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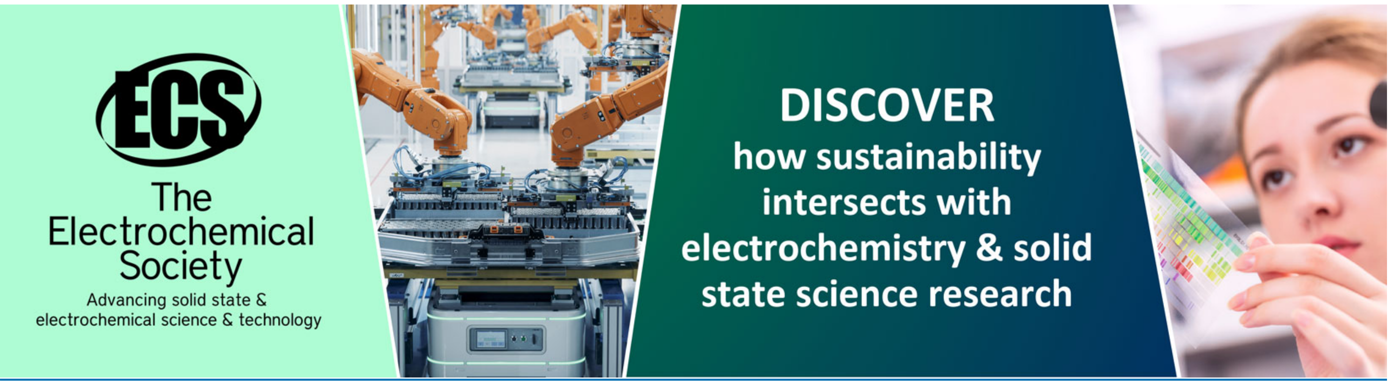

Development of sanitation technologies in African context : how could we make it more sustainable?

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Abstract. Access to sanitation technologies remains one of the biggest challenges in sub-Saharan Africa. To overcome this gap, a sanitation project called "Ameli-EAUR" translated from French as improvement of water and sanitation in urban and rural areas, was implemented in Burkina Faso for 5 years (2010-2016). The technologies from the project were designed on the basis of agro-sanitation concept, leading to package containing a composting toilet, a grey water treatment facility and a set of urine collection and treatment. The study aimed to evaluate of Ameli-EAUR project, one year after the end, and identify some key factors of sustainability of technologies. As methodology, a survey and a technical diagnostic of implemented technologies were done. The results showed that, the pilot families stopped using all the technologies one year after the end of the project. However, two main lessons can be learnt: (1) in term of efficiency and effectiveness of the project the technology of composting toilet was not robust enough, leading to a rapid abandonment after the project (2) in term of impact and sustainability, the economic incentive of the resource oriented sanitation concept was very weak compared to the needed workload. The technologies development in this kind of project should be carried on and associated with a more inclusive system driven by economic incentive.

1. Introduction

The lack of adequate sanitary installations and proper sanitary waste disposal systems leads to serious implications on human and environment health [1]. Sahelian countries are still among those where sanitation access is very limited [2]. The target 7c of United Nations millennium development goals (MDG) was to reduce by halve people without access to potable water and basic sanitation by 2015 [3]. In 2016, none of the Sahelian countries reached this target, leading to a big challenge to fill the gap as we start the Sustainable Development Goals (SDG) which target a universal access to water and sanitation [4]. Burkina Faso is not left out from this situation, this typical Sahelian country located in western Africa still face open defecation by the majority of its rural communities [5].

The sanitation challenge makes sanitation projects very relevant, in order to increase the number of adequate sanitation facilities. Several projects were initiated during the two past decades in Burkina Faso. Ecological Sanitation (ECOSAN) project is one of the biggest one which was initiated in 2006 for 3 years and aimed to develop onsite sanitation technologies in Ouagadougou, the capital city of Burkina Faso including by-product reuse in agriculture. Among the 5 criteria commonly used to assess such kind of developmental project, that is relevance, effectiveness, efficiency, impact and sustainability, the mid-term evaluation highlighted a weak sustainability for two reasons (1) the strategy of the project to cover the major part of investment expenses and (2) the fact that incomes generated per month by the sanitation system represent only 9% of the total operating expenses [6].

The Ameli-EAUR project on the other hand as described in the present paper was launched in 2010 for 5 years in 2 villages of Burkina Faso. The project aimed to develop onsite low cost and low maintenance system including waste separation and treatment and reuse of sanitation by-products (urine, faeces based compost and grey water) in agriculture. The final evaluation concluded with a mixed results. Indeed, the project relevance was not doubted because water and sanitation was a priority both for Government of Burkina Faso and The Japan International Cooperation Agency which financed the project. However, the efficiency and effectiveness of the project received a mixed opinion mainly due to a lack of maintenance system of facilities. Therefore, impact and sustainability were also judged as not reached.

2. Methodology

2.1 Presentation of Ameli-EAUR project

The project is named Ameli-EAUR project, the term "Ameli-EAUR" is a french acronym defined as "Improving Sustainable Water and Sanitation Systems in Sahel Region in Africa: Case of Burkina Faso". This project is an international development joint project on water, sanitation and hygiene between mainly the International Institute for Water and Environmental Engineering (2iE, Burkina Faso) and Hokkaido University (Japan) and funded by Japan International Cooperation Agency (JICA), Burkina Faso's Government and Japan Science and Technology Agency (JST). The project, started in 2009 and ended in 2014 (5 years), aimed at proposing a sustainable agro-sanitation model in Burkina Faso based on recycling households waste (grey water, urine and human excreta) as natural resources for agriculture.

2.2. Description of the sanitation technologies

2.2.1. Composting toilet

The composting toilet is an urine diverting type toilet. A reactor (of composting) and a urine collection tank are placed in a hole and covered by a platform where urine bowl, faeces hole and washing bowl were designed (Figure1). The reactor must be rotated after defecation to provide oxygen and mix faeces with matrices (i.e. sawdust). So a mixing system connected to the reactor is available on the platform. One of the most important improvements of the toilet was this mixing system. It has been changed for each version to enhance its robustness (Figure 2). The other main modification was the reactor. Previously wood was used but has been replaced in version 3 by metal matter to ovoid its rapid degradation (Figure 3). In addition, pilot families were trained on the inactivation and using of the compost.

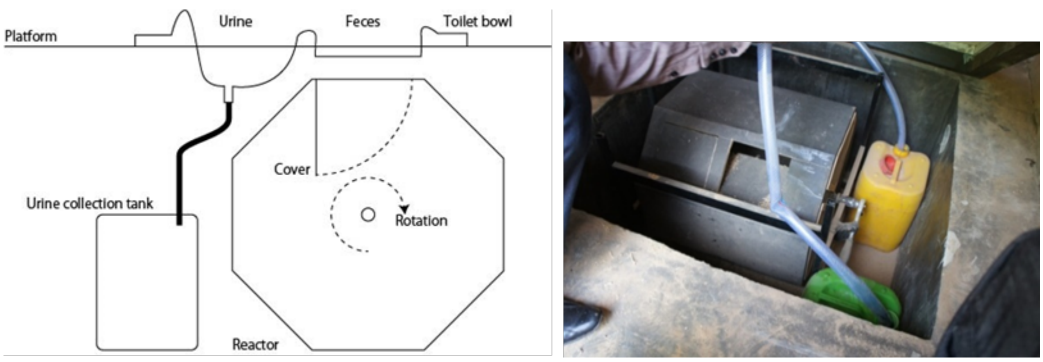

Figure 1. Composting toilet used in rural Burkina Faso (design and picture) [8].

First version Second version Third version

Figure 2. Composting toilet mixing system used in rural Burkina Faso) [8].

Figure 3. Composting toilet reactor made by wood and metal used in rural Burkina Faso [8].

2.2.2. Urine treatment set

The urine is collected in toilet as previously mentioned in the composting toilet description, but also in shower room where urinary bowl has been set to ovoid presence of urine in shower water. Figure 4 shows urine collection, packaging and treatment following the training pilot families received.

Figure 4. Collection of urine in PET bottles of 1.5 litres and exposition on roof during 7 -14 days in rural Burkina Faso.

2.2.3. Grey water treatment facility

Figure 5 presents the two versions of grey water treatment facility developed during the project. The system was made of an influent tank, an upper filter, a lower filter and a buried collection tank. The influent tank receives grey water from different activities like dishwashing, laundry etc. From version 1 to version 2, the influent tank was improved by adding a screen at the top to retain some solid waste (i.e. food waste). The upper filter is filled with gravel (1-9 mm). It receives grey water both from influent tank and shower room. The facility is placed just behind the shower room so that it can be directly connected by a pipe to collect the shower water. In version 2, the size of gravel in upper filter has been decreased (1-4 mm) to improve filtration while reducing the clogging time. The weight of the filter was also reduced to allow women to carry it during maintenance operations. The lower filter also filled with gravel (1-9 mm in version 1; 1-6 mm in version 2) receives grey water from the upper filter and discharge the treated grey water in the buried tank. Grey water is taken from the buried tank in a similar manner to a shallow well for irrigation purposes. The quality of treated grey water met WHO standard [8] for restricted irrigation but not allowed to be eaten as raw vegetable. This quality is due to grey water contamination by babies' bath water discharged in the influent tank.

Figure 5. Grey water treatment facility (first and second version) used in rural Burkina Faso.

2.2.4 Household garden and by-product reuse

The best urine to compost ratio was identified and published by Sangaré et al. [9]. The pilot families were trained based on this data. Each family had a small garden about 20 m² (Figure 6) near the grey water facility. Treated urine and water have been tested through cultivation of several crops (except for raw vegetables that are to be eaten) in accordance with the interest of families. Demonstration of compost application was limited to training with guidelines because the post-treatment developed to improve the microbial quality was too time consuming.

Figure 6. Household garden developed by a trained family in rural Burkina Faso.

2.3. Description of pilot families and sanitation technologies

Two pilot sites were identified at the beginning of the project. The first one was in rural area, within two villages near Ziniare, a small city situated at about 50 km from Ouagadougou. In each village, a preliminary survey was performed before the Chief of each village selected the pilot families. The survey helped to define some socio-cultural criteria to be taken into account in the final selection. Table 1 displays information about the pilot families. All pilot families received a package of sanitation technologies containing: a composting toilet, a grey water treatment facility with new or renovated shower room, a set of urine treatment. Family 3 (Table 1) received 3 packages due to the high number of residents, three brothers were living there with their wives and children.

Table 1. Description of pilot families in the two villages near Ziniare, Burkina Faso.

Location	Household	Number of person	Religion and occupation	Sanitation facilities before the project
Kologodjesse	Family 1	5	Christian Farmers	1 traditional toilet cement blocks + 1shower with local soil
	Family 2	18	Christian Farmers	3 shower rooms with local soil (1 was partly broken)
Barkoundba	Family 3	20	Muslim Breeders	1 toilet with collapsed wall + 1 collapse shower room
	Family 4	8	Muslim Breeders	1 toilet in local blocks (used as shower room because the shower room was collapsed

2.4. Survey method

A questionnaire was administrated to the pilot families of Kologodjesse. The survey was limited to this village because it is the only village where all facilities were working and employed at the end of the project. The questionnaire aimed to evaluate the level of satisfaction related to the use of the different facilities as well as the use of sanitation by-products i.e. treated urine, treated water and compost. The level of satisfaction is denoted in Table 2 with an “X” during the survey.

Table 2. Satisfaction questionnaire administered to pilot families of Kologodjesse, Burkina Faso.

Family Name	1	2	3	4	5	6
Composting toilet using & maintenance						
Shower room using						
Grey water facility maintenance						
Urine collection and treatment						
Reuse of treated urine in the garden						
Reuse of treated grey water in the garden						
Reuse of compost in the garden						
1. Unused, facility broken						
2. Unused, lack of interest						
3. Used, but not satisfied						
4. Used with mitigate satisfaction						
5. Used and satisfied						
6. Used and very satisfied						

2.5. Technical diagnostic of implemented sanitation facilities
The survey was followed by visiting the implemented sanitation facilities. The various components of each facility were checked for their well functionality as well as for any observations that will prevent their proper functionality.

3. Results
3.1. Result of the survey
Figure 7 summarize results of the satisfaction survey performed with pilot families of the Kologodjesse Village following the Ameli-EAUR project. As described in the legend of Table 2, the higher is the score is, the better is the satisfaction. For the shower room, the high score of 6 means that users appreciated the facility in term of easiness both for using and maintain. In contrast, urine treatment and reuse as well as composting toilets and compost reuse have very low scores (between 1 and 2). Such score reveal an abandonment of the facility using and/or the by-products reuse practice. The results show that the main reasons facilities remained unused was due to breakdown whereas none use of by-products was due to lack of interest.

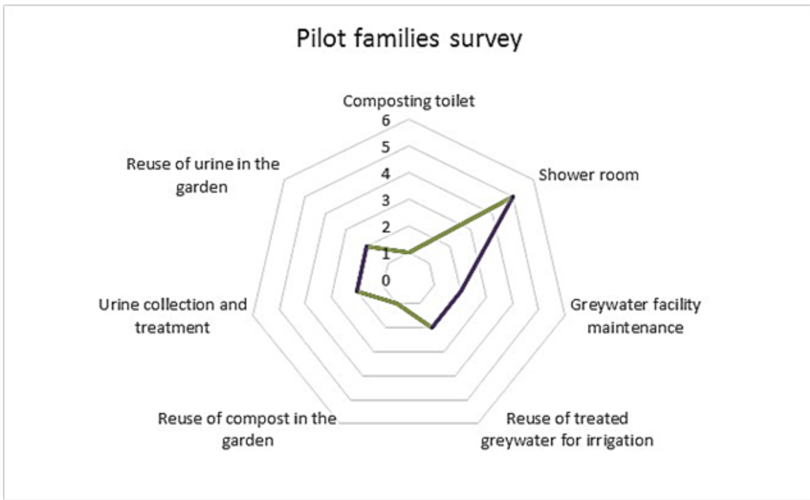

Figure 7. Results of pilot families' survey one year after the end of the project in Kologodjesse Village, Burkina Faso.

The mixing systems of composting toilets were all broken. During the project, this issue was frequent and several modifications were necessary to improve the crank. Lack of continued system maintenance after the project leads to the abandonment of broken facilities. It was learned through discussion with pilot families, that they are still waiting for project members to repair the toilet despite the agreement they signed to maintain all facilities after the end of the project. They justified the situation by lack of money to repair the crank but also by the fact that local trained technician to repair the toilet is too fair from the village. The filter media of grey water facilities were very clean in all pilot families. However, the buried tanks were full of grey water, implying that it was not used for gardening. They were no crops growing in the garden. By discussing with families, we realized that all filter media had been washed just before our visit. This highlights the progressive abandonment of the system. Some families attributed this to the fact that the garden is not well protected against livestock who systematically destroyed the cultivated vegetables. Urine is collected from the shower room urinary bowl but it is directly discharged into their traditional manure pit.

3.2. Technical diagnostic of implemented sanitation facilities
The technical diagnostic of implemented sanitation facilities showed that some components were not properly functional. At the shower, there is an accumulation of dirt on the cap of the urinal and piping; the presence of a lot of debris on the gravel; the tear of the filter and the drum cover is lost. The composting toilet is not functional and has been neglected in favour of the toilet which existed before the project because the reactor is no longer running when you move the handle. At the household garden, the family does not practice vegetable growing because of wandering of animals. Indeed, despite the protective grille, chickens, goats and pigs, raised in semi-open-air conditions, frequently penetrate inside the garden place to eat the vegetables. Pilot families did not find a way to avoid these intrusions so they finally abandoned the gardening.

3.3. Discussion
The survey highlighted a progressive abandonment of sanitation facilities one year after the end of the project. The main reasons of such abandonment are facilities breakdown and progressive lack of interest both to maintain/repair these facilities associated with a total disinterest for by-products reuse in agriculture. However, pilot families of Kologodjesse Village seem to have appreciated all the technologies and had expressed a very good commitment to carry on the by-product reuse. But as mentioned by Shove [10], technology appropriation in developing project is usually oversimplified by considering only the lack of correct technical device as the main cause of appropriation failure. The author mentioned the necessity to include several other constraints like markets, economic incentives and credits. Ushijima et al. [11] completed this analysis by proposing a post-modern sanitation concept, more inclusive than a simple development and implementation of technologies. This concept has particularly proposed to develop sanitation value chain driven by a business model and supported by innovative financial system.

4. Conclusion
To the question "what do you need for your own development?" people never ask for a toilet. Their priority are borehole for drinking water, school, health center etc. sanitation facilities are not among their priority. In the present project, the relevance to develop sanitation facilities for rural people in Sahelian country was expressed by the Government of Burkina Faso through its program for water and sanitation access. However, after 5 years of implementation followed by one year after the end of the project, two main lessons can be learnt: (1) in term of efficiency and effectiveness of the project the technology of composting toilet was not robust enough, leading to a rapid abandonment after the project (2) in term of impact and sustainability, the economic incentive of the resource oriented sanitation concept was very weak compared to the needed workload. So people progressively abandon the by-product reuse. In the perspective of further investigation, the technologies development should be carried on and associated with a more inclusive system driven by economic incentive

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