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Challenges in Sanitation

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ABSTRACT

Among the essential public utilities, sanitation and wastewater services present forms of organization and management that have contributed to make it low on the agenda of policy makers when it comes to the development of infrastructures. Backlogs in the provision of services to populations in emerging and developing countries confirm this fact. At the same time, the reasons for this are multiple and the issue is broad.

To address the issue, the ParisTech-Suez "Eau Pour Tous" Chair organized its 3rd scientific workshop on November 18, 2016, with the support of the *Agence Française de Development* and AgroParisTech on "Sanitation and its Challenges." This workshop is recognized as serving as a forum where experts can exchange institutional, operational and scientific views on public sanitation and drinking water supply services.

This publication gives an account of the actions, discussions and exchanges at this meeting and focuses on the organizational, economic and social issues.

The report centers on three key questions and discusses concrete, sometimes competing, conditions for successful experiences and innovations.

- How to explain that real benefits of sanitation in terms of public health and safety, especially for women, do not translate into high demand from users and more ambitious public policies?
- What coordination efforts must effectively be established between autonomous sanitation and networked sanitation, and on what scale?

- How have the emergence of environmental concerns and the increased participation of users caused public sanitation policies and their financing to change?

Even if their relative intensity depends on the context, driving forces often originate from demographic developments, climate change and urban growth in large metropolitan areas and surrounding suburbs.

Lastly, there appears to be a growing consensus on the need to resort to holistic approaches and multidisciplinarity.

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Preface

The 3rd Scientific workshop of the ParisTech Suez Chair “Eau Pour Tous” on November 18, 2016, began with the assumption that sanitation is a neglected essential public utility given the repeated failure to achieve the objectives set by the international community and States.

However, few public policies have such an impact on people’s lives. In addition, the investments related to necessary infrastructures provide undeniable returns from the point of view of funding institutions, provided that externalities and avoided costs are included in the economic analysis.

Addressing the reasons for this paradox led to us to revisit issues related to ‘water for all’, but also to critique, in the scientific sense, solutions and current actions, experiments or field applications, by mobilizing a range of disciplines and approaches. To share and understand the nature of the issues, to have addressed them by raising sometimes competing or even disputed views, is also to clear the path for answers to these issues.

The discussions rapidly converged on the finding of a discrepancy between the incomplete demand of users and politicians in charge to support the provision of this essential service and the available supply of technologically varied service organized and governed at different levels.

How do we find a balance that meets user expectations and takes better account of social dimensions inherent in sanitation issues? The very term ‘sanitation’ is significant. Historically, in 19th Century in Europe, the impetus was given by the State and cities in response to the emergence of hygiene campaigns. Public policy and wastewater collection and transportation infrastructures were put in place to geographically separate the sampling site from the discharge site, taking advantage of the propensity of rivers to flow downstream.

Solutions then adopted should not conceal the complexity of the problem and cause us to forget the issues and disputes that followed and which continue to drive the adoption of such solutions. Particularly acute difficulties confronting developing countries in this respect effectively underscore the need to re-examine the nature of the issues raised by sanitation and the diversity of possible solutions. Discussions and documents testify to the emergence of a consensus, some of wich are listed below.

First, the diversity of situations requires, rather than a generic solution, a solution adapted to the context based on the pressure exerted on the territory. This pressure is rooted in developments related to demography, climate change and its impact on the availability of water resources, as well as to urban growth in major metropolitan areas and their surrounding suburbs. The pressure is everywhere at work. But its intensity varies according to the situation and its often rapid developments leads to an essential requirement, which is to adapt, whether that involves technical, economic, social or governance issues. In terms of method, the use of comprehensive approaches and multidisciplinarity seems increasingly inescapable.

Then there is the issue of the nature of sanitation. Its primary role is health prevention, by eliminating any infectious matter from the immediate environment of individuals, and not just the mere wastewater treatment since it may continue to be highly infectious, even after treatment. As for environmental policies, a major issue stems from the fact that the benefit of reducing the occurrence of diseases, especially diarrhea, is little perceived by users.

This low perception of danger contributes to the persistence of open-air defecation, which still affects a considerable number of individuals in Asia and in Africa, estimated at 1 billion people, although pilot applications in some countries or regions have led to remarkable improvements. The continuation of this practice is also due to the impossibility of accessing toilets because of the low level of investment,

maintained by a lack of knowledge of the dangers involved. This results in major health risks to populations and in the contamination of water resources, and its criticality depends on the nature and intensity of afore mentioned factors.

In addition to health issues, other aspects of a socio-economic nature should also be taken into account. In fact, another major benefit provided by access to toilets is the possibility of isolating oneself. This is just as important, particularly for women, and from an early age, for reasons of protection, human dignity and social life. And it has a number of repercussions, for example, school absenteeism, which again affects the female population in particular.

Regarding the supply of sanitation services, it is particularly necessary to take account of the coexistence of different forms of sanitation organization: autonomous; semi-collective; centralized; and conventional. This is a reality that should affect a growing number of urban areas, under the combined effects of demographic, environmental and urban development pressures. Regardless of the technologies or organizational arrangements, this diversification of supply raises the issue of the coordination of these services, organized at different levels, and the development of regulation procedures, as well as that of monitoring compliance with standards and the quality of effluents discharged into the environment. A criterion for successful coordination is its capacity to adapt to the joint changes in services and urban development.

These findings underscore the need to understand decision-making in the sanitation sector and how this sector is organized. This is a prerequisite for any action as its governance is complex. Some go as far as to see this as the main source of the sector's problems. As such, a public services manager stated that, "The main block (…) is the attempt to resolve problems between actors and the excess costs generated by conflicts of jurisdiction and responsibilities."

More specifically, the institutional, legislative and regulatory framework is progressing, as evidenced by the recent recognition by the General Assembly of the United Nations of the right to sanitation as a fundamental human right. But practices are slow to change, and any changes are heterogeneous between countries. Moreover, translating higher-level rules into local rules to arbitrate the allocation of rights, to manage and control the sanitation sector…. This is not self-evident and depends on the existence and effectiveness of intermediary institutions. For example, people's right to sanitation and basic services may very well be challenged by the simple fact that they live in precarious, unserviced areas where the management of urban planning and public services remains compartmentalized.

Indeed, the multiplicity of actors make the institutional environment considerably complex because areas of action may overlap, whereas the main objective should be, for the sake of efficiency, creating synergies between these actors, organizations and users.

Several solutions to ajust the supply of services to the needs of people are discussed in participants' presentations and have been published and are therefore available for consultation. Some of these solutions have caught our attention because, from our perspective, they reflect changes that represent progress.

One concerns the financial aspect. Sanitation service projects – where hypothetically collective and decentralized forms of sanitation coexist – are economically viable. They are also financially fragile, which represents a major problem for the satisfaction of demand and the sustainability of the service. In fact, the low degree of willingness to pay among users results in a low recovery rate of costs. Business cannot support investment and operating expenses and infrastructure maintenance requirements. This budgetary imbalance quickly leads to a weakening quality of the service.

Today, the prospect of supporting the financial effort of households is no longer rejected by international financial agencies when projects generate positive externalities, when all stakeholders, including user committees, engage in the design of developments and investment and operating

expenses are fully funded by taxes and transfers. This is supplemented by the current practice of introducing internal adjustments which distribute the surplus among the various sectors: drinking water; sanitation; or electricity. Lastly, the presence of a regulator is then essential to determine the tariff mechanism and regulatory framework, specifying transfers and ensuring good infrastructure maintenance.

In addition, social dimensions are frequently neglected due to professional compartmentalization of actions and lack of user participation. However, the issue of sanitation largely depends on socio-cultural conceptions and service supply conditions. Indian experiences in sanitation show that social relations in a rigid hierarchy can coexist with rapid changes driven by entrepreneurship or structured by the regulation and mobilization of economic instruments.

Lastly, the absence of a temporal perspective, which characterizes long-term projects, emerged as a key issue for the implementation of the solutions presented. However, proceeding in stages is inevitable when it comes to long-term infrastructure, as is the case for sanitation.

In closing this presentation, it should be noted that the event was organized at the initiative of the ParisTech Suez “Eau Pour Tous” Chair, led by Jean-Antoine Faby, and was supported by AgroParisTech and the *Agence française de développement* (AFD). The Chair is a teaching and research program supported by various partners and aimed primarily at urban water and sanitation service managers in developing countries (*see:* http://www2.agroparistech.fr/Chaire-ParisTech-SUEZ-Eau-pour-Tous.html)

The event benefited from the very effective logistical support of the Chair, in particular, of Francine Audouy, Sandra Ceschin and Laurence Wunderle, for the AFD. The publications were made possible by the participants’ presentations and detailed notes taken by students during discussions.

Claude Ménard and Thierry Rieu, March 19, 2018.

Glossary of Abbreviations and Acronyms

AAE/AWA	*Association Africaine de l'Eau*/African Water Association
AFD	*Agence française de développement*/French Development Agency
ASTEE	*Association des Techniciens de l'Eau et de l'Environnement*/Association of Water and Environmental Technicians, France
EIB	European Investment Bank, Luxembourg
BORDA	Bremen Overseas Research and Development Association, Germany
CAPWO	Drinking Water Agency in Cairo and Alexandria
CEPT	Center for Environmental Planning and Technology, Ahmedabad, India
CES	*Centre d'Economie de la Sorbonne*/Sorbonne Economics Center, University of Paris (Panthéon-Sorbonne)
COP-22	22nd United Nations Conference on Climate Change
CPR	Center for Policy Research, New Delhi, India
COD	Chemical Oxygen Demand
EAA	*Eau et Assainissement pour l'Afrique*/Water and Sanitation for Africa, Ouagadougou
EAWAG	*Institut de Recherche de l'Eau du Domaine des écoles polytechniques fédérales suisses*/Water Research Institute of the Swiss Federal Polytechnic Schools
EWRA	Egyptian Water Regulatory Agency
G-EAU	Joint research unit *"Gestion de l'Eau, Acteurs, Usages"*/Water Management, Actors, Practices
HCWW	Water and wastewater company, Cairo
HNR	Non-regulatory habitat, Morocco
INAU	*Institut National d'Aménagement et d'Urbanisme*/National Institute of Development and Urban Planning, Morocco
INDH	*Initiative Nationale de Développement Humain*/National Human Development Initiative, Morocco
IRD	Development Research Institute
IWA	International Water Association
KCCA	Kampala Capital City Authority

LSHTM	London School of Hygiene and Tropical Medicine, London
LYDEC	*Société d'exploitation de l'eau, de l'électricité, de l'assainissement liquide et de l'éclairage du Grand Casablanca*/Water, Electricity, Liquid Sanitation and Lighting Company for Greater Casablanca
MS OPT	*"Eau Pour Tous"* International Master's program, AgroParisTech
NOPWASD	National Drinking Water and Sanitation Organization, Egypt
ONAD	*Office National de l'Assainissement et du Drainage de Côte d'Ivoire*/National Sanitation and Drainage Office of Ivory Coast
ONAS	*Office National de l'Assainissement du Sénégal*National Sanitation Office of Senegal
ONEP	*Office National de l'Eau Potable*/National Drinking Water Office, Morocco
OPT	ParisTech-Suez "Water for All" Chair
GDP	Gross Domestic Product
ABR	Anaerobic Baffled Reactor
RASOP-Africa	Reinforcing capacity of African Sanitation Operators
UASB	Upflow Anaerobic Sludge Blanket Reactors
WWTP	Waste Water Treatment Plant

Welcome Address

Gilles TRYSTRAM, Director General of AgroParisTech, Paris

I am delighted to open this event, the third scientific event organized by the *Eau Pour Tous* Chair as part of a partnership between AgroParisTech and Suez Environment. This is an occasion to bring together scientists, engineers and students around major issues. This is clearly an important issue and objective, all the more so since we are bringing together countries from the south and from the north, with colleagues coming from all over the world, around a platform to conduct these exchanges.

For AgroParisTech, this event also complements students' training. The presence today of students who will be given the opportunity to meet statekholders, who deal with these issues on a daily basis, will give our meeting extra meaning.

The workshop program was defined by the Scientific Committee of the Eau Pour Tous Chair. We are at the heart of what should help us to draft our research questions, beyond the isues dealing with implementation. Research questions will then give rise to applications. Following that, we must familiarize ourselves with, and understand the nature of the issues so as to address them. Only then will the scientific path be cleared to solve these issues.

The Scientific Committee of the ParisTech "SUEZ-Eau Pour Tous" Chair has indeed chosen sanitation as its theme, given that it is strategic and needs to be dealt with today. I will not summarize the various presentations and subthemes chosen for the event. This opportunity to meet, to discuss, to exchange views, and even to present competing viewpoints, is precious. Indeed, tackling sanitation issues should be dealt with a variety of forms depending on the geographical area because sanitation isdirectly related to human activities. The organization and development of cities and regions require specific approaches. Sanitation is therefore undoubtedly essential.

Water, for its part, has a number of positive virtues, but it can also be a negative driving force, particularly when it comes to health or human health issues, or agriculture, which then ultimately affects human health and has an impact on animal health. One should remember that 2015 Sustainable Development Goals have corrected the errors made with the Millennium Development Goals, which failed to address water related issues. Today, on the contrary, five or six of the Sustainable Development Goals deal directly or indirectly with water. As such, it is clear that health issues related to water and access to water are both extremely important and hot topics.

At AgroParisTech, we also approach Sanitation as a goal. Sanitation also raises the issue of management and engineering of equipment, not to mention the development of human infrastructure. What is a network? Some networks are necessary to distribute water, but there are also information networks, human circulation networks. This then raises the issue of urban development and how sanitation equipment should be coordinated with the water distributed to the population. The definition of the service, and more particularly of the sanitation service, is to be read in the watermark of these issues: What form does it take in the various geographical areas? in political and human organizations? This essential issue may interfere with other services in the world of agriculture, food, the environment, to name a few.

Public Health and Sanitation

Opening Speech: Sanitation and Health in the Developing World

Sandy CAIRNCROSS, London School of Hygiene and Tropical Medicine, London

Clarifying the Concepts

Discussing sanitation and health in the Developing World first and foremost involves clarifying the concept of sanitation and its specific aspects. The term “sanitation” is taken in its strict sense, i.e. the elimination of human excreta. As such, the term as used here does not include water supply management, storm water drainage, household refuse collection, etc., although these issues are generally associated with the concept of sanitation.

A distinction should also be drawn between the actual and crucial contribution of sanitation to improving health and, by contrast, the low emphasis on its health benefits as arguments in creating demand for sanitation. In fact, improvement of health is not the benefit perceived as most important by the user, with individuals generally not tending to notice any positive health changes. In reality, it is comfort, convenience, social prestige and safety which drive the demand for sanitation.

There is also an important gender dimension to sanitation, as sanitation is more of a priority for women than it is for men. The benefits of sanitation for women are indeed considerable, given that in certain Asian societies, women are required to wait until nightfall – for fear of being seen by men – before they can relieve themselves outdoors. Sanitation therefore contributes to their protection against sexual harassment and even rape, as evidenced by recent horrific accounts of aggression against women, particularly in India. On the other hand, there seems to be a strong correlation between sanitation and girls’ schooling. The start of menstruation leads young girls to seek private spaces to tend to their hygiene. If schools are not adequately equipped, these young girls often prefer to stay home, for the day, the week or even for the rest of their education. As a result, the impact of the lack of sanitation for women is significant. While it is difficult to argue that the direct consequence of a lack of latrines is the risk of exposure to sexual harassment or rape, these often appear to occur near public toilets. Any installation of public toilets should therefore include equipment that guarantees women’s safety.

Improving health then turns out to be only one of the factors generating the demand for sanitation. A study in the Philippines showed that in rural areas, latrines were first appreciated for the absence of flies and bad smells, and only after for the cleanliness of the environment and the discretion offered to visitors. The health benefits – i.e. the reduction of the occurrence of diseases – came last. Another study in Benin – where the population seems little aware of the benefits of sanitation – supports these results: On average, the improvement of health was listed last among benefits. The term “health” is ranked twentieth in the list of benefits given by individuals interviewed. Accordingly, improving health does not appear to be the key argument for encouraging and promoting the installation of sanitation facilities.

Links between Public Health and Sanitation

Given engineers' habit of focusing on the quantitative aspects of reality, the analysis of the health dimension is tantamount to considering each species of organisms causing diseases (pathogens) found in stool and deriving statistical information on the proportion of the population infected by a given pathogen. The most prevalent are viruses and intestinal worms (e.g. ascaris or roundworm). In contrast, pathogens appear only rarely in urine, with the exception of typhoid fever and schistosomiasis.

An additional perspective comes from clinical studies of infected individuals by evaluating the amount, or proportion of microbes found in their daily stool. The results obtained provide an estimate of daily and individual production of pathogenic microorganisms and indicate a greater presence of viruses and bacteria than of intestinal worms. It is interesting to note that combining these two approaches confirms the fact that the entire population does not get infected simultaneously.

Simple quantitative reasoning is used to explain how wastewater, even if roughly treated by a septic system, continues to be highly infectious. If 1% of the population of a community is infected with cholera and if each infected person produces 100 million vibrios a day, this means an average of one million vibrios per infected person per day across the entire population of the community. Assuming that the entire population is connected to a sewer system and has access to drinking water and uses an average of 100 liters of water per person, this results in the presence of 10,000 vibrios per liter of wastewater. Knowing that about 90% of these microorganisms are eliminated by septic tanks and transport in the sewer system, the final concentration will average 1,000 vibrios per liter of wastewater, representing a significant infection potential.

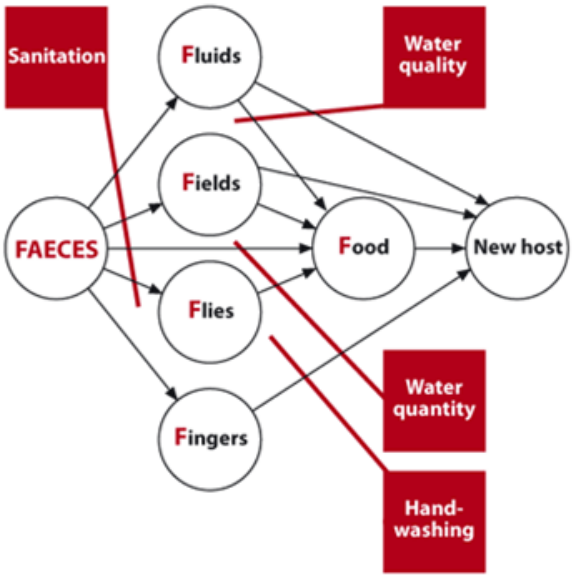
Studies of intestinal worm eggs in wastewater lead to similar conclusions. But the most important diseases, from the point of view of public health, are diarrheal, caused by viruses, bacteria and protozoa. The primary role of sanitation is health prevention by eliminating infectious matter from individuals' immediate environment.

There are two types of pathogens that cause diarrhea: bacteria (fecal-oral bacterial infection) or viruses and protozoa (non-bacterial fecal-oral infection). Protozoa can cause infection by ingestion of a more limited dose than bacteria can. Several species of both categories are often carried through animal excreta. Nevertheless, their presence adds a risk and makes solving the sanitation and public health problem even more complex. This situation is not uncommon. In India, for example, it is quite common to see cattle roaming and defecating on public roads. Feachem, Bradley et al. (1983) attempted to establish a classification of excreta-related infections and took into account the presence or absence of sanitation facilities

Ultimately, it turns out that sanitation has a negligible effect on non-bacterial infections (caused by viruses and protozoa) and a low to moderate effect on bacterial infections. Hepatitis A (virus), for example, is still present in Europe despite widespread access to sanitation facilities. Providing toilets in Africa would probably not eliminate it from this continent.

How diarrheal pathogens are transmitted varies. The following diagram of fecal-oral transmission pathways (called the "F" diagram) shows how fecal matter may be transmitted to another host through fluids, soil, fingers and food. For this reason, improving individuals' environmental health plays a crucial role in improving public health. Better quality water means fewer transmitted infections, more available water helps improve hygiene and reduces contact with fecal matter through handwashing.

Figure 1 – Diagram of fecal-oral transmission routes ("F" diagram)



The peculiarity of sanitation is to act upstream of the infection transmission system. For this reason, the installation of sanitation facilities is expected to have a significant impact on public health and its prevention.

Methodological snares

Studies relating to sanitation and its effects on health indicate serious methodological issues. The majority of these studies are based on observations and not on randomized controlled trials, which are used in public health research. While the effect of drugs can be studied using rigorous experimental protocols, this is not the case when measuring the impact of latrine ownership and use. Experiments in India, funded by the Gates Foundation, attempted to apply a traditional statistical methodology, with little success. The objective was to determine whether access to latrines resulted in decreased open-air defecation by 10% for women and a lower rate for men and children.

The main difficulty encountered arises from the fact that the implemented experiment provides households with both access to water and sanitation and that it is the simultaneous impact of these two variables – drinking water supply and sanitation –that is observed without being able to estimate the contribution of each.

This difficulty is compounded by the existence of biases related to the heterogeneity of the sample made up of community households, e.g. between those who own latrines and those who do not. This is illustrated by quantitative studies in Brazil and in Bangladesh, two very different countries. These studies show that those who own latrines generally have a higher level of hygiene in other life situations: In Bangladesh, mothers of very young children living in houses equipped with toilets washed their hands more frequently than those who did not have this access. In the same way, in Brazil, mothers from households equipped with toilets will wash their babies' pacifier after it falls on the floor while mothers from households not equipped with toilets will put their baby's pacifier back in their mouth without washing it. However, we cannot say whether it is the perceived interest in a latrine or the sense of hygiene that causes people to install a latrine at home. In other words, a survey of

people with a TV at home might reveal that they have less of a chance of suffering from diarrhea, but this would in no way mean that a television protects them from diarrhea.

The same difficulty arises for infections caused by intestinal worms since it is often difficult for an individual to know where an infection came from. For example, one of the telltale signs is symptomatic asthma. In a study in India, researchers found that two thirds of suspected asthma cases actually presented "Loeffler Syndrome" symptoms, with lung damage having actually been caused by ingestion of Ascaris eggs. Through a rather bizarre transmission cycle, these worms penetrate the intestinal walls, move to the lungs and then return to the stomach. Some researchers questioned the reason for this move to the lungs and concluded that this was a way for the parasite to regulate its population inside the host to guarantee its survival.

Musca sorbens flies tend to land on children's faces and are therefore an important public health issue. Their specific feature is that they only develop in contact with human fecal matter. During an experiment in Gambia, Paul Emerson reduced the total fly population by using insecticides in villages, which was a costly endeavor. Their reduced population resulted in a significant decrease (28%) in trachoma cases. However, the installation of sanitation facilities in other villages reduced the population of only Musca sorbens and also reduced trachoma cases.

Numerous other experiments (Trichuris, or whipworm, and chronic diarrhea; worms responsible for Ankylostoma and anemia in children), illustrate the difficulty of identifying the explanatory variables of a symptom in a statistically more robust way. In addition, they are often unfortunately not statistically significant and should be duplicated on a larger scale to better determine actions to take on population health.

When the public and political interact

After highlighting the methodological weaknesses of some studies, it is also important to present the one conducted by Moraes during the 1980s in Salvador de Bahia, Brazil, for its broader impact on public health. This was a pilot study carried out in nine favelas: three without a sanitation infrastructure (Situation 1); three with a stormwater drainage system (Situation 2); and three others with both a drainage system and a wastewater network (Situation 3). It made it possible to compare three situations with less methodological biases and resulted in interesting findings:

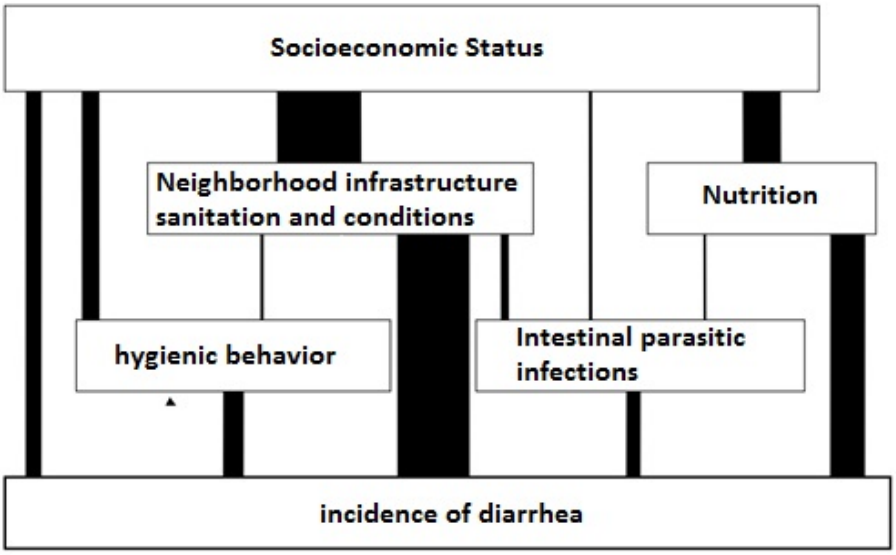
- For households equipped with latrines, children were affected by diarrhea half as frequently as their neighbors who did not have any latrines. This in no way leads to a finding of a connection with sanitation.
- There was a political dimension to the discussion of the results through inhabitants' ability to exert pressure. In fact, a community without a health infrastructure (Situation 1) had to lobby the prefect of the region to install a rainwater drainage system (Situation 2).
- Some households in Situation 2 connected their sewer systems to the stormwater drainage system. This led to the proliferation of rats and caused health damage to their neighborhood.
- The last group of favelas (Situation 3) had a separate sewage collection system. The number of cases of diarrhea in the communities in Situation 3 was divided by three compared to the average in Situation 1.

A similar effect was observed in a study monitoring infection by intestinal worms where there was a gradual introduction of sanitation network equipment. A gradual reduction in the spread of worm

infection was observed. This study was followed by the launch of a large-scale sanitation network project called “Bahia Azul” throughout Salvador de Bahia. In seven years, the coverage rate of the sanitation service increased from 20% to 80%, a remarkable achievement for a city with a population of 2.5 million.

The evaluation project that followed compared two groups of children who grew up before or after the project. It showed a decrease of 20% in diarrhea cases in the city. More specifically, the areas identified as experiencing the greatest health improvement were those with the densest sewerage networks. This analysis was refined by Genser et al. They demonstrated that 23% of the risk of contracting diarrhea was attributable to the socio-economic status of households in view of their living conditions and the quality of the sanitation infrastructure available.

Figure 2 - Breakdown of the risks of contracting diarrhea (Source: Genser et al., 2008)



By contrast, after the general implementation of the sewage system, the correlation between sanitation, poverty and disease was reduced by half, from 23% to 11%. In fact, at the end of the project, households not served by a sanitation system were not only the poorest but also those that were the most difficult to connect based on hydraulic or geographical reasons.

The Daunting Consequences of Non-Sanitation

It is important to draw attention to Dean Spears’ (2011) work in India on open-air defecation and its effects on health. One of the most remarkable results was the correlation found between open-air defecation and stunting of children, with the elimination of the influence of the “number of calories consumed per day” factor. Open-air defecation had a greater impact on a child’s growth than did the daily intake of a minimum number of calories. On the basis of other inquiries conducted in different countries, this result has been confirmed by the finding that open-air defecation is a good predictor of a child’s size at a given age.

Moreover, the study in Salvador de Bahia highlights two distinct modes of transmission of diarrheal infection according to location: On the one hand, inside and around the home; on the other, outside, in neighborhoods where the condition of sewer pipes could expose children to contact with excreta.

Peter Kolsky refined this analysis by introducing a spatial dimension and distinguishing the domestic space from the public space, itself divided into several levels: neighborhood; city; river; environment. He highlights that public health officials viewed the domestic space (i.e. the home) as the key factor in the success of a water supply project, while engineers focused on network design, environmental discharge conditions and wastewater treatment infrastructure. This discrepancy means that the sanitation and public health problem is not addressed in a comprehensive way by taking account of the connections between the home and the natural environment in terms of outflow.

Lastly, public policies must distinguish between the “green agenda”, which aims to improve environmental quality on a comprehensive level, and the “brown agenda”, which aims to improve household environments. While residents of Salvador de Bahia benefited from sanitary facilities, this is not entirely the result of an objective intent to improve residents’ quality of life, but from a desire to promote economic development in the city by improving its attraction for tourists.

Discussion: Is sanitation a neglected public policy?

Théophile GNAGNE, *Eau et Assainissement pour l'Afrique*, Ouagadougou

The hygiene approach, which correlates the lack of sanitation with the spread of disease, developed by Sandy Cairncross, highlights the discrepancy of the comfort argument advanced by households during studies on the benefits of sanitation conducted in the Philippines and Benin. However, this non-awareness of households to the health impact of sanitation is also found at the political and economic decision-making level. For this reason, sanitation is last on their list of concerns and is not generally considered "profitable" politically.

This begs the question: Why the lack of sanitation projects in Africa? With a population of 650 million that continues to be deprived of sanitation infrastructure, Africa is today in a situation identical to that of 19th Century Europe. The difference lies in the imposition of sanitation by European states in response to health problems. This priority in public policies has been reinforced by the recent emergence of environmental issues: The idea of leaving industrial, urban or household wastewater without treating it is no longer accepted.

One of the ways of promoting sanitation among policy makers could be to highlight the link between sanitation and economic growth, as the studies of the World Bank tend to show. They demonstrate the relationship between sanitation and economic growth in countries, encourage the implementation of health policies and demonstrate the economic backlogs caused by inaction.

In fact, against the backdrop of a blatant food and energy deficit, the possibility of using the resources from sanitation to make up for this deficit, even to a small extent, could lead to interesting economic growth prospects. As such, an argument based on hard data on energy production and the addition of fertilizers would give visibility to sanitation, which visibility is today lacking but essential. It partly explains explains the success of access to drinking water policies: A water reservoir, since it is visible, could be unveiled and politically declared, while sanitation infrastructure is by its nature buried and not very visible.

Finally, as long as policy makers are not interested in sanitation, the health situation is unlikely to improve. Under the assumption that economic growth, induced by sanitation, is enough to arouse the interest of policy makers, we will have to act on public health, while producing biofertilizers and renewable energy.

Discussion with Audience Participants

The opinions expressed in discussions with audience participants and summarized below are those of the individuals who spoke and do not necessarily represent those of the panel speakers.

Sandy Cairncross' and Théophile Gnagne presentations sparked discussions on three distinct topics: sanitation research; the different perspectives from engineers and public health experts; and the economic value of water.

There is currently little research dedicated exclusively to sanitation, focusing on the study of jurisdictions leading policy makers to implement a sanitation project or deepening the issue of users behavior change. However, we are seeing developments.

The Gates Foundation is conducting a number of large-scale projects on this issue, even though initial results are modest. An Indian project called “Super Amma” focuses on behavioral changes regarding hygiene (washing of hands, using soap) and has generated encouraging results.

Regarding the issue of the different perspectives of engineers and public health experts, engineers are mainly involved in the design of infrastructure projects supported by international institutions, such as the World Bank or the African Development Bank. As a result, they have little presence in projects aimed at assessing changes in practice or behavior in the area of health. This trend could be explained by their training and their appeal to quantitative approaches. As a result, there is still a way to go to convince international institutions of the relevance of involving health experts in these projects. The challenge is to change the way they look at sanitation and to develop programs that promote social acceptability.

Regarding the economic value of water, it turns out that the elasticity of demand for drinking water is low or even zero. Demand varies little even in drought conditions and when prices soar. Conversely, demand may fall dramatically in times of plenty. It is important to note that the cost of water supply may account for 10% to 20% of a family’s resources, not just financially but the time it takes to actually get the water. Since income does not depend on the availability of water resources, it is the poorest who devote the largest share of their resources to water supply.

Finally, in addition to technical discussions, the problem of sanitation raises questions of gender and human dignity: When will there be communication and studies on these aspects?

Social Demand and Social Acceptability of Sanitation

"Swachh Bharat Abhiyan" Making India Open Defecation Free in 2019: Will it Succeed? "

Dinesh MEHTA, CEPT University, Ahmedabad, Gujarat, India

The need for a clean India

The term "Swachh Bahrat", "A Clean India" in English, is the slogan for the sanitation program launched by the Prime Minister of India, in power since 2014. Since taking office, one of his first policy actions focused on sanitation and he has mobilized public resources and the Indian population around the goal of cleaning up the country. With 600 million people practicing open-air defecation, India is considered the international capital of open-air defecation, with Indonesia close behind; Bangladesh, for its part, has succeeded in virtually eliminating this practice.

With Indian cities facing a high-risk health situation, the program first concentrated on sanitation in urban areas: of 350 million inhabitants, 62 million lack toilets and 20 million only have access to communal toilets. While studies by the World Health Organisation (WHO) and the World Bank estimate that the use of communal toilets cannot represent a safe health situation, through our studies, we succeeded in demonstrating that a toilet used by 2 or 3 families generates few health risks. These communal toilets are the reality of a significant part of the population of India: For example, in Bombay, 40% of inhabitants live in shanty towns, with no space available for installing toilets. Common toilets are then necessary: some are well managed, others less so.

Context and data of the research program

The 2011 data of the survey of the households and their assets demonstrated that individuals have more cellular phones than toilets. The need for a cellular phone is visible: It is a tool that facilitates professional activity and generates certain economic benefits. By contrast, the benefits generated by the installation of toilets are not as perceptible. The Prime Minister's decision to launch a sanitation program aimed to change this attitude and behavior.

The Performance Assessment System (PAS) research project was funded to oversee and better monitor the implementation of major urban infrastructure investment projects. Two distinct points of view emerge:

- that of the engineer, focused on the construction of networks while ease of access to sanitation service should also be ensured; and
- that of local public sector authorities, whose competence lies in providing efficient public services to the end user.

In this way, the objective of our research project is to assess the performance of these public services and the effectiveness of associated local public policies, using a recent database. At present, the

performance of 870 local authorities in urban areas has been monitored for five years. These data are also available in real time[1].

In this account, only the sanitation dimension of the national program is presented. Our study relates to Maharashtra, the most urbanized state in India, and where Mumbai[2] is located. Maharashtra is where a large part of the population depends on communal toilets and where the practice of open-air defecation is significant.

Swachh Bharat Abhiyan: Project methodology

Academic studies relate more generally to habitat, due to the organization by discipline of the teaching provided: architecture; urban planning; engineering of buildings and of urban infrastructure.... Our approach to local sanitation falls within a comprehensive vision of urban planning by analyzing the compatibility of the sanitation project with present or future urban infrastructure. In other words, we consider the city as a whole, identifying the problems encountered, the places where open-air defecation is practiced, the motivations for this practice and the reasons for the lack of toilets (lack of financial resources, lack of space, etc.). To facilitate the conduct of household surveys, Android applications were developed enabling researchers and students to gather data during their field actions.

The project was conducted in several stages:

- Diagnosing the situation;
- Identifying the demand for sanitation (current practices, implementation capacity, etc.);
- Seeking funding from public sector authorities and support in drawing up requests;
- Assisting the poor population to complete forms;
- Assisting local authorities in assessing the actual needs and expected benefits;
- Launching an awareness-raising campaign, organizing meetings with civil society stakeholders and disseminating information through various media (radio, television).

In terms of results, these field actions, and with stakeholders throughout the project, contributed to motivating inhabitants to demand the installation of toilets. The most effective actions seem to us to be the administrative support provided for drawing up funding requests to local authorities, with this assistance available throughout the entire duration of the project, and above all awareness-raising among schoolchildren.

Several toilets are today provided by local service providers. The mechanism adopted is that of the septic tank. This choice led us to define and disseminate standards for their design. All of these documents and this information is then used as training material.

[1] Consult www.pas.gov.in to access the databases
[2] The political decision-makers of Maharashtra had taken the initiative of associating themselves with the research team directed by Dinesh Mehta to assist them with the implementation of the national sanitation program.

Identifying dissuasive or incentivizing actions

Dissuading unsuitable practices

The response of local authorities to the practice of open-air defecation takes the form of variable actions of a highly contrasting nature. Some develop dissuasive actions ("naming and shaming") by monitoring the locations used most frequently for this purpose and filming the involved individuals. Others have used incentives by rewarding changes in practice with prizes.

It is interesting to note that half of the cities in Maharashtra (100 cities out of 200) stated that the practice of open-air defecation has disappeared without us knowing the real impact of our project. Such a result has only been achieved in Maharashtra. Even with this restriction, this development represents a major success since Maharashtra includes half of the cities in the country.

The status of toilets: between private and public goods

We start from the principal that the collection and treatment of wastewater is as crucial as the installation of toilets. A system of indices of the level of sanitation achieved by cities as defined by the ODF (*Open Defecation Free)* indicator, with three levels of increasing performance*:* ODF; ODF+; ODF++.

Sanitation projects require particularly large investments in infrastructure and raise the question of ownership, whether public or private. Legally, toilets are considered private property, even if they were built as part of a national program implemented by the state's public policy. This raises the question of the possibility of public support for their installation.

By contrast, public authorities invest considerable amounts in the installation of sewer networks and treatment stations, which are not always functional. These amounts depend on the project design and the sanitation levels targeted. The optimization of financing, performance levels of transport and treatment facilities are some topics we are studying.

Strengthening projects by inter-sectorial approaches

Two thirds of the demands for toilets derived from neighborhoods, which cannot be classified as shantytowns. These are mainly dilapidated houses, equipped with external toilets, requiring significant work. We have therefore associated credit and microcredit organizations with our project in order to support the funding of the equipment. We also undertook to inform households of the available means of funding, while guiding them towards appropriate institutions. Moreover, we are interested in the following questions (already asked by Dean Spears):

- Why aren't households equipped with toilets?
- If they have toilets, what are their constraints?
- How should the installation of the toilets be financed?

Self-assistance

Self-assistance and the involvement of end users are also important in the creation process and then in management of sanitation devices. As part of the project, we assisted and supported the organization of several autonomous assistance groups or committees, particularly those composed of women. In this way, we organized a committee in which 10 women came together to borrow and manage funding resources.

Partnerships with companies

The last lever is the creation of the "India Sanitation Coalition", which brings together companies whose field of activity is sanitation. To illustrate this, this week, Mumbai is holding a meeting which brings together professionals in sanitation and installation of toilets (Toilet Board Coalition Meeting). The economic and commercial dimension is therefore just as important in the project, with crowdfunding being another lead to explore.

Conclusion

In several cities within Maharashtra, we have succeeded in eliminating the practice of open-air defecation. This has been the result of multiple factors. First of all, we acted in partnership. If the project, as such, derives from a national program, we also involved universities, financial institutions, sanitation professionals, etc. Political mobilization at the federal and local levels also contributed greatly to the success of this implementation, given that the autonomy of local decision makers was preserved.

The approach adopted by Maharashtra is based on demand: only those expressing a desire to install toilets receive funding. At the same time, building toilets is not sufficient. Our objective is also to achieve an "ODF+" rating.

"Demand and Social Acceptability of Sanitation: The Invisible challenges of Gender, Caste and Labor"

Marie-Hélène Zerah, IRD/*Centre d'Etudes en Sciences Sociales sur les Mondes Africains, Américains et Asiatiques* [Center for Social Science Studies for Africa, the Americas and Asia], Paris and Sweta Cess, Center for Policy Research, New Delhi, India

This account offers research perspectives aiming at a more accurate understanding of the sociological issues arising with regard to sanitation. It is based on a project in progress, which notably studies the possibility of developing alternative technologies, new funding and governance models, as well as other institutional assemblies. It is carried out in collaboration with the Center for Policy Research in India, with the financial support of the Gates Foundation, which is highly active in the region regarding sanitation and its challenges.

In addition to traditional technical-economic questions in the analysis of networked services, the sanitation sector presents specific challenges linked to the issue of gender, the interlinking between the nature of labor and social structures, in particular the role of castes, and the possibility for young people to appropriate this question. We wish to develop a research program around these areas. The first stage is in progress with a survey in Delhi to achieve a better understanding of the links between gender and sanitation and the connections between labor, sanitation and caste. The results of several months' fieldwork, likely to raise questions and to open part of the discussion, will be presented.

A debate arising in India

In India, the question of sanitation emerges in public discussions on urban development. Around this question, there is a reflection on the definition of inclusion, when the sanitation sector was left aside during both the colonial and the postcolonial period. Numerous studies have shown that the problem of funding constitutes a continuing barrier, without forgetting:

1. The phenomenon of gigantism, which tends to prioritize the scale of infrastructure over the dimension of the service;

2. The tendency of elites to escape sanitation problems, insofar as these concern them, making it difficult to build a notion of general interest.

In view of the accumulated backwardness in sanitation, a national program, the Swaach Bharat Mission, launched in 2014, aims to give a new impetus to this sector. The observations which have just been announced constitute a basis from emerging from apathy. The double notion of inclusion is mobilized, since the idea is to produce both universal services for everyone, while improving access to toilets and to hygiene. The work of historians on the postcolonial period has shown that part of the work linked to sanitation, notably manual removal of excreta, is carried out by the lowest castes, contributing to the construction of highly inadequate network infrastructure. Consequently, political decision makers have legislated to prohibit recourse to manual removal of excreta, which will simultaneously permit an improvement in the working conditions of workers in the sanitation sector.

At the same time, the *Swachh Bharat Mission* has emphasized funding and technology; the question of sanitation nevertheless depends largely on socio-cultural conceptions and the provision of the service.

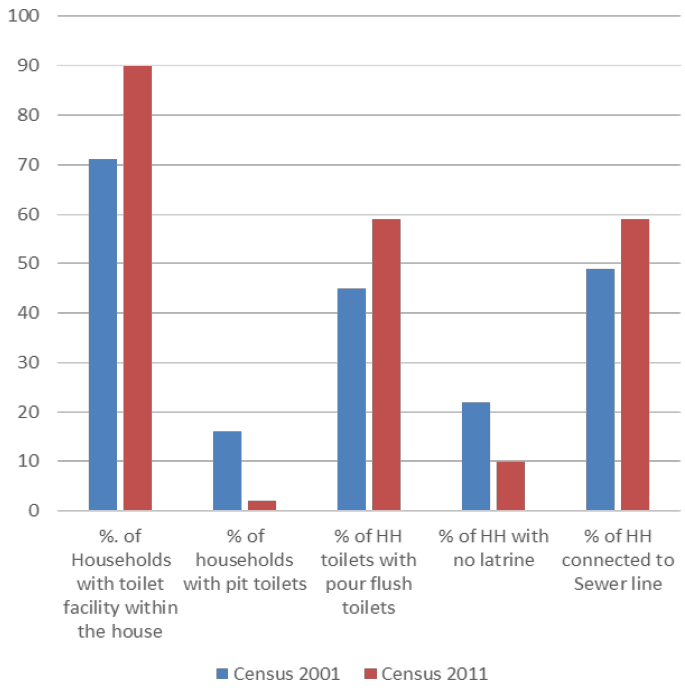
The individual as prism

During public discussions in the city, which probably concerned research more than public action, the Swachh Bharat Missions reopened the question of the relationship between labor and caste, as well as that of dignity. Indeed, sanitation, in its capacity to ensure the dignity of individuals, takes on major importance, notably for sanitation jobs, such as manual scavengers, municipal employees responsible for the cleaning of drainage networks or also ragpickers.

In this presentation, we are interested in those whose work consists of the mechanical evacuation of septic tanks. These are effectively located at the crossroads between the challenges of improving networks and the end of open-air defecation, in the knowledge that studies on the importance of the septic tanks are far less numerous in India than in South East Asia or African countries.

In Delhi, the capital of India and the second largest city in the country by size, the role of these septic tanks remains extremely important, even if public policy aims to generalize connection to the sanitation network. There are numerous neighborhoods in Delhi that only have septic tanks and are not simply composed of slums. This group includes former villages incorporated into the city of Delhi, or low-density neighborhoods located on the periphery. Halfway between the initiatives to develop services and to change the behavior of users, it represents a particularly interesting object for researchers.

Figure 3: Evolution of types of sanitation in the city of Delhi between the 2001 and 2011 censuses (Source: NCT)



By contrast, studies on the regulation of companies responsible for emptying septic tanks, on encouragement to improve their performances and on environmental regulations on the treatment of gray water are few or even non-existent in India.

Since this study is in progress, the proposed elements are developing and being progressively constructed. They initially represent working hypotheses which waive the idealized trajectory of a rapidly operational centralized service starting from the blank sheet which exists today.

To problems concerning the dignity of the labor is added the prospect of sanitation as a site where a space can exist, in apparently paradoxical fashion, for the emergence of new forms of entrepreneurship. Our research project consists of deciphering the profile of these workers, their practices, the remodeling of labor issues and the possibility for other entrepreneurs to intervene and improve access to sanitation.

Prospects

The problem of caste remains essential. Since we are not specialists in the issue, it is still difficult for us to propose its coordination with public policy challenges. It is nevertheless possible to observe very varied practices, between owners of trucks, entrepreneurs and those carrying out the emptying, notably in terms of relations with the user. I agree with Professor Mehta's statement that Indian society is far from fixed; that first of all, we must understand its practices to then implement policies for regulation, licensing or improvement of working conditions.

Sanitation may also play a role of go-between between the rural and urban economies. Owners of tankers belong to different socio-economic groups, who wish to develop an activity which is promising, easy and diversifiable. This capacity to innovate and find solutions must be studied in parallel to an analysis of labor and environmental regulation costs. For now, the market is not structured, waste deriving from septic tanks persists and represents a problem. Decentralized solutions, not based on connection to a sanitation network which are envisaged today must be accompanied by a regulatory framework and regulatory mechanisms.

In this way, with regard to sanitation, it must be observed that social relationships set in a rigid hierarchy may coexist with possibilities for mobility by the entrepreneurial class, and of structuring through the regulation of prices, control of labor and regulation of the environment.

Implementation of Liquid Sanitation Programs in Five African Capitals: What Level of Social Acceptability?

Mbaye MBEGUERE, African Water Association

Blatant inequalities and imbalances

This presentation provides an example of a strategy for promotion of sanitation designed for the African continent, in the knowledge that 2.5 billion people lack sanitation and that 84% of Sub-Saharan populations use independent sanitation. Sanitation strategies and approaches must be drawn up taking account of the sociological, cultural and economic context into which they are inserted, instead of blindly applying the traditional formulas originating with development and financial agencies.

To illustrate this, the Cambérène waste water treatment plant in Dakar functions relatively well but represents an electricity cost of almost 1 million dollars for the capital, which has a global annual sanitation budget of only 6 million dollars. In this context, the independent sanitation solution, which is cheap in terms of operating costs, takes on particular significance with regard to the necessary investments in sanitation infrastructure, costing an estimated 5.5 billion dollars per year for 18 African countries.

At the same time, the coverage and quality of services proposed by the operators of independent sanitation services, who are essentially African, remain grossly inadequate. The challenge is therefore to improve the sanitation service through more effective incentives with regard to operators.

For now, we can only note the low degree of competence of operators in operating sanitation systems, in a context of rapid demographic growth and uncontrolled and tentacular urbanization.

The work of the African Water Association

The African Water Association is a strong institution, recognized for reinforcing the capacities of water and sanitation companies in Africa (70 sanitation companies are members). Regular meetings are held, every four months, in an African capital, in order to discuss the issue of sanitation. Moreover, a conference is organized every two years with international stakeholders in the field to discuss challenges and current and future projects. The last conference, held in Nairobi, was attended by nearly 2,000 participants, experts and representatives of organizations working on water and sanitation.

The RASOP-Africa project, implemented by the association and funded by the Gates Foundation, aims to improve the coverage and quality of the service for independent sanitation service and management the fecal sludges for at least one million people in Sub-Saharan Africa. It has four goals:

- Adapting and disseminating technical directives for promoting independent sanitation and the management of fecal sludges: In seeking to improve sanitation, it is possible to encounter a lack of tools, whether general or localized. We accordingly wish to ensure that these tools are known, promoted and adopted by the state to ensure a genuine improvement in the current situation;
- Strengthening of the capacities of sanitation operators in five African countries through the design and dissemination of normalized operating procedures;

- Supporting operators to draw up strategic sanitation plans and an appropriate regulatory framework;
- Improving the governance and responsibility of the management team of the African Water Association program.

Monitoring local stakeholders

One of the key factors for the success of the RASOP-Africa project is the implementation of a partnership system between African cities. This is primarily a question of surveying the cities distinguished by the quality of their tools or actions. With regard to fecal sludges, it is mainly Durban that distinguishes itself by permitting free access to toilets and free removal by Ethekwene Municipality, an innovative and efficient company in technological and social matters. The idea would then be to encourage African cities to draw inspiration from this model, or even to reproduce it in countries.

In Dakar, the work of the ONAS (*Office National de l'Assainissement du Sénégal*) has permitted the implementation of numerous ambitious projects, such as:

- The installation of toilets in an area susceptible to be flooded;
- An economic model permitting poor populations to access the installation of toilets,
- A call center placing different scavengers in competition to execute missions requested by local populations.

This is also a question of permitting other African countries to appropriate these tools in order to develop the sanitation system which they need. In this way, for certain projects, populations took the initiative and created a guarantee fund to aid scavengers to renew their vehicle fleet, as well as a comparable mechanism for drinking water and the treatment of sludges.

We also considered that the ONAS and Ethekwene Municipality could play the role of mentor for cities which have been less successful with their plans, so that they benefit from the experience of the former:

- Yaoundé Municipality, Cameroon;
- KCCA (Kampala Capital City Authority), Uganda;
- Lusaka Water, Zambia;
- ONAD/YKRO Municipality, Ivory Coast;
- ANGESEM Bamako, Mali.

Kampala and Lusaka accordingly benefited from the advice of Ethekwene Municipality and Bamako, Ykro and Yaoundé from the monitoring of the ONAS. The aim is to compare (benchmarking), to exchange experiences and to identify appropriate tools for implementation on the ground.

A value chain to be maintained

Sanitation may be regarded as a value chain. The development of sanitation in Africa is nevertheless often limited to the policies which will certainly permit the installation of latrines in the city and the implementation of plants for treatment of fecal sludges, but which do not raise the issue of links between activities, evacuation procedures (mechanical or manual) and the potential revenue for the companies.

Discussion

Jacques Bertrand, AquaOrbi/Chair ParisTech "Suez-Eau Pour Tous", Montpellier, France

The three preceding[3] interventions present complementary elements for the study of sanitation problems, focusing on:

1. The considerable leverage of political involvement in sanitation projects, as is demonstrated by Maharashtra;
2. The role of employees responsible for the service, overlooked to the benefit of the policy and the beneficiary; and
3. The importance of promoting decentralized sanitation, which, in addition to its essential importance for dignity, hygiene and health outside of the collective sanitation zone, is a synonym for employment, as well as for financial contributions in addition to the support of the state.

Several contradictions nevertheless challenge this:

- Are sanitation projects too costly or can they be considered as a source of revenue? Public sector authorities often state that collective sanitation would be too costly, whence the need both to mobilize households financially and to encourage them to create latrines. This latter solution may nevertheless be revealed to be even more costly than collective sanitation when the full cost is calculated.
- Should autonomous sanitation be considered as a step towards collective sanitation? If so, should its organization ultimately be centralized? Or should it be conceived differently, by mobilizing current and innovative technologies?

We should note the heavy involvement of the Gates Foundation in sanitation projects in India and in Africa. Indeed, this foundation funds sanitation research projects in developing countries. In India, at least 60 institutions benefit from its funding. On account of this, certain researchers wonder about and even termed this support imperialistic, since it orients the public sanitation policies of certain countries towards decentralized solutions, far removed from traditional sanitation network projects.

We are therefore witnessing a change in paradigm for sanitation policies: The African experience[4] demonstrates the success of a lower-cost technology for the treatment of fecal matter compared to the

[3] Intervening parties: Dinesh Mehta, Marie-Hélène Zerah, Mbaye Mbeguere

installation of a network of sewers and waste water treatment plants. These so-called traditional projects are very expensive in financial terms and consume 90% of the budgets allocated to sanitation projects.

At the same time, contrary to received ideas, it is not so much the investment requirements of sanitation projects which are the hardest to satisfy, since funders are inclined to finance the construction of networks of sewers. The true difficulty lies in their operating cost. Indeed, a waste water treatment plant entails high-energy costs. The question then arises not in terms of investment costs, but of operating costs. The operation of autonomous sanitation is nevertheless much cheaper than that of collective sanitation.

Regarding the question of the cost of sanitation, which some figures regarded as excessive and others insufficient, a reply surely lies in the demand and the operating cost of the systems. The extent of septic tanks in India, mentioned in the work of Dean Spears, is induced by local reticence in cleaning this infrastructure. With regard to the origin of this reticence, it is undoubtedly complex and complicated to understand. The problem of operation arises not only in centralized networks but also in autonomous sanitation solutions. Autonomous sanitation does not resolve all of the infrastructure questions necessary for the quality of the service.

Discussion with Audience Participants

The opinions expressed in discussions with audience participants and summarized below are those of the individuals who spoke and do not necessarily represent those of the panel speakers.

The interventions of D. Mehta, M-H. Zerah and M. Mbeguere generated exchanges on three distinct topics: the apparent opposition of autonomous sanitation and collective sanitation via a network, the links between access to water and to sanitation, then the historic dimension of the development of the field.

Contrasting autonomous sanitation and network-based sanitation does not appear, for certain individuals, to be a relevant aspect for reflection, since this debate could divert attention from the question of access to sanitation. Access is nevertheless a central question. It would be desirable to establish a common vision or even coordination between collective sanitation and decentralized sanitation systems. In reality, the opposition relates more to the impacts on the environment, which depend on population density and the location of developments in an urban or rural environment.

Access to drinking water should involve the installation of a separating system for evacuation of wastewater. This would permit access concomitant to access to water and sanitation. In addition, isn't the question of social demand for sanitation linked to prior regulation of access to drinking water? This is indeed one of the challenges presented by public decision makers in India, where only 300 cities are equipped with an evacuation network for grey water. Moreover, it was demonstrated[5] that open air defecation and the absence of access to drinking water are highly correlated. There is thus indeed a link between access to drinking water and sanitation.

Lastly, it remains very important to take the historical dimension of sanitation into account. The full coverage of Western cities by networks of sewers resulted from local political decisions, establishing

[4] Presented by Mbaye Mbeguere: "Implementation of Liquid Sanitation Programs in Five African Capitals: What Degree of Social Acceptability?"
[5] Research executed by Mehta and Mira

the obligation to install a collective sanitation mechanism for sanitary reasons. Furthermore, social mobilization also contributed to ensuring the advance of these projects. This comment raises the issue of the status of sanitation: is it ultimately a private good or a public one? Indeed, if history has shown that sanitation networks in Western cities were financed with public money, this scheme seems hardly realistic in the case of developing countries with limited financial resources. Recourse to sanitation could thus be conceived as a public policy, bearing in mind that the investment of public authorities in the field of sanitation is firstly motivated by a question of public health and that it remains crucial for reasons of financing. It is thus important to know the mechanisms for the construction of the perception of sanitation as a question of a service of general interest.

Network sanitation and on site sanitation: Avenues for coordination

Decentralized sanitation systems in middle-income settings: challenges and opportunities

Christoph LÜTHI, Institut de Recherche de l'Eau du Domaine des écoles polytechniques fédérales suisses – Sandec, Zurich, Switzerland

The advantages and inconveniences of small-scale solutions

As a preamble, it should be noted that French researchers have developed beds planted with macrophytes, one of the most effective decentralized solutions and have tested and duplicated these hundreds of times, above all in the south of the country, in order to treat wastewater from local authorities.

Managing fecal sludges on a small-scale forms part of the solutions offering the best cost/benefit ratio, since it offers a middle way between low-cost local solutions for low population density zones and large-scale solutions which are more conventional, complex and with high operating costs.

The small-scale solutions offer certain advantages. They do not require electricity, have a low operating and maintenance cost, some do not produce sludges, they have a long lifespan and allow a significant reduction in dissolved biochemical oxygen demand (BOD).

Against this, these solutions require solid expertise, since some technologies do not permit a significant reduction in pathogens. It is then indispensable to add a complementary treatment of the effluents and sludges produced.

To illustrate our comments, we have chosen the case of a research project in progress, in India and southern Asia, financed by the Gates Foundation and managed by Eawag-Sandec with the support of the IIT Madras[6] and BORDA[7] . This is a 2-year program, which studies small-scale sanitation devices present in India.

EAWAG in India and South Asia

The objective of this program is to develop practical recommendations on small-scale sanitation systems, aimed at central public stakeholders and potential investors. More specifically, we analyze the institutional and managerial “systems” necessary for assembly and the effective and profitable operation of such solutions.

One of the most complex objectives of the program is to examine the investment and operating expenses and the maintenance requirements of the infrastructure as a function of the considered operating scales. Lastly, we shall study the contexts in which a small-scale device would constitute an optimal and durable solution.

[6] Indian Institute of Technology – Madras
[7] BORDA – (Bremen Overseas Research and Development Association – Germany) www.borda.de

400 devices in 4 countries (India, Nepal, Bangladesh and Pakistan) have been selected according to 4 principal criteria:

- Being operational for at least 2 years;
- Using established and proven technologies (no prototypes);
- Servicing 10 to 1,000 households, producing 140 liters of wastewater per day (benchmark contingent on the Indian context);
- Treating household wastewater rather than industrial effluents.

The priority sites for this research project are residential (70%), but also commercial and institutional. The selected geographical zone corresponds to the South of India and includes the states of Karnataka and Tamil Nadu. Indeed, they are engines for the promotion of small-scale sanitation in urban and peri-urban zones. Lastly, we shall consider two large cities, Bangalore and Chennai, where thousands of the devices have been installed over the last 5 years.

We shall analyze the regulatory and institutional framework in the two States, as well as in New Delhi and Mysore, a smaller city, in order to understand how the sector is governed, both at federal and at local and municipal levels.

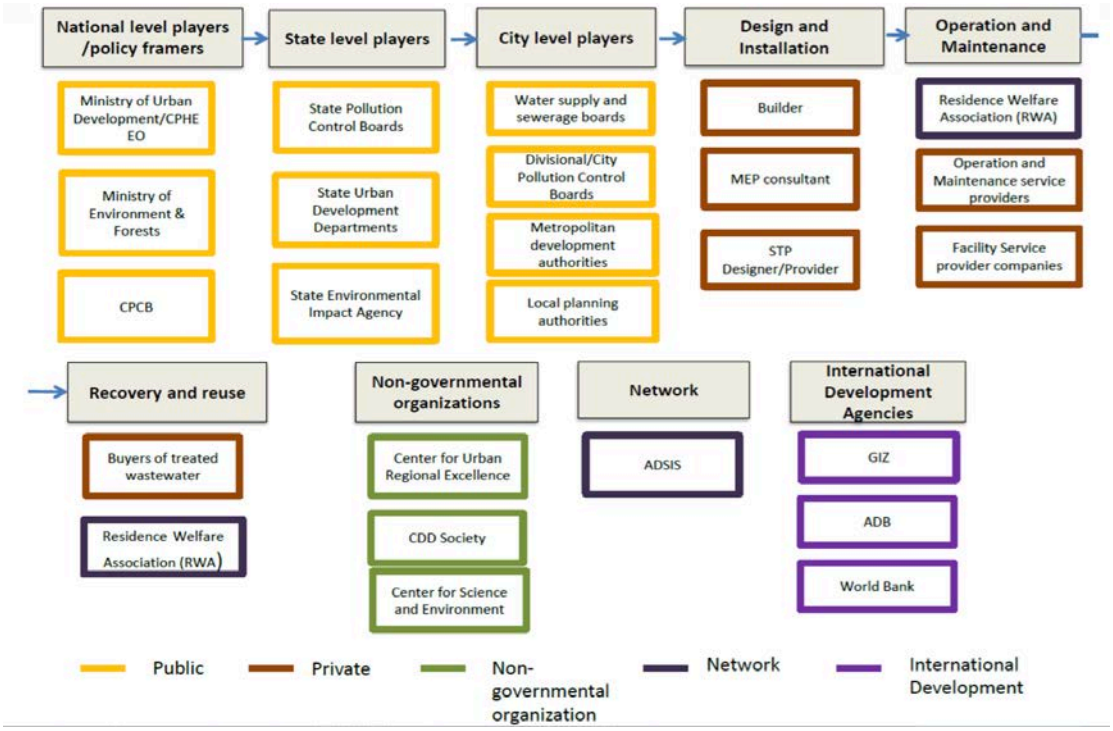
Several major obstacles

A complex institutional framework

One of the major problems of the sanitation sector in India lies in the complexity of its institutional framework: from federal level (Ministry, agencies) to the level of the states (Pollution control entities, Departments of urban development and Agencies for studying environmental impact) and at the level of the city and its stakeholders. Unlike the other studied countries, India has a very dynamic private sector, in which consultants, providers of maintenance services and other companies which design and install sanitation devices are prospering.

This multitude of stakeholders renders the institutional environment highly complex, since the perimeters for intervention overlap, while the principal objective is to be able to create synergies between these stakeholders and organizations.

Figure 4 - A complex institutional environment in India (source: EAWAG)



The regulatory framework

Some regulations in effect also generate difficulties. This is a question, for example, of the standards for liquid effluents, established by a circular of 2007, which provides that all waste water treatment installations must reuse the wastewater treated in situ: this is a considerable challenge in the current context. Indeed, if neighboring villages, in a rural zone, may be interested in the treated wastewater to irrigate their crops, it seems impossible to apply such a regulation in an urban environment.

The State office for the supply and storage of water is responsible for public sanitation services and drinking water. In this capacity, it draws up provisional plans for development of the corresponding infrastructure of the city. It nevertheless exercises no control over the process of attribution of construction permits, which is piloted independently by the state pollution control entities. This illustrates the disparities which appear between infrastructure projects in the city and the regulations applied by the state pollution control entity.

Understaffing

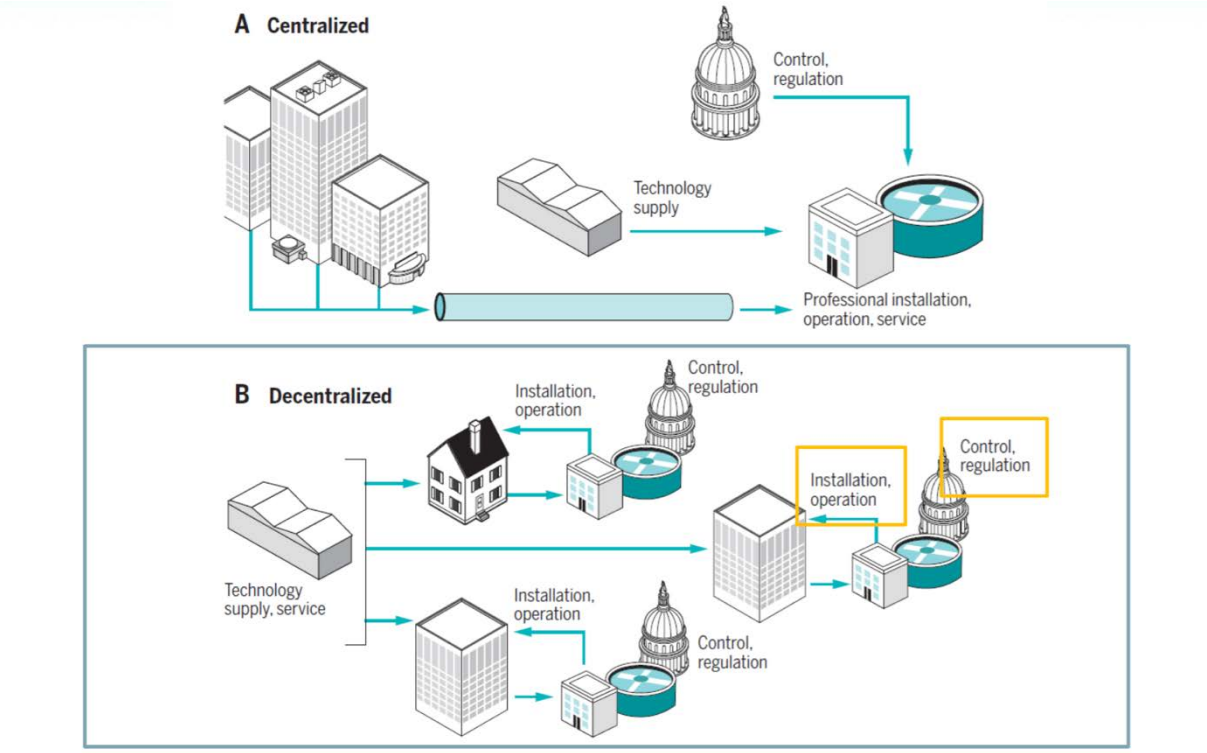
State pollution control entities suffer particularly from understaffing and are unable to manage the growing number of local sanitation devices. In the state of Bangalore, 4,500 sanitation devices are in the process of installation. As such, very few controls of the performance of the installations can be carried out. This encourages users to reduce investment and operating expenses, by drawing on unqualified operators and to halt treatment at night… to the detriment of the effectiveness of treatment of effluents. These practices testify to the lack of organization and regulation of the sector. They should be combated.

Technologies for today and tomorrow

The institutional model benefits from an extensive range of technologies, from the simplest device (the decentralized wastewater treatment system) to the most sophisticated one (oxidation of activated carbon). These latter are so technologically advanced that very few stakeholders have mastered them; they nevertheless contribute to the development of a dynamic private sector. Klaro, which offers a turnkey solution for the residential suburbs of Chennai is an example of this. The prefabricated treatment devices are designed in such a way to correspond to the needs expressed by property developers, in such a way as to simplify the choice between the different existing systems. The inconvenience always lies in the fact that very few controls are conducted on these devices.

The basic models for treatment of wastewater are just as interesting as those which are technologically sophisticated. In Nepal, a school in Kathmandu and the hospital in Sushma use a decentralized treatment system, based on the French model of beds planted with macrophytes. This system offers undeniable potential but still requires the implementation of a favorable environment. The Gates Foundation is working in this sense in proposing the establishment of a new regulatory framework, while encouraging and important paradigms shift. It consists of moving from a centralized system to a more decentralized one for control, regulation, installation and operation of these treatment devices, in which the private sector will have a decisive role to play.

Figure 5 - For a new regulatory framework (source: Larsen, Hoffmann, Lüthi, et al.; "Emerging solutions to the water challenges", *Science*, May 2016)



Key conclusions

From our research, priority actions emerge, aiming to:

- Design public policies which support the installation of small-scale sanitation in India;

- Disentangle the institutional confusion, clarify governance and explain the boundaries for action of the different stakeholders on all scales;

- Need for centralized management of these decentralized systems by including a simplification of the regulations and stricter control of standards and quality of the effluents discharged into the environment.

Today, it is difficult to access these treatment systems and to conduct quality controls of the effluents. Improving this situation has become essential to avoid the propensity of operators to minimize operating costs and to underinvest to the detriment of performance in treating effluents.

Sanitation in Egypt: Challenges and future perspectives

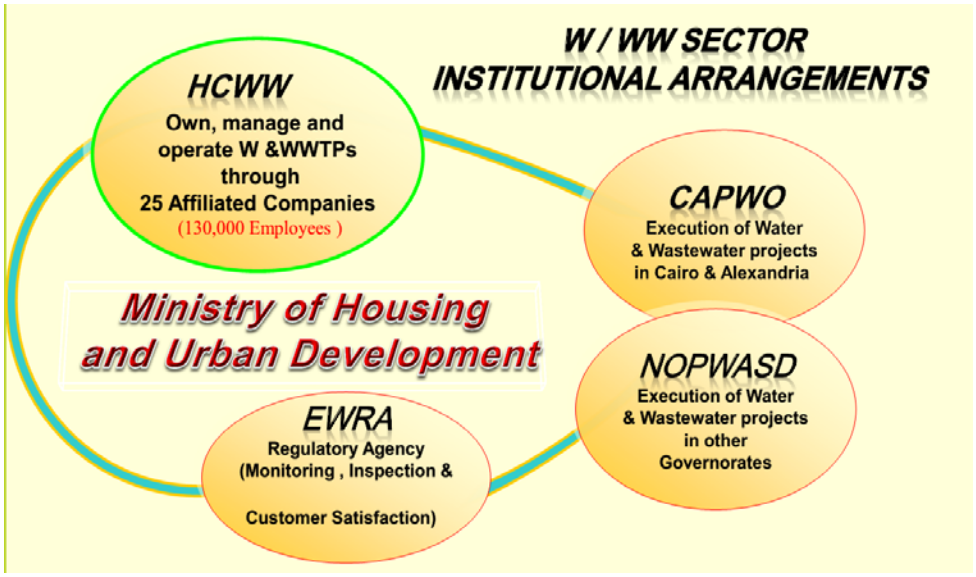
Rifaat Abdel WAHAAB, Holding Company of Water and Wastewater, Egypt

A review of sanitation in Egypt

Egypt is a country with 90 million inhabitants, who live in 249 cities, 4,766 villages and 30,000 hamlets. The country is facing problems of water scarcity with a ratio in 2016 of 670 m^3 of water available per inhabitant per year, which will fall to around 500 m^3 of water per year in 2025. This hydric tension is driving an interest in the reuse of wastewater and in the productivity of each cubic meter of water. At the initiative of the Egyptian government, several reforms have been implemented, thereby establishing 4 institutions responsible for water, under the aegis of the Minister of the environment and of urban development:

- The Drinking Water Agency in Cairo and Alexandria (CAPWO) and the National Organisation for Drinking Water and Sanitation (NOPWASD) have the task of implementing the programs for distribution of drinking water and the treatment of wastewater;
- The Water Regulatory Agency (EWRA) is in charge of the piloting and control of the quality and of performance of equipment;
- The Water and Wastewater Company (HCWW) possesses, manages, operates and carries out maintenance operations on all plants within the country, through 25 subsidiaries.

Figure 6: Organization of the management of drinking water and of sanitation in Egypt.



The water and wastewater sectors produce the equivalent of 25 million cubic meters of water per day with 2,700 stations for the treatment of drinking water and a network of 146,000 km of pipes. However, only half of this water passes through sanitation networks with 12 million cubic meters of wastewater per day; there are 412 waste water treatment plants, thereby covering the requirements of 56% of the total population. Moreover, if 93% of urban zones are covered by sanitation networks, this is only the case for 15% of rural zones. A considerable effort is necessary to achieve the sanitation objectives for 2022.

For urban zones, 7% of new developments built have not yet been connected to a sanitation network. Certain projects are in progress but are facing difficulties: 40% of existing WWTP are saturated and would require extensions. In the region of the Delta, where there is little available space for large-scale projects, recourse to innovation and technology is crucial for doubling the treatment capacity of these stations.

Figure 7: Coverage of drinking water supply requirements in Egypt.

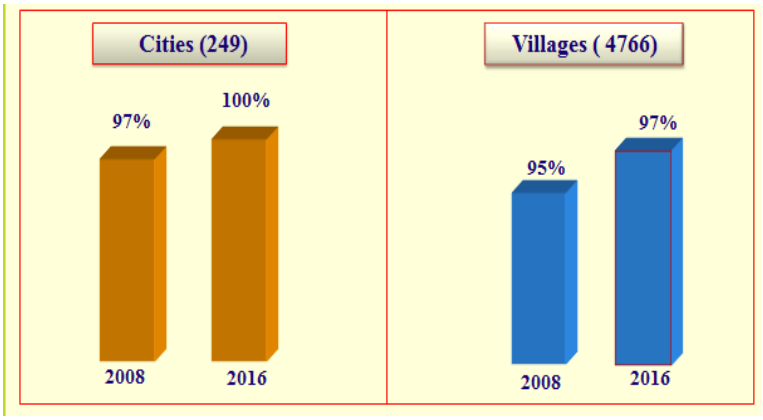
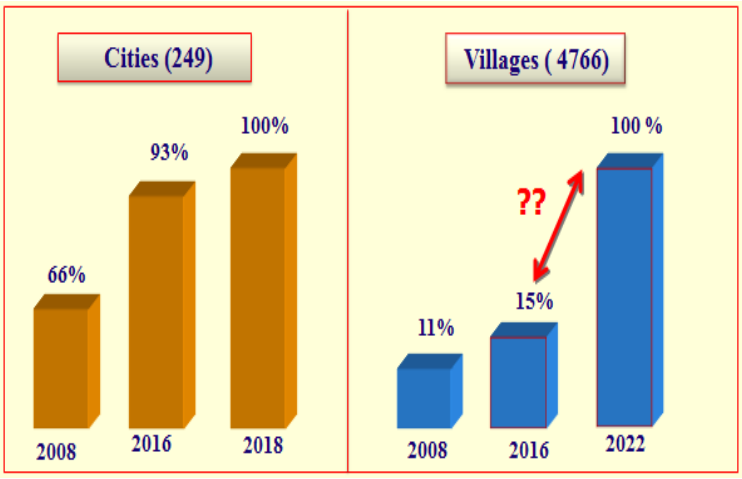


Figure 8: Coverage of sanitation requirements in Egypt.



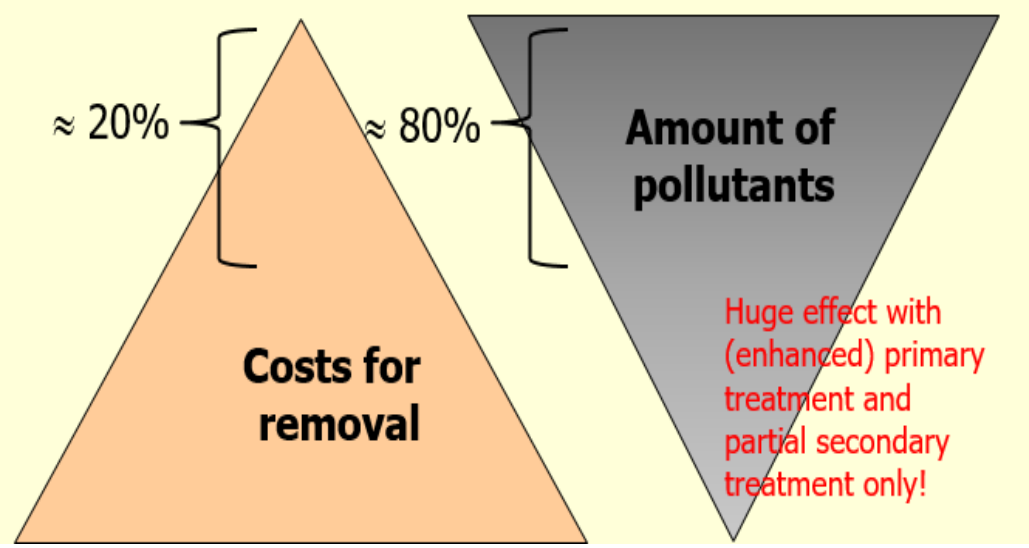
Egyptian standards for wastewater treatment technologies

Wastewater in Egypt is 2 to 4 times more concentrated than in the European Union, thereby reaching values of 1,500 mg/L for COD (chemical oxygen demand). These high values could be explained by significant discharges from septic tanks, since in certain villages, they are also used to eliminate animal waste.

Like in any developing country, the country is experiencing exponential urbanization, which is driving an increase in land prices. This situation entails a demand for compact sanitation systems. Egypt has tested all of the available technologies in the world, including centralized, decentralized, small-scale, activated sludge systems, etc. At present, we are testing the so-called “bio-block” installations, a state-of-the-art technology for very small local authorities, which we are importing from Belarus.

Deciding on the adoption of a centralized or decentralized system depends on the local environment, the population, the topography and the development of urban and rural zones. A comparative approach to the technologies used in view of the standards and conditions has allowed us to construct an assessment grid, including the following criteria: appropriateness of the technology, ease of operation, safety, continuous dependency on electricity supply, dependency on imported equipment and the surface area mobilized for the construction of the stations. Moreover, compliance with current standards has also been an element to be studied. The discrepancy between the desire of HCWW to relax these standards and the attempts by the public-sector authorities to reinforce them highlights the regulatory challenges of the sector. HCWW is in the process of negotiating with the public-sector authorities to obtain a progressive relaxation over a 5-year period.

Figure 9: Selection of treatment procedures in the face of competing objectives.



Lastly, a financial analysis of these technologies was also carried out, focusing on investment and operating costs for each type of sanitation mechanism.

It emerges from this that even if some technologies are effective, their design does not take sufficient account of local conditions. This latter parameter orients us towards the choice of an aerobic treatment. These may be anaerobic reactors with baffles (RAC), of lagooning plants using macrophytes) and upflow anaerobic sludge blanket reactors (UASB). In this way, the topography and high temperatures in Upper Egypt tend to favor the adoption of anaerobic technologies, while the shortage of available land in the region of the Delta leads to the adoption of more compact state-of-the-art technologies.

Sludges from waste water treatment plants

The management of sludges produced by WWTP must form an integral part of sanitation projects. Within Egypt, certain factors have allowed a change in perception of these sludges:

- Awareness of the environmental and health risks;
- A change of perspective, where sludge has an economic value (e.g. fertilizers);
- The increase in prices of chemical fertilizers;
- Potential market demand, especially in the context of the project for rehabilitation of desert lands.

At present, sludges from the WWTP are collected after primary or secondary treatment and directed towards drying beds, 70% of these sludges are then used in agriculture as fertilizers. It nevertheless remains important to reduce the rate of pathogens in these sludges, whence the project to shift to anaerobic treatments. In Cairo, a WWTP of current size treats more than 1.5 cubic meters per day; 60% of operating costs are covered by the production of biogas and its conversion into electricity. A “green energy plan” was designed in order to estimate in each region the volume of biogas produced and its energy equivalent. It is indeed essential to consider in the choice the capacity of the technology to take account of operating costs.

The challenges of the sanitation sector

The challenges of the sanitation sector result from several factors of different origins: technical, political, regulatory, institutional, financial and cultural. This latter factor is directly linked to the acceptance by users. In Egypt, this question is particularly important, notably in rural zones in which the inhabitants tend to refuse to install local sanitation devices.

Regarding technical problems, the absence of preliminary studies before the implementation of the projects lead: to cases of rapid saturation of treatment plants, since strong demographic growth has not been anticipated or to cases of impairment of the installations, since this charge of animal waste into the sewers was not foreseen in the design. In reality, consultants and entrepreneurs seem to confuse low cost and equipment quality.

With regard to the policy dimension and more specifically, the question of government assistance, the sector is suffering from an absence of a clear and strong strategic vision of sanitation in a rural zone. More than 4,000 villages lack sanitation devices, only having available latrines connected to collective networks, thereby threatening the general quality of wastewater to be treated. By relying on projects supported by the European Union, the World Bank and local investors, 500 villages shall be upgraded in 6 or 7 months’ time.

At regulatory level, it should be underlined that the standards in effect are not appropriate to a rural context and are hence difficult to implement, even using treatment systems with advantageous cost/benefit ratios. Compared to Moroccan, Jordanian and even European regulations, Egypt is stricter, especially for values of chemical oxygen demand (COD). The current trend is toward a relaxation of standards for discharges.

Moreover, the sector remains heavily affected by the human resources and the limited capacity of the country. The adoption of decentralized mechanisms should also be encouraged.

Prospects

As a private company, HCWW promotes extensive primary treatment, in order to reduce the polluting load by half, in accordance with the policy of the Ministry of the Environment and of Urban Development. This option has the advantage of limiting discharges of potentially pathogenic sludges in the vicinity of villages and has positive health consequences for the inhabitants while providing a certain social equity. Another consequence of the implementation of low-cost technological and energy projects is to release sufficient financial resources to support the operating costs of the WWTP.

Conclusions

Several elements must be considered:

- It is important to conduct preliminary studies before deciding on the execution of any project in a rural zone;
- The results of these studies should be systematically included in the national strategic sanitation plan;
- Sanitation equipment must be standardized in order to develop economies of scale and reduce construction deadlines;
- The development of leadership in the water sector is crucial;
- The development of an institution responsible for the centralized management of decentralized sanitation systems will be highly beneficial for the sector;
- The inclusion of the private sector in sanitation projects should be piloted and monitored, particularly at the level of manufacture of equipment, its durability and the economic model;
- The management of sludges issued from WWTP cannot be an option in Egypt but a necessity for the protection of the environment and of health;
- Biogases are a very interesting source of green energy, which could have a positive impact on the reduction in emissions of greenhouse gases.

Discussion

Denis DESILLE and Sarah BOTTON, *Agence Française de Development*/AFD, Paris

A common point emerges from these presentations[8]: the emergence of decentralized sanitation solutions, confirmed in India and announced, at least in a rural environment, in Egypt. These are indeed technological and service solutions, halfway between autonomous sanitation and the more conventional one found in major urban centers. This notion also has another name: the mini-network of sewers.

In Egypt, conventional sanitation dominates in urban environments, with a coverage rate of 93%, while the rate of access in a rural environment is far lower, at around 15%. The challenge for the Egyptian government is to intervene in a rural environment and to connect households to mini-stations in order to implement these sanitation solutions. In a complimentary way, Christoph Lüthi described the entire range of existing solutions for decentralized treatment, with capacities varying between 10 and 10,000 households.

A second topic is the relationship between collective sanitation and autonomous sanitation; the last one being predominant in numerous contexts: 90% of the neighborhoods of New Delhi use this system, like 84% of neighborhoods in sub-Saharan Africa. Even more importantly, the first investor in sanitation, especially in in sub-Saharan Africa, remains households. Under the joint effect of demographic growth, on the one hand and inadequacy of financings for the sector on the other, households will continue to bear this charge.

With regard to the Gates Foundation and the hypothetical reluctance of other funding agencies to support autonomous sanitation, it should be underlined that the counterparties of the funders (including the AFD) are principally States, municipalities, decentralized entities, or operators. They are not households: households cannot seek support from funders directly; these latter parties only respond at sovereign or non-sovereign level, according to the configurations. When the counterparty is ready to commit to a reflection, whether on centralized network solutions or on autonomous sanitation, an exchange with households may be envisaged. We encounter here again the importance of a good articulation between technical solutions, the design of the development, the implementation, etc.

This articulation occurs on two levels: on the one hand, over all of the links of the chain between collection, transport and evacuation or emptying and sanitation treatment; on the other hand, between the systems themselves, e.g. between collective and autonomous sanitation, or also semi-collective. This reflects the inherent plurality of the sector where different collective challenges are present: health and environmental.

In this way, three major questions emerge:

- How to manage mini-networks of sewers upstream, in the context of decentralized treatment?
- The cohabitation between autonomous sanitation, semi-collective sanitation, centralized sanitation and conventional sanitation appears to be a durable reality. What are the implementation procedures? Must this cohabitation be taken into account starting from the planning stage? Which poolings of resources are possible between these different levels of services?

[8] Presentations by C.Luethi and R. Abdel Wahaab

- Lastly, thinking sanitation in terms of articulation is to consider the development of cities and hence the consistency of the choice and mechanisms. This is to conceive of services, which may be public goods, of general interest or the elements of a *bottom-up* approach: in latter context, what is then the role of the public service?

To these questions, we may outline elements of answers:

- Sanitation problems in India effectively derive from an absence of urban planning. Public sector authorities have to take control of the situation in order to regain consistency between infrastructure, demographic growth and regulation.

- The coexistence between centralized and decentralized sanitation depends on decisions taken by the public-sector authorities. In Egypt, these depend heavily on environmental and geographical criteria.

Discussion with Audience Participants

The opinions expressed in discussions with audience participants and summarized below are those of the individuals who spoke and do not necessarily represent those of the panel speakers.

The interventions by C. Lüthi and R. Abdel Wahaab led to exchanges on two distinct topics: the levers involving sanitation for achieving sustainable development objectives (ODD) and the place for coordination in the effectiveness of a system.

It appears that the challenge of sanitation does not relate to a technological issue but rather to an institutional one. Since sanitation is a cross-cutting sector, involving a very large number of stakeholders, the definition of action plans and the identification of contacts becomes all the more complex. It is also important to provide firstly readability and then effectiveness for the dynamics of stakeholders and the governance of the sector, to permit an outline of strategies and of priority action plans. Such initiatives are far from being the rule in geographies in which the AFD intervenes. When objectives are clear and priorities well identified, the technical engineering may be expressed to deploy relevant technical solutions.

At the same time, the existence of clear and pragmatic sector frameworks is not sufficient in itself. In the case of India, the lack of professional skills, experience and sometimes methodological rigor within public entities will be extremely detrimental. Decentralized systems, which require a certain finesse in regulation, required training of intermediate decision makers.

With regard to the question of coordination, it is central to connect small-scale and centralized devices. The challenge of successful coordination is the capacity to implement appropriate adjustments in the face of each change of context; there are many who consider that the public-sector authorities are responsible for ensuring this coordination.

Public policy, financial resources and users participation

Advantages and malfunctions of a project approach: water and sanitation connections in the Greater Casablanca

Aziz EL MAOULA EL IRAKI, *Institut National d'Aménagement et d'Urbanisme*, Rabat, Morocco

The context of the project

The LYDEC project is being implemented in the outer regions of Casablanca, consisting of 272 neighborhoods, 86,700 households and nearly 500,000 inhabitants in an agricultural reserve zone, in which it is prohibited to build on a plot of less than a hectare. This is also an underequipped zone, classified as a "Non-Regulatory Environment" (HNR) with permanent structures, without prior authorization for subdivision and construction and without the necessary infrastructure equipment. From a sociological perspective, the composition of the inhabitants is very heterogeneous, with a strong desire for integration and genuine organizational capacities of populations.

Like all peri-urban zones, this one is characterized by a high degree of fragmentation of political power. It includes eleven municipalities, four governors ("prefects"), and a wali ("super prefect") for the region. Since the policy context of the non-regulatory environment has been a source of instability, the State has followed the recommendations of the World Bank and entrusted the management of water to a private operator. In this way, since 2000, the State only intervenes as circumstances dictate, as a function of local political contexts. This organization naturally affects the forms of financing for infrastructure.

Following the attacks of 2005, the new sovereign of Morocco has sought to develop the National Human Development Initiative (INDH), a vast program for combating urban and rural exclusion. The decision was relayed locally in order to intervene and connect the 500,000 inhabitants occupying the periphery of Casablanca. The Prefect, the municipality of Casablanca and LYDEC thus signed a memorandum of understanding, with the seal of the INDH, which is a measure of the humanist desires promoting the project. At the same time, it was not signed by all of the territorial authorities of Greater Casablanca, whence the need to make numerous amendments. Specific agreements by operation shall be added to it in order to set the roles and place of each partner at local level.

The leadership of LYDEC and its project approach

The project was designed by LYDEC in order to define the neighborhoods to be considered, the mapping and the financings, while implementing an internal structure dedicated to the project. Provision had also been made for an initiative for monitoring the inhabitants. The specific agreements per operation had set in advance the conditions for local implementation: with the authorities for the technical choices and customer standards; with the beneficiaries for the customer standards and financial contributions.

The work of monitoring beneficiaries was particularly important for permitting awareness raising of good waste and wastewater management practices. Moreover, this work was accompanied by a

definition of LYDEC's commitments, while highlighting exogenous "blocking" factors. A monthly monitoring even helped to identify the partners involved in these "blockages".

This proactive approach by following partnerships permitted a genuine dynamic, from which our search for financings subsequently benefited. This was also a unique experience, for the executives and agents of LYDEC, which enriched the information on the zone stored in a database in unrivalled fashion.

By contrast, the process has not been stabilized in institutional and financial terms with local authorities which could not be mobilized to a large degree. For example, on identification of the lists of target sites or neighborhoods, certain prefects refused to recognize provisional occupation status, on the ground that they represented illegal housing situations.

It is important to recall that land prices in this zone amount to 2 million euros per hectare and that the acquisition cost for the municipality is thus very heavy. Furthermore, given that construction sites are organized within an informal framework, agreements are defined on a case-by-case basis by the project manager, the beneficiary and the local system. For their part, the funders behaved heterogeneously: several cases of loss of goodwill were recorded. For example, the ONEP (the *Office National de l'Eau Potable*) refused to assume the sanitation part, thereby impacting 40% of the population of the region and Omrane, the developer in charge of the waster water treatment ponds .

With regard to agreements on allocations, the attribution conditions have been highly constraining, notably a linked to the results proposed by the World Bank, by their complexity and their low relative amount, since assistance only related to a very small part of the agreement (€ 3 million out of € 180 million of investments).

The impacts of the project

If the project has had undeniable positive impacts for health and hygiene, its results nevertheless remain limited, due to the project's focus on drinking water, without paying attention to highways, collective equipment, safety or transport. On account of this, the effects regarding inclusion are only being felt very slowly.

Furthermore, the assumption concerns a population, part of whom is well educated, which had already installed connections to drinking water. These latter parties have not seen a fundamental improvement in the service, which will represent problems for the continuation of the project. Lastly, a phenomenon must be observed of the eviction of the most underprivileged populations as the neighborhood is developed: the greater the increase in the standard of living within a given perimeter, the lower the numbers of the most underprivileged populations who can remain there.

If this project initiative was able to introduce an unquestionable dynamism and flexibility, it nevertheless raises the question of urban project ownership and political regulation in metropolitan areas.

Sanitation: Costs, financing and governance. The case of Casablanca

Claude DE MIRAS, *Institut de Recherche pour le Développement*, Marseille

As a preliminary, it is important to note that the interventions heard so far have allowed two levels to be identified: that of national political decision-making and that of territorial public action. Local implementation does not always derive simply from the directives defined at national level and, on the contrary, may become bogged down in institutional nebulae and coordination problems.

The introduction of sanitation into public policy

In the region of Casablanca, the economic capital of Morocco, the actions for improved access to drinking water affected 98.7% of the population in an urban environment and 65.3% in a rural environment. Improved access to sanitation concerns 84% of the persons in an urban environment and 65% of those living in a rural environment. Morocco follows a policy linked to the Millennium objectives, which have produced their results regarding electricity, then sanitation, before concentrating today on stormwater.

With regard to liquid sanitation, the 2005 national sanitation plan should be recalled, by virtue of which, the rates of connection and of waste water treatment improve, thereby accompanying the considerable growth in the generation of wastewater since 1960. The product of the action policy is visible both through the volumes processed by waste water treatment plants and the diversity of the implemented technologies. The size of the project amounts to 54 billion dirhams by 2020. The cost of the investment is assumed 30% by the State and 70% by the operator. The project, initially reserved to parastatals and to the *Office National de l'Eau Potable* (ONEP), is now open to the concessions of Tétouan, Tanger, Rabat and Casablanca under certain conditions.

Sanitation in the context of Casablanca

Collective action in Casablanca has mobilized stakeholders deriving from different spheres, responsible for implementing political decisions on a local scale. It is interesting to observe that the footprint, in social, financial and environmental terms, is particularly strong. The sectors of drinking water, sanitation and stormwater will thus constitute markers of the quality of governance of the territories, but also of the difficulty of coordination. The case of Casablanca moreover demonstrates the interest in studying, beyond the global cost, the transaction costs and the costs of negotiation, which reveal the constraints induced by the consideration of the local context.

Casablanca is a city of contrasts: behind the modest rate growth rate (+1.5%), we may observe a demographic contraction in the center of the city (-1%) and a great dynamism on the periphery. As an interesting fact, the growth of the urbanized surface area is twice as rapid as the growth of the population; a ratio which will not fail to have an impact on the design of networks.

Demand for sanitation services on the periphery is proportional to the extremely dynamic growth underlined above. Every property owner is obliged to connect any residence or residential complex located within the urban perimeter. The historically unitary network has been operating, since the 1990s in a separated network, between stormwater, on the one hand, and household water on the other.

Sanitation requires much more significant resources than public water or electricity services. Investment and financings are allocated between:

- Infrastructure (pipes exceeding 800 mm);
- Distribution (tertiary network leading to domiciles);
- Operation;
- Reimbursable works (participation assumed by developers for works falling within the private domain).

It is important to note the origin of the financings. They result from the operation of the delegated service, participation from the developers and the renewal allocations. Would it be fair, however, to state that “water pays for water”? The answer lies in the internal adjustments linked to the perequation betwwen various utilities: drinking water and electricity provision, sanitation. That means this latter is partially financed by the surplus drawn from electricity, allowing the contractual objectives to be met.

However, a comparison of the service requirements produced by urban growth through the development of the “spontaneous urbanization" reveals a major discrepancy with regard to the designed capacities provided in the agreement established by the public sector authorities. It emerges from the differences observed between real urban growth and that is provided in the planning documents: diagram of urban development, master plans of water and sanitation.

In order to respond to this discrepancy, urban agencies authorize and distribute multiple waivers, resulting in urban sprawl, which contractually obliges the operator to follow its evolution. We may imagine the difficulties and excess costs generated by this type of urban management, shattering the logic of “water pays for water”. To illustrate this, 5,000 hectares of projects have submitted a request for connections in the last two years, of which more than 800 outside of the perimeter of the master plan.

In this context of urban sprawl, LYDEC must propose solutions to the absence of grouping of developments. Indeed, in these zones open to urbanization, the operators do not coordinate to ensure the consistency and optimization of the location of public networks. The clients are drawn by the cheapest land, located in an open zone, and this without paying attention to whether or not there is a sanitation network. This results in an irrationality of urban planning which it is important to control better.

The example of Morocco illustrates the continuity of sequencing in access to public services, while revealing their fragility with regard to the phenomena of climate change which has not yet been taken into account by the authorities and which will undoubtedly translate into higher costs.

Discussion

Kouamé André N'GUESSAN, *Office National de l'Assainissement et du Drainage*, Abidjan, Ivory Coast

Sanitation is a basic service which contributes to preventing problems of public health, to ensuring harmonious economic development and to guaranteeing human dignity. The development of this sector requires significant financial resources in view of the low level of global access, which varies greatly from one continent to the other. In most cases, mobilization strategies for financial resources are more oriented towards funders and donors. In this way, endogenous financings, those provided by households (investment and maintenance of non-collective works) are neither recorded nor structured when they represent a significant and sustainable source.

The proper functioning of the sanitation sector takes the form of the assignment of liability to stakeholders and a clarification of missions. The State, public and private structures, households and funders… must intervene within a structured framework. Unfortunately, consistent institutional and regulatory frameworks which would permit this are still lacking. In this way, the first brake on sanitation projects remains the attempts to resolve problems between stakeholders and the excess costs generated by the conflicts of authorities and responsibilities.

The development of cities is today carried out horizontally and leads to urban sprawl. However, the excess cost induced by the connection of a client geographically far removed from the existing network is considerable. The price of sanitation by user could be reduced by implementing a vertical urban development plan, designed for a strong population grouped within a reduced geographical area.

The assumption of users within authorized or unauthorized areas represents another significant challenge: although the right to sanitation has become a universal right, it is subject to the limits constituted by unserviced and undivided perimeters, which are hence not recognized by funders, or even by local or central governments. The right to sanitation and basic services of these populations is called into question by the fact that they live in precarious and unsecured areas.

Referring to the preceding presentations, we should question the stance of the public-sector authorities with regard to a problem of development of sanitation within a local perimeter. Moreover, shouldn't the institutional framework also settle questions of mobilization of financing and of competent human resources in the case of transfers of skills from Central Government to Local Authorities?

Closing speech: The challenge of financial sustainability.

Edouard Pérard, European Investment Bank, Luxembourg

The European Investment Bank (EIB) is the bank of the European Union. Its shareholders are member States and its activity is essentially focused on Europe and in secondary fashion on developing countries. It grants 77 billion euros in loans per year, of which some 8 billion euros of lines to developing countries. The EIB is thus the armed wing of the European Union's development policy.

The EIB has a loan volume of 4 to 5 billion euros per year in the water and sanitation sector, of which 15% in developing countries. It supports a wide variety of projects, both in Europe and outside of the continent. For example, the Technical Department is active in numerous countries, from Malawi to Morocco to Rotterdam and to Delft, via the Thames, where we are notably financing a tunnel located 80 meters underground.

The economic issue of sanitation

30% of the world's population does not have improved access to sanitation. 10% of the world's population consumes food deriving from fields irrigated by wastewater. It is calculated that there are at least 300,000 deaths per year due to lack of sanitation.

A World Bank study assessed the impact in economic terms of the absence of sanitation: in Cambodia, it amounts to 7% of GDP, in India to 6%, in Indonesia to 2%, in Liberia to 2%, in Pakistan to 6% and in Nigeria to 1.3%. This represents considerable amounts.

Sanitation must also be recognized for its positive impacts: it is thus profitable or even very profitable. The World Bank has highlighted cost-benefit ratios of universal access to sanitation. The average annual rate is 5.5% but amounts to 8% in East Asia. Considering all of these cases, we estimate the rate of economic profitability at 10 to 15%, according to the externalities taken into account: the lifespan of the infrastructure, health, the environment, the Common Agricultural Policy, tourism, etc.).

Not all projects are justified however. Poor preparation, planning and effective integration into urban development plans may give rise to very low rates of economic profitability.

Financing of sanitation

The first characteristic of investment infrastructure is the physical lifespan of the infrastructure. There are reference lifespans: of 50 to 120 years for pipes, 30 to 40 years for civil engineering, 10 to 15 years for electromechanical installations... this is thus infrastructure with long lifespans.

The EIB is making an effort to ensure that the duration of the financing corresponds to the economic lifespan of the projects, by seeking longevity, a synonym for intergenerational equity. The investments are generally spread over 20 years; only one generation should not be obliged to bear these. The economic lifespan nevertheless differs from the physical lifespan and may be shorter. Indeed, regulatory evolution, technical obsolescence and lack of maintenance may significantly reduce the economic lifespan.

There is a second interest in attempting to match economic and physical lifespans, which is to stagger investments over time. The longer the duration of the loans, the less the service tariffs must be increased to finance the investment in this infrastructure. The role of the regulator is essential here for guaranteeing the tariff and regulatory framework and for promoting good maintenance. This framework

must be clear and independent. It must specify a tariff methodology and transfers between stakeholders which are consistent with the political choices of the country.

The sources of financing of the projects are multiples and take many forms, translating into a wide range of instruments:

- Public allocations, the donations and transfers represent limited resources;
- The revenues generated by service tariffs, which depend on the level of collection and the financial capacity is of the users;
- Sovereign, municipal or corporate debt;
- Bonds, which are used more by certain Southern or Asian countries;
- Public-private partnerships (PPP) in which the project owner is not the sole contributor to equity;
- Participation of investment funds which are emerging in Europe and in Asia, notably in China.

Within the context of their collaboration, the *Agence Française de Développement* (AFD) and the EIB also offer credit lines for more modest projects. By way of illustration, these two entities have recently signed an outline agreement with a Moroccan bank to finance small projects for private companies specializing in the treatment of wastewater.

These forms of financing may be combined, even if their complexities differ. The first rule to keep in mind is not to exclude any possibility. Diversity should be promoted.

Financial instability, a brake on the development of sanitation

The first obstacle to sanitation projects lies in the difficulty of guaranteeing the financial sustainability of the service. The activity must be able to bear operating, maintenance and investment expenses. In practice, according to a United Nations study of 94 countries, tariffs for services linked to water are unable to cover all of these expenses. Sanitation is the less able to cover its costs within the list of water utilities.. With regard to funders, they cannot finance operating expenses and only assume investment expenses.

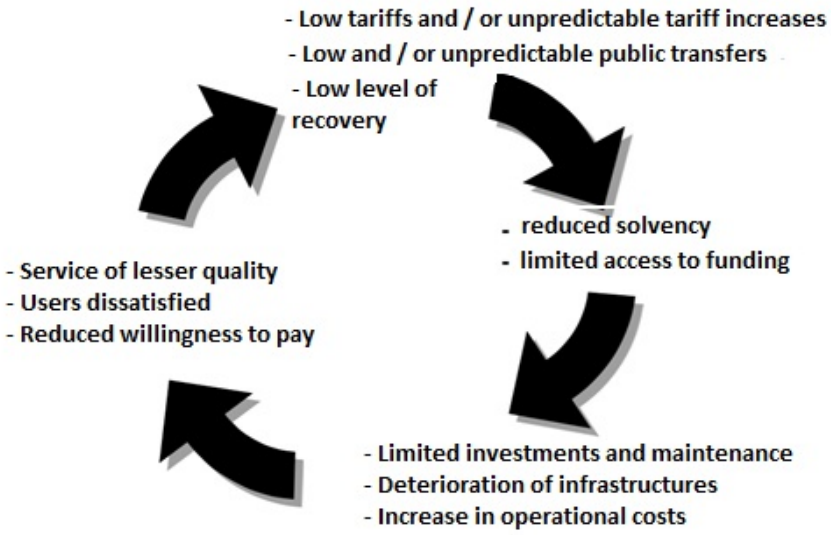
How then can the sustainability of the projects be insured? One way of ensuring this sustainability is to rely on widely recognized and accepted resources: taxes, tariffs and transfers. For projects which are sources of positive externalities, funders accept that investment and operating expenses are entirely financed by taxes and transfers.

This situation nevertheless raises significant problems of equity: financing sanitation through taxes, when these projects do not necessarily target the poorest, on the contrary entails new inequalities. This was the case of a project for a waste water treatment plant in Africa, for which the tariffs were only supposed to cover 30% of the operating expenses, with the remainder then being borne by all of the taxpayers.

The problem of financial sustainability is directly linked to the high degree of political sensitivity on the questions of tariffs and transfers. In the majority of countries, tariff and transfer increases are unforeseeable, in addition to being generally very small. Operators of the services are then obliged to turn systematically to the competent political authority on which they depend. The resulting financial instability harms the financial health of the operators, investments and the poorest.

The diagram (figure 10) should be read as follows: at the top, low tariffs or unpredictable tariff increases, low and/or unpredictable public transfers and a low level of collection. For operators, this situation leads to reduced solvency and to limited access to financings; whence a reduction in investments, a rarefaction of maintenance operations and an increase in operating costs.

Figure 10 - The challenge of financial sustainability (source: EIB)



In view of the reduction in service quality, the user will be dissatisfied and less inclined to pay for the service. In this context, any increase in tariffs becomes inconceivable, since these would no longer correspond to the provided service.

Improving the financial sustainability of the services is thus extremely complicated. It is more a question of governance than of the financial procedures for collection. The EIB hence assesses projects by considering three principal dimensions: governance, financial sustainability and operational effectiveness.

The EIB currently works in collaboration with the European Bank for Reconstruction and Development (BERD) on a project for assistance to the *Office National d'Assainissement du Sénégal* (ONAS) in order to improve the dimension of “financial sustainability”. Instead of introducing a financial ratio clause into the agreement, supplemented by tariff studies, a different choice is made by implementing a dialogue over four years, between the different stakeholders of the sector, in order to facilitate the return to a financially feasible situation. The ONAS shall assume the dialogue with the Ministries on these different issues, with the support of the EIB. The objective is to arrive at a framework proposal accepted by all the stakeholders of the sector.

The three identified issues are:

- Governance of services. This includes a clarification of the action perimeters of the ONAS, the ways of updating approval procedures for planning and operating policies, the demand procedures for tariff and transfer modifications, in order to avoid recourse *in extremis* to higher authorities;

- Financial sustainability through a transparent methodology for calculating tariff developments and short-, medium-and long-term transfers; the application of the polluter-payer principle; sector policy on subsidies; the devising of a financial model;

- Operational effectiveness, with the introduction of monitoring of management, comparison of performance with other services at regional and international level and of an action plan to improve information systems internally and the rate of recovery of invoices.

The economic and financial dimensions are essential. Sanitation is the poor relation of public policies, when its real impact on the life of populations is immense and the investment is highly profitable. Furthermore, the sources and forms of financing are numerous. If financial stability remains a major problem, it firstly relates to governance, which must rest on a readable regulatory framework, which is stable over time and independent.

Discussion with Audience Participants

The opinions expressed in discussions with audience participants and summarized below are those of the individuals who spoke and do not necessarily represent those of the panel speakers.

The interventions by A. El Iraki, C. de Miras and E. Perard led to exchanges principally on the financing mechanisms for sanitation projects on the basis of the example of LYDEC in Casablanca.

The property developer contributes to the financing of a part of the sanitation network. This contribution may be considered as an advance on investment, demanded by the operator to commit to the extension of the network. An alternative would be the introduction of a taxation mechanism funded by developers and based on land rents. The fund so created would seek resources for the exploitation of the implemented sanitation systems. Another strategic financing route appears to be: investment by the inhabitants of the neighborhoods. Indeed, there are examples of successful mobilization by the beneficiaries of the service when classic financing has proved to be unfeasible. Sanitation can then be extended to thousands of families. In Mozambique, it was possible to cover the basic sanitation requirements by virtue of a mechanism of this type. Innovation is necessary to deal with the question of sanitary engineering n a different manner, while maintaining serious prior studies of the costs of the infrastructure.

Wrapping it up

Diane D'ARRAS, SUEZ and International Water Association (IWA), Paris

This day devoted to sanitation and to its challenges has allowed attention to be drawn to the biases existing in the fields of sanitation and health:

- The first lies in the interpretation of the results of the studies and of research carried out in order to avoid confusing the causes with the facts and the facts with the cause.

- The second which is highlighted, derives from the governance: if they are concerned with defining their actions as well as possible, the funders often find that public authorities, representing users, are their only contacts. When users do not express themselves directly, even if they are represented, including by benevolent individuals, the bias may be strong. These biases are then reflected in the implemented solutions.

We must also specify the terms and the notions used in the water sector and sanitation:

- "Toilets" are not only synonyms for sanitation, they also offer the possibility of isolation, a right of which 1 billion people are deprived today. If we are convinced that toilets promote hygiene, above all they provide the dignity, comfort and access to maximum protection. We should thus avoid emphasizing only human health, even if we are all persuaded of its importance. More specifically, a woman needs closed toilets and this from her earliest years. The importance of the debate between a centralized or decentralized device is lower in this context.

- The definition of the term "sanitation" is not specified between: graywater, stormwater, health, environment… The choices will depend on the level of development of the country. In France, issues of hygiene treated, firstly, within the framework of the *Association des scientifiques et des hygiénistes de l'eau* [Association of scientists and water hygienists], today known under the name of *Association des Techniciens de l'Eau et de l'Environnement* [Association of water and environmental technicians] (ASTEE). It is regrettable that this first approach is still dominant and casts a shadow on issues which are nevertheless essential, which lead to the protection of the environment (discharges of effluents). Each research program must have corresponding aims which are precise, clearly defined and consistent with the context.

The choice of technical solutions depends heavily on the national context. The technical-economic optimum depends on the size and density of the population, on the level of progress of the project and on history. The English have long been suspicious of drilling water, since the water table of the City of London was polluted. Water from the Thames seemed safer to them. Studies must be segmented and we must remain vigilant in the face of biases and abusive generalizations.

In conclusion, we should take an interest in the following fields of research, in order to stabilize their content and ideas:

Governance

Does decentralization entail the obligation to create a control system? Does the solution consist of centralizing management? Which methods should be adopted, which forms of government should be developed: national or local, organizational delegation? The notion of governance is moreover understood very differently according to cultures and legal systems. For some, the field of the regulator is limited to the quality of the provided service; for others, it includes an important economic component.

A project may not be financed without being inserted into an effective economic framework. The regulator is today taking shape and is intended to occupy an entirely separate place in the decision-making process, notably in a monopoly situation. It is essential to have a regulator with a mission of economic effectiveness, resting on a consideration of the public and private challenges. We are lucky to have a winner of the Nobel Prize for economics in France who has dedicated an important part of his work to game theory and monopolies.

Our work on governance relates both to its comprehension and to education, training and sharing. Even if we already have a significant literature, much remains to be done before we achieve the “right” level of regulation, as a function of the various models.

Temporality of projects

It should be observed that if each of the projects presented today included stages, as they should, these were not systematically positioned in time. They could thus last for two or for twenty years. How do we re-incorporate the notion of time into the achievement of intermediate objectives? There is certainly a reluctance to indicate maturities which will always be longer than desired. At the same time, in some cities, ten or even twenty years will not be too much for the correct realization of the projects. By not issuing estimates or forecasts, we shall neglect a fundamental element.

This shall take the form of a reappraisal of the models and by genuine work on education, conceived over a thirty-year period, i.e. a generation.

The possibility of flexibility of action

Among good engineers, the tendency is to seek the optimal, ideal solution, while accepting that it is hard to imagine that this does not exist. With regard to sanitation, the important thing is probably to advance, even to rebound, when necessary. It must be possible to advance in line with the realities, by applying the most convincing and time-tested solutions at each stage of a path which cannot be a straight line, since it relates to dynamic and mobile cities.

Conclusions

Céline GILQUIN, Division of water and sanitation, Agence Française de Development, Paris

It has been an honor for the AFD to host this day devoted to sanitation.

For several years, we have all been committed to recalling that sanitation is a sector, including collection, transport and treatment. Today, we have also dealt extensively with the challenge of health and the environment associated with this sector. On the last day of the COP22 in Marrakesh and on the eve of World Toilet Day, I would like to recall the link between the challenges of climate and access to sanitation: water resources of the most exposed to climate change and we have recalled today, on several occasions, the importance of sanitation as a means of preserving this resource.

Sanitation is also an issue of health and human dignity for the 2.5 billion people who do not have access to improved toilets, while one billion practice open air defecation. The AFD, through its Water and Sanitation Division, assigns 30% of its dedicated funding to the water sector, to financing sanitation, i.e. 200 million euros per year. This amount should increase significantly and could reach 300 million euros per year. This level may seem small in view of the challenges, but it must be observed that demand is modest since the beneficiary countries are poorly mobilized, despite the economic profitability of these projects. I would thus like to underline the importance of pleading for sanitation, by recalling the costs linked to the absence of sanitation, which are extensively known, and by mobilizing civil society.

The low degree of institutional maturity of the sanitation sector, at least relative to drinking water, constitutes a second brake on the funding of the sector. To this is added complexity of intervention linked to the diversity of stakeholders mobilized for sanitation. With the AFD essentially funding investments, funding devoted to autonomous sanitation can benefit multiple stakeholders, including households, small, often informal evacuation companies and the authorities or companies in charge of treatment plants. In this way, funding independent sanitation chain requires the deployment of a full range of different and appropriate tools. To illustrate this, a project for treatment of fecal sludges may include a microfinance component aimed at households, a meso-finance component for scavengers, and a more traditional credit component for treatment plants. Such approaches, while necessary, remain complex to implement.

Lastly, to this complexity is added the low degree of financial profitability of sanitation services, which undermines projects and recalls the necessary presence of public sector stakeholders.

I would like to offer my warm thanks to the Chair ParisTech Suez *Eau Pour Tous*, and notably its Scientific Board, Thierry Rieu and Claude Ménard, who prepared this meeting. I would like to thank the presenters for their quality presentations. I would like to express my admiration for everyone not having gone over their allotted times. Remarkable! I would also like to thank the translation teams, all of the AgroParisTech teams, the students, my colleagues at the AFD who organized this conference, everyone at Suez and last but not least, the participants who attended this event.

Very special thanks are due to Sandy Cairncross. You came to the AFD to present to our team, which has been fundamental in my approach to development projects. I am very happy to see you again and to attend a new and brilliant presentation by you.

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The *Agence Française de Développement* [French Development Agency] (AFD), a public sector financial institution which implements the policy defined by the French government, acts to combat poverty and to promote sustainable development.

Present on four continents through a network of 85 offices, the AFD finances and monitors project which improve the living conditions of populations, support economic growth and protect the planet.

In 2017, AFD devoted 10.4 billion euros to the financing of projects in developing countries and overseas territories.

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