards the population of the search area. In our study the basic factors of norms, ability and self-regulation were marked as the main factors influencing the behavior of handwashing after contact with feces and before eating.

Behavioral change interventions related to handwashing for each factor:

Factors related to norms:

At the end of the baseline study, it was noted that handwashing with soap is not considered in the sample as a standard practice applied by all. So the RANAS model proposes an awareness-raising activity that makes use of a social model that approves of handwashing to influence the habits of the population. The promotional activity that is selected is **the diffusion of a film in the district**, with the main character being a very popular person in the movie business and a reference for communities. This character will promote behavior in the film as a paternal aunt or "bajjen"

responsible for transmitting good values in Senegalese society. The use of this social model to convey the message about hand-washing with soap aims, according to the RANAS model, to convey the message that this behavior is a widespread social norm and to create influence.

For the factors of ability and self-regulation:

Lack of permanent access to water and soap, as well as absence of a specific area in the household that is dedicated to handwashing do not make things easier. Subsequently, outreach activities are provided at the household level, through home visits, to promote the acquisition by the household of a functional hand-washing unit (known by its French acronym DLM). The first visit aims to raise awareness in the household of the need for a DLM acquired with their own means, through a participatory interview. Once the household members make the decision, the next two visits will help support and monitor the household based on its schedule for the installation of a DLM. During these visits a participatory approach, and not a "message-based" one, is adopted with the household members to find a specific solution to their obstacle, enabling them to easily wash their hands at key times whenever they want. Emphasis is solely laid on the availability of the DLM at the household level, because the results of the baseline study seem to indicate that handwashing with soap is neither systematic nor easy due to the

non-existence or inadequacy of DLM. However, the mere availability of a DLM at the household level does not mean its regular use at key times. For that to happen, another type of intervention called "commitment" is proposed by the RANAS model to encourage households to adopt handwashing with soap as a habit. This intervention is designed in the form of commitment sessions conducted by hygiene promotion specialists. These sessions are either done with an individual (at the household level) or with a group (at the neighborhood level). These group sessions are designed to obtain the commitment of volunteer participants to practicing handwashing at key times. Monitoring at the household level is expected thereafter for those who commit. The material to be used during commitment sessions includes a film produced to influence the norms factors. Additional materials, serving as reminder signs of the commitment, are developed for the household. The first sign is to be displayed outside the house. This sign features a picture accompanied by a slogan. For the second sign posted inside the house, a picture of the person who committed is featured.

Operational plan for the implementation of behavioral change interventions:

For a successful implementation of these interventions, 11 relays were trained on the approach they need to adopt (Film screening, Household visits, Commitment Session). These interventions are implemented within the research sample in Pikine

SAMA NJABOOT DI RAXASOOK SAABU, DOGU NAA CI !



Outdoor sign of the commitment of the house

and Guédiawaye.

The objective of the research was to find the most effective intervention; so a comparative analysis of the different interventions is planned. Thus four clusters are formed:

Cluster 1: Group for home visits monitored by 3 relays in 179 households; the communes of Guinaw Rail Nord, Guinaw Rail Sud, and Djiddah Thiaroye Kaw are affected.

Cluster 2: Group for Film monitored by 2 relays in 178 households; the communes of Medina Gounass, Ndiarem Limamoulaye, Tivaouane Diacksao, and Wakhinane Nimzatt are affected.

Cluster 3: Group for a combination of home visits and film, monitored by 3 relays in 179 households; the communes of Diamaguène Sicap Mbao and Thiaroye Sur Mer are affected.

Cluster 4: Group for a combination of Home Visits, Film and Commitment monitored by 3 relays in 180 households; the communes of Keur Massar, Yeumbeul Nord, and Yeumbeul Sud are affected.

These interventions will be conducted over six months from the month of May 2014.

Dr Astou FALL
OXFAM



Training of relays in Diamageune Sicap Mbao – April 23, 2014

Adding value to sludge from wastewater or desludgings

ONAS in the field of industrial ecology

For a few years now, ONAS has been working in industrial ecology, engaging firmly in its industrial missions to add value to by-products, particularly sludge from wastewater or desludgings.

Industrial ecology is, in fact, a relatively new concept. It is an approach offering development opportunities to many stakeholders. It is not, strictly speaking, a new discipline, but a new practice of environmental management.

Industrial ecology seeks to meet the emerging needs of individuals and companies that need to integrate the environment into their strategy, especially under the pressure of regulations.

Since its creation under the law number 96-02 on February 22, 1996, ONAS has sold sewer connections, purified water and assistance to third parties (studies, supervision, etc.). It is only in recent years that ONAS has become firmly committed to a mission of industrial use of by-products, particularly sludge from wastewater or desludgings. ONAS is, so to speak, immersed in industrial ecology and is slowly but surely advancing.

Today, the treatment of wastewater in the treatment plant of Cambérène generates waste that is a great source of energy that can partially replace fossil fuels.

Commissioned in 1989, the wastewater treatment plant of Cambérène had an initial capacity of 9600 m³/day in secondary treatment. Its recent expansion helped increase the processing capacity from 17000 m³/day for an input of raw sewage equivalent to 24000 m³/day.

There was therefore a threefold increase of the daily wastewater flow arriving at the WWTP, due to increased sewer connections through the social connections program, following the restructuring and strengthening of sanitation infrastructure in the affected areas, but also an increase in effluents from the pit emptying and waste that is dumped at fecal sludge treatment plant in Cambérène.

In 2004, the expansion of the wastewater treatment plant in Cambérène allowed the consolidation of a sludge treatment process producing methane gas.

The site of fecal sludge treatment includes the following equipment:

- Three digesters;
- A boiler working with steam;
- A generator using gas, with a capacity of 350 KW.

The sludge produced by the wastewater treatment (about 9000 kg/day) is treated by the anaerobic digestion (that is to say in the absence of oxygen) of organic material.

During this digestion, biogas mainly composed of methane (CH₄) and carbon dioxide (CO₂) is produced. If it is not collected and released into the atmosphere, biogas is a powerful greenhouse gas. Indeed, the global warming potential of methane, which is the main component of biogas, is 23 times greater than CO₂. **Biogas is collected and used for the generation of electric power to operate some of the treatment plant's equipment, thus helping to reduce the electricity bill and the operating expenses of ONAS. The electricity generated through biogas can cover about 22% of the energy needs of the WWTP.**

However, energy consumption of the generator using gas does not exceed 35% of the volume of biogas produced; the remaining 65% is burned through a flare. The transformation of methane into CO₂ by flaring is a lesser evil, limiting the greenhouse impact. There are three main biogas sectors:

- storage of waste to landfill leachate,
- treatment of waste through digesters or biogas production units,

ONAS uses only part of the waste generated by human activities to produce biogas. These include wastewater and fecal sludge treatment plants.

At the 17th Congress of the African Water Association (AWA) held from 17 to 20 February 2014 in Abidjan, Côte d'Ivoire, ONAS made several presentations during the technical sessions organized in parallel. They addressed various topics, but the one that is related to our subject is the reuse of fecal sludge as a credible alternative to thermal energy in industry (FAME Project).

Principles of industrial ecology

Compared to conventional environmental management policy (recycling, pollution control, energy efficiency, clean technologies, etc.), industrial ecology combines sectorial and cross-sectorial approaches in an integrated process.

It is based on two principles: circular economy and cooperation.

Circular economy implies that "waste and byproducts of certain people become resources for others" (heat and steam, water, gas, biomass and liquid fertilizers, sewage sludge, etc.).

Cooperation is important in terms of sharing services between companies or in terms of collaboration between local stakeholders on promising projects for progress and innovation.

Conditions for successful industrial ecology

The conditions for a successful industrial symbiosis are:

- **Diversity:** company activities must be different and complementary, so as to use waste from one company as a resource for another one,
- **Proximity:** The cost of transporting waste resources should not be prohibitive,
- **Cooperation:** To enable the implementation of the symbiosis, the companies and their leaders must develop among themselves relationships based on cooperation, communication and mutual trust.

Industrial ecology is inspired by the functioning of natural ecosystems, recreating for the industrial system an organization characterized by an optimal use of resources and a high rate of recycling of matter and energy.

The first significant experience in the world of industrial ecology, successful in Denmark with the port of Kalundborg, has stimulated many approaches to industrial ecology in recent years in France, Switzerland and Belgium.

Moreover, industrial ecology is beginning to be taught at undergraduate and postgraduate degree level. Therefore, companies are interested in industrial ecology; so are the general public and local communities concerned with sustainable development policies.

From this point of view, ONAS will strengthen its partnership with the private sector and with the cities of Dakar, Pikine, and Guédiawaye surrounding the Cambérène treatment plant.

Moussa Alioune BA
Sanitary Engineer
Technical Advisor to the
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Collective sanitation and management of fecal sludge in Dakar

A comparative economic and financial evaluation of the systems

Access to adequate sanitation is a major component of poverty reduction because sanitation is more than ever related to health, social services, the environment, in short to development. Although efforts have been made in this sector for some time now with 1.2 billion people in the world who have had access to improved sanitation between 1990 and 2004 (WHO, 2008), several experts in this field have shown that the city sewer system is the crucial part of the sanitation sector, because it is neither accessible nor affordable to the poor. Consequently, the fecal sludge management system and the semi collective system are deemed technically viable and cost less. For this purpose, the analysis of the economic and financial flows of sanitation systems becomes a necessity and helps quantify the costs while improving management in this sector.

Dakar, the capital of Senegal, was our analytical laboratory because it has the privilege of consolidating all systems and centralizing their managements in a shared service called ONAS. Besides, it is possible to access the records relating to investment and operations for the stakeholders, namely the state, public and private operators, and beneficiaries. In this study, real data is leveraged to estimate the real numbers of the city sewer system and the new fecal sludge management method, in terms of investment and operation, and for each stakeholder concerned. We highlight, as recommended by Hutton (2009), who pays what and for what service, with a goal of providing a tool for decision making to help people choose a system and a basic analysis for pricing. However, it should be noted that this study is limited to a first look at the main parts of the systems. The comparison is limited to economic aspects: environmental and health assessment of the two systems is left to the experts in this field.

1. Objectives of the study

The objective of this study is to determine the costs of investment and operation of collective sanitation and fecal sludge management systems with the aim of comparing the systems. We are interested in determining though this study the economic and financial flows of sanitation systems, namely the city sewer system and the new fecal sludge management system, incorporating input from relevant stakeholders, in a schematic way following Steiner (2004). To do this, we use the data available for the city of Dakar to learn about the infrastructure in place and the costs of this infrastructure.

Potential discussions include:

- Economic comparison of the two systems,
- Discussion on pricing,
- Proposal for a reflection on the choice of a system in a given situation (case studies).

2. Methodology

The establishment of patterns of the economic and financial flows of a given sanitation system requires several steps:

2.1. Stakeholder Identification

The role of and monetary relations between each of the stakeholders are established, as well as the main items of expenditure. The contributions of stakeholders in terms of staff costs are analyzed according to:

- Investment or operation
- The city sewer or the new fecal sludge management system
- The major items of expenses of the two systems

For the city sewer system, the following are involved: Sewer, Connections, Pumping Plant, and Treatment Plant. For the new fecal sludge management system (known by its French acronym GBV), the following is at stake: Pits, Desludging Trucks, and Dumping Site.

2.2. Establishing a Basis for Calculations

The basis for calculation is considered as the number by which we divide a given amount to have the same unit of comparison. Each household taking part in sanitation has expenditures (relating mostly to the creation of the infrastructure) and operation (relating to operation of the infrastructure). Each expense can be divided by the number of inhabitants affected by this expenditure, which then constitutes the financial basis for calculation of the expense.

We have chosen a basis that is equivalent to the number of beneficiary inhabitants, instead of the basis corresponding to the cubic meters of water used or the linear meters of pipe, because this seems more effective to us than comparing collective and autonomous sanitation systems. Indeed, it is interesting to see the process by which we can evaluate expenses in this sector to find out the cost per beneficiary, either to cover

investments or to cover operating expenses for both the collective system and the autonomous system, and this further facilitates reflection on pricing.

The cubic meter of water used does not represent the volume of water pumped from the septic tank and is therefore unsuitable for sanitation in the GBV model. As for the linear meter of pipe, it can only be applied to the collective system; therefore it does not provide a basis for consistent comparison of the two systems.

2.3. Accuracy of the explanatory variables for each unit

We use the term "variables" because the significance of the information is not the same from one individual to another. These variables are called explanatory, since they justify the basis of the observed or studied item.

In our case, each expense is related to the key parameters affecting it. For example, the parameters influencing the per capita cost of a sewer are: topography (installation depth), soil type (difficulties to dig), the size of the pipe and the number of inhabitants draining their wastewater into it.

The establishment of the explanatory variables helps to connect the established financial flows to the parameters that are deemed to influence them. We can also use these variables to model the financial flows in other situations in the study areas.

2.4. Hypothesis for the correction of costs

- Update

Infrastructure costs that require it are updated based on the French index of construction (Ministry of Public Works, 2008) considered as closer to price changes in the Senegalese construction sector than a general

rate of inflation. The formula used is the following:

$$\bullet ST = S0 (1+i)$$

When ST =current value; S0=original value and i=inflation rate over the period considered.

We choose to study the costs of more than 10 years.

- Depreciation

The flows of the two sanitation systems are initially shown schematically for investment and exploitation. Then, based on the expected useful life (EUL) of infrastructure, the investment is included in the operation in the form of depreciation costs.

The EUL is linked to the depreciation by the following formula:

$$\bullet EUL = 100/D^* \text{ with } D^* = \text{depreciation rate}$$

$$\text{Annuity} = V0 \times 1/ EUL$$

When V0 = the original value of the investment in infrastructure.

The EUL selected in this study are derived from data provided by ONAS in the financial model. These are:

- City Sewer System:
 - Pipes: - cast material (concrete, cement) = 50 years
 - PVC material = 30 years
- Pumping Plant: 30 years
- Treatment Plant: 30 years
- Home Connection: 20 years
- GBV
 - Truck: 15 years
 - Pit: 50 years
 - Dumping Site: 30 years

Investment cost of the collective system

The investment cost of the collective system is shared between donors and households. Cost values are extracted from the financial model provided by ONAS (ICEA, 2007).

Decomposition of the investment cost for donors

- Investment cost of the network

The collective network in Cambérène covers around 340 km with 26 pumping plants. The cost is determined by reference to the cost of the network in Sahn Notaire that is part of Cambérène, and therefore has similar explanatory variables. The prorated cost of the Sahn Notaire linear pipeline is estimated as follows:

Division of the investment costs of the network in Cambérène

Unit	Content	Costs (million FCFA)	Cost per capita (FCFA)
Network	Connections	7998	31000
	Pipes	23282	90240
	Pumping Plants	10954	42460
Total		34236	163700

This cost can be explained by the size of the network, the volume to be collected, and the topography. Indeed, the topography is relatively flat in Dakar (Peninsula) and the soil is sandy (easy to dig).

- Investment cost of the WWTP

The table below shows the distribution of the investment of the WWTP based on its components:

Repartition of the Treatment Plant in Cambérène

Unit	Content	Costs (million FCFA)	Cost per capita and per year (FCFA)
Treatment Plant	Treatment sector	13238	51310
	Water disinfection sector		
	Biogas recuperation sector		
	Buildings		
Total		13238	51310

Investment costs of households

They increase their investments in the chain of the city sewer system towards achieving the household connections or other connections to the network. There are two ways of connecting to the city sewer system, namely the regular connection and the social connection. The cost of regular connection is estimated at 380,000 francs; this is somewhat linked to the cost of construction materials (sand, cement, steel, etc.) and the costs of labor. The cost of social connections is estimated at 19,000 francs; this cost is due to the availability in ONAS of a subsidy program for costs borne by households, because household incomes are low.

3.1.1.2. Operating cost of the collective system

The operating costs of the network concern unclogging, cleaning, and repairing damage to the pipes.

Expenditure on pumping plants is composed of energy for pumps, cleaning, repairs, and guards for security.

Repartition of the operating cost of connections to the city sewer system in Cambérène

Poste	Content	Cost (million FCFA)	Cost per capita per year (FCFA)
External contractors	Cleaning	411.25	1600
	Unclogging		
	Repairs		
Direct and internal work by ONAS	ONAS Staff (22 staff members, including 8 permanent and 14 non-permanent)	60.56	235
Staff costs covered by ONAS (senior management team) for connections and city sewers in Cambérène		33.283	129
Total		505	1964

Repartition of the operating costs of pumping plants for city sewers in Cambérène

Position	Content	Cost (million FCFA)	Cost per capita per year (FCFA)
Pumping plants	Staff (5 permanents et 8 non-permanents)	37.23	145
	Electricity	75.6	295
	Gas	31.2	120
	Equipment	9	35
	Mat&Consommables	4.8	18
	Reparation by DMMG	8.4	320
	Staff costs covered by ONAS (senior management team) for the pumping plants		19.67
Total		259	1008

6. Comparison of the systems

Representation of financial flows in the current situation led us to the following conclusions:

- Investment for a city sewer in Cambérène is 11 times more expensive than investment in fecal sludge;
- Even excluding depreciation, operation of GBV is still 2 times cheaper than city sewer;
- Currently, ONAS charges a fee from GBV populations to supplement its operating budget for city sewers. If only households connected to the city sewer paid for its operation, that would represent only 20% of the operating costs of the system; the government or external donors would have to support the rest of the costs;
- For GBV on the other hand, the system shows a slight deficit, especially in transport because desludgers lose money through individual desludgings. But the sanitation tax, if it were assigned to the service of those who pay, would largely compensate for any loss, and even generate profit or reduce the cost of desludging;
- Companies operate slightly at a loss, and compensate with other more profitable activities (Gning, 2008).

Conclusion

In its entirety by reference to our case study, analysis of sanitation flows showed that the city sewer system is very expensive to the point that it cannot be installed everywhere to meet people's needs. Likewise, the study showed that even the cheapest city sewer system is more expensive than the GBV.

In addition, the study showed that GBV has several positive externalities. Indeed, this system is in a growing economic dynamism (increase in the number of desludging companies) and has a promising future, given that over 80% of the rural and peri-urban population lacks adequate sanitation infrastructure.

Approval of GBV will be a great tool because it will be saving big investment for donors and also be a source of revenue. Nevertheless, we recommend decreasing or even eliminating the sanitation tax for beneficiaries of the GBV to reduce their operating expenses. It would be useful to organize a dialogue among sanitation stakeholders to see under what circumstances domestic desludging could be profitable.

However, it should be noted that the study took into account the coupling of the dumping site with the wastewater treatment plant of the city sewer system. Therefore, the analysis has not been extended to determine the extra costs of treating the leachate (liquid obtained after drying fecal sludge).

Sow O.S., Dodane, P.H., Mbéguéré M., Koné D



Une dépositrice de boues de vidange à Dakar

Innovative technology for the value addition to fecal sludge

The first "OMNI-PROCESSOR" arriving soon in Dakar

Bill & Melinda Gates Foundation has given ONAS the opportunity to test the first prototype of the omni-processor in Dakar. In fact, this facility will be installed in one of the fecal sludge treatment plants (FSTP) at the end of the year to be operational in early 2015. It will be operated and monitored in close collaboration with the private consortium in charge of managing the three FSTPs in Dakar.

The "Omni-Processor" (OP) is a facility for the cogeneration of electricity and heat, which converts combustible sludge and solid waste into electricity, hot water and ash. This technology has been developed by the company Janicki Industries, under the Bill & Melinda Gates Foundation's "Water, Sanitation and Hygiene", which funds important research on innovative technological solutions in treatment and valorization of sanitation products in developing countries.

Technology

The concept of this technology is simple but effective. The combustion of materials generates energy used to produce steam at high pressure. The steam drives a reciprocating piston engine that is connected to an electric generator. The exhaust steam of the piston engine supplies energy to a drying device for incoming sludge; then the outgoing material is recovered for other hot water applications, or cooled. The residue from the combustion (ash) is composed of non-combustible materials (minerals) contained in waste.

The steam engine, the central element of this technology, is manufactured with standard auto parts for easy maintenance and repair. Auto mechanics that are available locally may take care of any repairs.

The Omni-Processor, operating at full capacity, consumes 7 tons of combustible dry matter per day. It delivers a net power of 125 Kw of electricity, with an annual production of 1,000 Mwh of electricity, equivalent to 8,000 hours of operation per year, and

can produce up to 28 m3 of hot water per day. Waste to be treated must contain at least 20% solids and can be thickened sludge, municipal solid waste – in short, any combustible material.

The hot water produced by the pathogen-free system can be used for applications on-site or in nearby establishments (slaughterhouses, hospitals, etc.) or cooled and used in construction, agriculture, etc. Ash rich in phosphorus and potassium can be used as fertilizer, or in the manufacture of bricks for construction.

The Omni-Processor occupies little space (120 m2) compared to a FSTP, excluding the dumping tank and storage area for residues. Its small size allows it to be integrated into any existing FSTP or WWTP and alter the chain of treatment and valorization of fecal sludge.

Stakes

For the specific treatment of sludge, the daily capacity of the Omni-processor is 450 m3 of raw sludge with 1.5% solids, more than the combined capacity of the three FSTP in





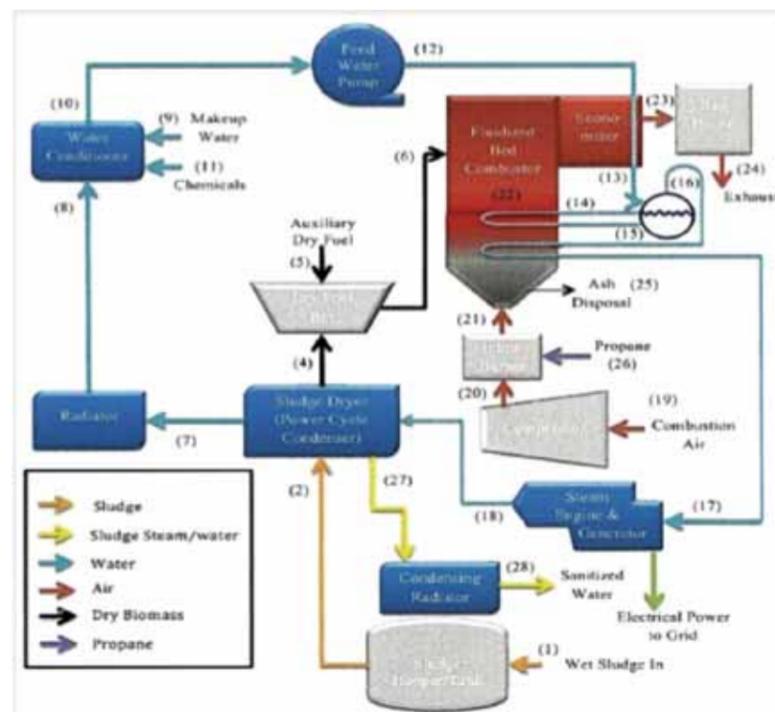
Cambérène, Niayes and Rufisque respectively suitable for loads up to 120 m3, 60 m3, and 60 m3 per day. With the omni-processor, the amount of post-treatment solids to manage, the amount of time to treat sludge (drying) and odors related to the expulsion of sludge in the open air are significantly reduced.

Furthermore, electricity can be sold to SENELEC to generate an income of nearly 75 million CFA per year or consumed on site to make systems more self-reliant and allow money to be saved on energy bills. The omni-processor paves the way, in terms of processing capacity, to a partnership between ONAS and local municipalities, for integrated management of urban sanitation.

Costs

The acquisition, freight and installation the Omni-Processor costs about 1 million USD or 450 million to 500 million CFA francs. Annual maintenance, spare parts and 24-hour remote monitoring are provided by the manufacturer "Janicki Industries" for about 27.5 million CFA francs per year. Only one technician is qualified enough to fully operate the Omni-Processor.

Abdoulaye FAYE
Biogas Expert



Dr. Doulaye Koné, Project Manager at the Bill and Melinda Gates Foundation

"We want to help make sanitation a market sector" »



What are the projects that the Bill and Melinda Gates Foundation is implementing in Senegal?

The Bill & Melinda Gates Foundation is guided by the belief that all human lives are equal. It strives to help all people lead healthy, productive lives. In Senegal, we work with the government and other partners on a number of important projects. These projects include family health, humanitarian emergency relief (during floods), and sanitation. Our investments aim to develop autonomous sanitation and the management sector of fecal sludge from latrines and septic tanks used by more than 90% of the population in Senegal and the vast majority of Africans. The city sewer system is extremely expensive for the poor, and it is also extremely expensive to build and maintain. The few wastewater treatment plants that exist in many countries suffer from major malfunctions because of these high costs. We must remember that unfortunately, in the world today, 2.5 billion people have no access to adequate toilets and about 1.1 billion people defecate in the open air.

How do you plan on supporting African countries including Senegal, to use technologies inspired by African socio-cultural realities when constructing works and toilets?

Investments made by the Bill and Melinda Gates Foundation in the field of autonomous sanitation aim to make management tools and technologies available to all stakeholders in order to make sanitation into a market sector, just like the sectors of telephone and drinking water. Of course, with technological innovations available today, it is possible to produce gas, fertilizers, and electricity from the treatment of fecal matter. Don't get me wrong, everything that we consume daily is energy. Part is converted by our bodies for our physiological needs, and the excess is released as urine and feces! Treatment methods also enable us to eliminate all of the pathogens. New reinvented toilet technologies, on which the Foundation works with its partners, not only eliminate pathogens but also valorize or eliminate feces and treat water for cleaning, washing

hands, or recycling. We also work with a large number of development actors among which there are NGOs, bilateral and multilateral organizations, and private sector representatives, to conduct advocacy at the policy level, promote best practices and accelerate access to sanitation services. Examples include the African Ministers' Council on Water (AMCOW), the African Water Association (AWA), the African Water Facility (AWF), and the Pan African Agency for Water and Sanitation for Africa (WSA), WaterAid, Plan, World Bank and its Water and Sanitation Program, as well as UN agencies.

What benefit could countries like Senegal get by constructing sanitation facilities?

Recent studies by the World Bank in Africa show that economic losses due to poor sanitation are astronomical. It is estimated that the impact of poor sanitation affects economic indicators such as GDP growth of 1 to 2.5% in Sub-Saharan Africa. The same study estimated these losses at about 5.5 billion U.S. dollars per year for 18 African countries representing more than half of Africa's population!

Lack of sanitation is responsible for the death of about 700,000 children under 5 each year worldwide. Diseases related to feces affect the ability of nutrient absorption in the body, and affect mental and physical development of the child. For girls and women, lack of access to toilets may be the cause of school failure, sexual assault (especially during the night), or humiliation.

To remedy this, we must innovate by developing technologies that eliminate germs from human waste and creating models of equitable and affordable services for all, especially for the most vulnerable households.

. This is the meaning of the fecal sludge market structuring program established by ONAS and funded by the Foundation. The ultimate goal is to develop a model for managing fecal sludge, able to address the various management challenges. Through a scientific process, it will be necessary to answer the questions that arise in terms of institutional and legislative sector organization, mobilization and involvement of the private sector, the use of ICT to improve services and the development of infrastructure to meet the needs of collection, transport, treatment and recycling of sludge. Management models of autonomous sanitation work like the one ONAS implements in Senegal are replicable in most African cities, where the vast majority of people - over 90% in cities - uses latrines or defecate in the open air. The Dakar model provides a framework that allows private companies to participate in tenders for the provision of sanitation services. People should no longer build toilets and abandon them, but rather organize the supply market of toilet services, as well as collection and processing of sludge. New technologies allow entrepreneurs to provide a package service with high added value for the customer as happens today in the water, mobile telephony or cable TV sectors with which we are familiar.

Do you think that delegating management of plants under the PSMBV is a good option?

The case of Senegal is a pioneer in Africa, an example that deserves to be replicated. In addition to the political will of the government, the private sector is also very strong, very competent, which encourages the authorities to formalize the existence of private companies. The Association of Mechanical Desludgers is a good example of dynamic sanitation opera-

tors; their professionalism convinced the authority in place to assign them a major role in the provision of sanitation services and to delegate management of fecal sludge treatment plants to them.

You know, the first units of fecal sludge treatment built almost 10 years ago are still functional; this is unique in Africa! New units have recently been built in other cities like Mbacké, Diourbel, Tivaouane, Richard-Toll and Mbour.

After 10 years of operation by ONAS, and after several studies on the constraints and opportunities to transform the management of sludge into a merchant sector, ONAS finally came to the conclusion that the first plants can now be entrusted to the private sector for more optimization and profitability. This is an important experiment in sanitation because the state and the private sector have together come to the conclusion that profitability of the operation of such units is possible. Sanitation can certainly be a market sector, a sector that creates employment and innovation, contrary to previous beliefs. The private sector brings new investment, innovation to improve the profitability of the sector, but also an income paid to the state through fees or taxes collected. Plants that once were seen as a burden under the operation of ONAS begin to generate financial resources. This model of partnership with the private sector is not new to Senegal. It is already well-established in other sectors. SDE (Senegal des Eaux, a national water company), for example, uses the [private] supply network and plants producing drinking water for large urban centers. I have strong hope that in the coming years we will see the emergence of large companies in the sanitation sector, similar to SDE!

How to develop real value addition strategies of sanitation byproducts to see a return on investment?

Today, most city dwellers pay for sanitation services one way or another. This is done either through sanitation fees or taxes, or the acquisition of household toilets with latrines or septic tanks, or during desludgings of these facilities. Many people in Africa still lack access to toilets. In precarious neighborhoods, people often pay for access to toilets managed by small private operators. ONAS has shown in Dakar that it is possible to structure the sanitation market in order to provide quality services to a large number of people. Maximizing the return on investment will require business models in different segments of the value chain to be profitable. The objective is to create value from fecal sludge with an impact on the value chain that should eventually lead to a lower cost of desludging for poor households. Making sanitation into a market sector requires a new approach centered on valorization. Following this perspective, the technical solutions will be evaluated in their ability to generate by-products with high valorization potential.

Also, the market can be organized so that the supply and maintenance of toilets (in houses or public schools), the collection of byproducts or sludge itself, and treatment of fecal matter subsectors are profitable. If the state or an industrial network can buy electricity, gas and fertilizers from fecal sludge treatment plants at competitive rates, companies and investors will multiply these business models very quickly. To do this will require the services in charge of job promotion, development of industry and energy resources, as well as commercial and investment banks to collaborate closely with the sanitation

sector so as to create an environment that is adequate for the development of these new economic operators.

Access to sanitation in precarious and poor neighborhoods of all major African cities is an equation. Is there any other alternative to this injustice?

I gave the example of the model ONAS is developing in Senegal. There are also examples in other countries like Kenya where we are also working with the government and a network of partners to develop tailored approaches. The challenge in informal settlements is mainly due to the small houses and narrow streets, the level of poverty, the high population density, and the lack of infrastructure and basic services. However, today there are economic models that allow service providers to operate in these neighborhoods. For example, if you do not have a phone or no electricity with which to call, you can call from a telephone booth. Like this phone booth, one could imagine technological solutions for charging public toilets that could relieve a lot of people. In Ghana, for example, there is a very interesting example of a company called CleanTeam which demonstrates that slum dwellers are ready to subscribe for paying services or rent toilets. In these neighborhoods, having a toilet at home reduces the risk of sexual abuse of young girls and other kinds of humiliation that women may suffer. Technological solutions exist today. Industry leaders should organize the provision of the service and apply the same rules of procurement through bidding so that new sanitation operators can effectively play their role. A toilet is less expensive than a cell phone and has much greater economic and health benefits. A country that wants to emerge cannot ignore such a crucial problem!

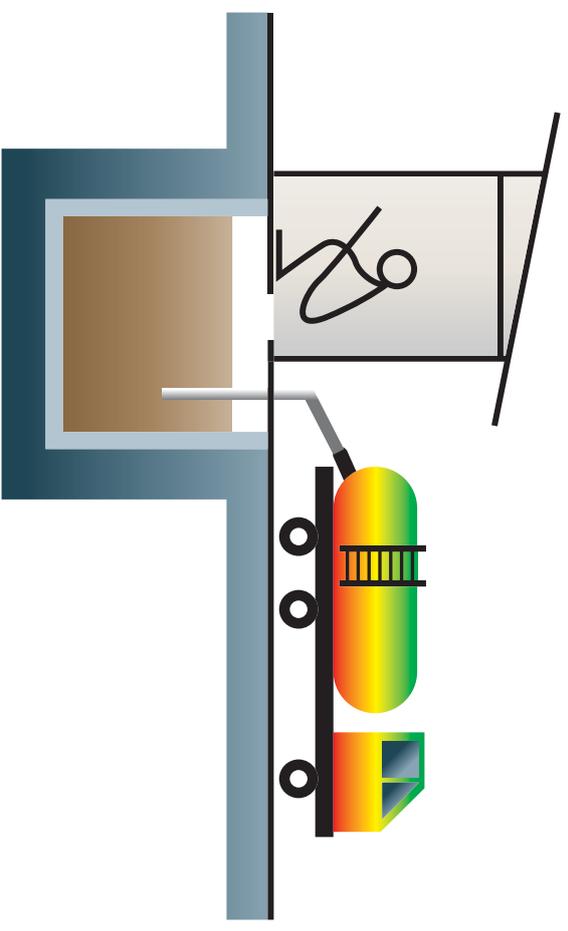
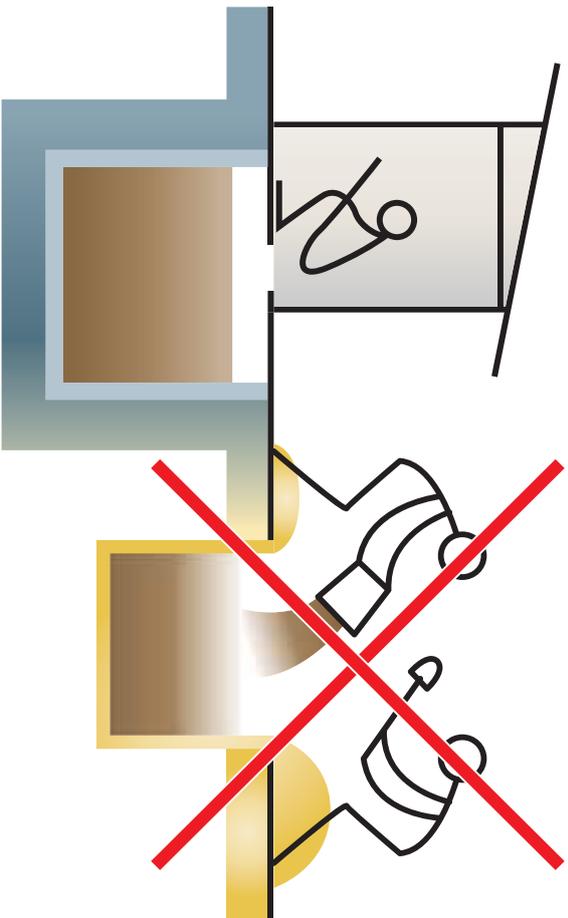
By Idrissa SANE,
from the Soleil newspaper.



L'assainissement pour un meilleur cadre de vie

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