

ATTENTIVE SEMINAR

Constructed wetlands, robust and reliable solutions for **domestic wastewater sanitation**



📅 TUESDAY, OCTOBER 17TH

📍 HÔTEL BAKOUA - TROIS ILETS - MARTINIQUE

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- ATTENTIVE project background
- Vertical flow constructed wetland filters: objectives
- Allocated resources
- Sanitation and Vertical Flow Constructed Wetlands (Filtres Plantés de Végétaux - FPV) for small and medium sized local authorities
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- Conception and sizing of Vertical Flow Constructed Wetlands (FPV)
- Achievements and returns on operations
- Other applications (Industrial, Individual domestic sanitation, etc.)



OPENING SPEECH



Arnaud RENE-CORAIL (Mayor of Trois-Ilets)

“ The City of Trois-Ilets is pleased to welcome the work on the restitution of the ATTENTIVE seminar which deserves to be considered as a key event for the water sector. Coastal town whose coast is occupied by sandy beaches, urbanized areas, mangrove, it is therefore directly concerned by the problematic mentioned and the evolution of the Regulatory Laws provisions on Sanitation Management.

Sanitation plays a role in preserving the quality of bathing water, thus indirectly in the tourism-related economy. We hope to eventually propose constructed wetlands sanitation projects in future housing subdivisions, for example in the different neighborhoods that are still not connected to the sewage system even if Trois-Ilets is the most sanitized municipality of Martinique. ”



Félix FONTAINE (Vice-President of Espace Sud)

“ Since January 1, 2017, Espace Sud has exercised the «Water and Sanitation» competence in the 12 southern communes, following the disappearance of the SICSM. This intermunicipal union took part in the ATTENTIVE project. It is now up to Espace Sud to continue. Investments in sanitation must take into account the constraints of a territory which concentrates more than 30% of the population of the island.

As part of the ATTENTIVE project, two vertical flow constructed wetlands water treatment plants have been created in the South. The first in François in 2010-2011 and then in the district of Taupinière, Diamant, very close to the mangrove area. Espace Sud is concerned by such issue and responds regularly to calls for proposals related to the ATTENTIVE project in order to meet the requirements of a logic of improvement of the public service, a reduction of costs and respect for the environment. ”



Claude LISE (President of ODE)

“ Led by the Office De l'Eau Martinique for four years now, the ATTENTIVE project has been evaluated at nearly one million euros, financed by nearly 45% by the French Agency for Biodiversity (FAB, formerly ONEMA). The ATTENTIVE project was rewarded in 2014 by the former Minister of the Environment, Mrs. Ségolène ROYAL, with a first national prize in applied ecological engineering for the treatment of wastewater and rainwater.

The ATTENTIVE seminar is to report the results of the work carried out in Martinique and Guadeloupe on what constitutes the adaptation to the tropical Caribbean context principles of sizing, construction and exploitation of a technology already proven for mainland France for almost 20 years now. This alternative project represents a real chance for the territory of Martinique but also for other geographical areas. It answers to different health, environmental, economic and cooperation issues. It provides concrete answers to the problem of contamination of aquatic environments in Martinique, the main source of organic contamination apart from micropollutants and pesticides coming from sanitation. Its effective implementation should encourage the creation of innovative sectors that will positively impact the sustainable development of Martinique and all those who adopt it. The Office De l'Eau Martinique is committed to supporting all decision makers both technically and

financially, so that they take ownership of this innovative technology favorable to economic and sustainable development that will contribute to the preservation of our tropical environment and will enable us to make our environment a priority. The FAB is currently relying on the ODE to launch a sanitation project at Les Salines, a project based on the technology to be discussed today. Thank you to all the partners who, alongside the Office De l'Eau Martinique, have made this ATTENTIVE project a success and will certainly continue being supportive for future developments. ”

PRESENTATION OF ATTENTIVE PROJECT



OBSERVATIONS AND ASSESSMENT OF SANITATION IN MARTINIQUE

Loïc MANGEOT (Deputy Director - ODE)

- Structural delay in remediation that has been compensated for larger units but remains a problem for very small stations. In Martinique: 300 treatment plants, the 30 largest have undergone rehabilitation programs and are working properly. The intermediary 70 work moderately and the other 200 work badly.
- Presence of sanitation networks that are often too long, the topography is not very favorable (presence of hills, so of posts of recovery, which increases the duration of stay of the effluents). There are releases including H₂S gas that corrode the structures. The aging of the structures is premature, many electro-mechanical or reinforced concrete equipment is completely corroded and will have to be redone.
- Problem of exploitation of the small works: it is not easy to exploit small works scattered over the whole territory. They are often neglected not only by the communities but also by the private structures that exploit them.
- Leaching of these structures during rainy weather causes rapid pollution of the receiving environment.
- Multiplication of stations that originated in a development that was sometimes anarchic with networks that did not follow. To replace these stations, we must try to find solutions.

ATTENTIVE PROJECT BACKGROUND

Michela ADIN (General Director - ODE)

A meeting between IRSTEA and the SICSM researchers allowed to consider this type of station.

- **2009** Launch of the project with SICSM, who operates the Southern part of island, and discussion of alternative patterns of development and innovative researches..
- **2012** Launch of the call for proposal by the Ministry of Environment.
- **2012** Signature of an agreement between ONEMA (the actual FAB) and ODE.
- **2014**
 - Signature of the ATTENTIVE agreement and official launch of the project.
 - Rewarded by the former Minister of Environment.
- **2015** Signing of an addendum to integrate the Guadeloupe Water Office and the Greater North Urban Community (CANGT).



If the ATTENTIVE project focuses today on the Caribbean, the field of intervention is much wider because it also affects Reunion, Mayotte and French Guiana. A certain number of factors are necessary to ensure the development of a real sector.

One of the areas of progress would be to launch innovative research with alternative solutions for sanitation.

It is about finding synergy and building with public and private decision-makers, the scientists who lead the works and the researches as well as the private actors so as to transfer the knowledge to the decision makers, the builders and the technical supervision.

VERTICAL FLOW CONSTRUCTED WETLAND FILTERS: OBJECTIVES

Lucas PELUS (*Sanitation engineer - ODE*)

- ⊙ The aim was to adapt the industry locally by building somewhat different stations with systems that are robust, easy to operate, economical to build, operate, and that allow integrated sludge management.
- ⊙ One of the challenges was to be able to adapt the sector locally. Some questions were asked especially on the surface of the filters. Indeed, the larger the station, the more pollution can be treated, especially as the local climate favors bacterial activity. The idea was to reduce the surface of the stations while treating as much pollution. The vertical flow constructed wetland filters will remain efficient despite the rain, there will be no departure of sludge as on activated sludge stations.

The other challenge was to find a local non-invasive plant equivalent to *Phragmites australis*, a plant that should have similar mechanical properties to allow the filters to work by facilitating the infiltration of water through the sandy substrate.

⊙ The interests of the project were:

- The transfer of technical skills and the possibility of benefitting from metrological equipment and training;
- Environmental benefits;
- Industrial benefits.



ALLOCATED RESOURCES

Michela ADIN (*General Director - ODE*)

⊙ Financial resources

- 35 experimental reports
- 33 parameters measured by balance sheet
- 22 tropical plants tested on a small scale
- 9 plants tested in life size

⊙ Financial resources

- Total budget (excluding construction) of € 914 000 including € 400,000 FAB grant

⊙ Human resources

- 1,664 work days
- 9 Steering Committees

SANITATION AND VERTICAL FLOW CONSTRUCTED WETLANDS (FILTRES PLANTÉS DE VÉGÉTAUX - FPV) FOR SMALL AND MEDIUM SIZED LOCAL AUTHORITIES

Pascal MOLLE (*Researcher - IRSTEA*)

⊙ Choice of sanitation technique

The analysis of the performances of the various systems makes it possible to see that on processes such as activated sludge or biological disks which include decantation stages, 10% of the self-monitoring reports have a zero yield, mainly related to departures from mud. Regarding constructed wetlands, there is no sludge outlet, so it is a much more reliable technology. The choice of the technique therefore has consequences.

The 2012 DEAL report on Martinique shows that 85% of the stations for the less than 2,000 IE (Inhabitant Equivalent) do not respect the minimum set by the 2007 decree: off-service equipment over very long periods, under-sizing, and bad exploitation. Of the stations that work, very little respect the level of rejection. The 2014 DEAL (Environment, Planning and Housing Bureau) report shows that the smaller the stations, the more unacceptable their operation is in terms of performance..

⊙ Different processes:

- Unsaturated vertical flow filter,
- Horizontal flow filter (process not used in the West Indies),
- Horizontal filter with forced ventilation.



◉ Multiplicity of treatment channels

A treatment plant is not only composed of a single process of constructed wetlands, there may be juxtapositions. It is possible to work on a single floor and to associate constructed wetlands between them or with conventional processes.

◉ Advantages

Water and sludge treatment: the organic deposition will increase by 2 cm / year in a temperate climate, the rate of accumulation should be lower in tropical climate.

◉ Adaptation to tropical climate

It led to work only on two filters on the 1st floor, the kinetics of degradation being increased by the temperature. As a result, the surface of the structure is considerably reduced. The unsaturated / saturated vertical flow filter process can serve many applications on a single-stage system that has its place in certain contexts. The choice of sizing is an important point.

The pathway combined with the bacterial bed (Taupinière station) includes a 1st stage with unsaturated / saturated flow filters and a bacterial bed sized at a very low load to finish nitrification.

◉ Robustness of the treatment

- Load variation
- Rainfall variation
- Finding plants with the required mechanical role was a key issue. It took three years of work on all the French overseas departments on selecting the appropriate plants that were to be used in these constructed wetlands. The idea was to have several possible plants in each department.
- In terms of maintenance, one of the most important tasks is the wetland management. It's something simple that local communities can manage.



EXPERIENCE FEEDBACK – PROJECT MANAGEMENT

Frédéric L'ETANG (Director of Sanitation - Espace Sud)

Leslie VEREPLA (Deputy Director - North Caribbean Sanitation Unit Guadeloupe)

◉ History and context

The vertical flow constructed wetland technology is suitable for small and medium sized sanitation plants. Several technical constraints for a connection to the public network encourage local treatment. The State reluctance and land issues were among the brakes to installing constructed wetlands..

◉ Construction and commissioning

Three stations: Mansarde Rancée, Taupinière and Mangles with three contexts, three configurations and three objectives, a multitude of possibilities but in reality a single station responsible for validating and consolidating performance results. Recent climatic events have shown performance beyond expectations.

◉ Performance, exploitation and limits

The stations operate under load with very good performance, the same is true for hydraulic and organic overloads. The adaptation of plants, however, knows some limits and the maintenance must be more regular.

◉ Costs

It takes about € 1,000 in investment by Inhabitant Equivalent (IE). This amount includes, among other things, the research program. It is the multiplication of projects that will optimize these investment costs. The lack of equipment inevitably leads to lower operating costs and the cost of plant maintenance varies according to the provider..



CONCEPTION AND SIZING OF VERTICAL FLOW CONSTRUCTED WETLANDS (FPV)

Rémi LOMBARD -LATUNE (Research engineer IRSTEA)

Overall background

- 1950 First trials of water treatment from wetlands tropical plants..
- 1978 1st mission of CEMAGREF (currently IRSTEA) for the evaluation of the performances of the station
- 1980 Design of the first experimental stations by the CEMAGREF
- 1980 Expansion of the sector thanks to a public / private partnership
- 2006 Beginning of the first works in the overseas departments (1st treatment plant built in Mayotte)
- 2010 Beginning of larger -scale operations in the French overseas departments.

Constructed Wetlands have been developed following the results of public research, so they are not owned by a private company. They consist of a mass of gravel artificially separated from the ground by a geomembrane, crossed by pipes that will allow both aeration and drainage of the water brought. These waters are raw sewage. Water and sludge co-management is carried out on the structures, hence the purifying biomass that will be responsible for treating the pollution that is fixed on the gravel. Plants intervene to ensure aeration of the environment. These vertically flowing filters are fully unsaturated media with the exception of the saturated layer added at the bottom of the filter. It is an aerobic environment with aerobic pollutant degradation processes, thus without odor.

For this fine-grained culture, **three processes of degradation** will be found:

- Biological (biomass)
- Physics (filtration)
- Chemical (adsorption mainly carried out on the skin layer that develops on the surface)

One of the challenges of filter design: **maintaining the aerobic conditions inside the filter.**

Three processes make it possible to renew the air inside the massif:

- Sequenced feeding by covering
- Aeration / drainage network
- Mechanical action of plant stems on the mud layer.

Biomass management: alternation of feeding and rest phases: mineralization of the accumulated biomass.

Sustainability of the system: The continuous supply of wastewater causes an increase in biomass until the clogging of the filter. Multiple time scales help to ensure the durability of the system that can be threatened in the event of failure of one of the scales, thus reducing the life of the filters.

Variants of Vertical Flow Constructed Wetlands: Work was carried out either as part of the ATTENTIVE project or at the level of actions with ONEMA.

Role of plants: They provide support for the development of bacteria and a greater biodiversity of microorganisms inside the filter.



⊙ Performances

- **DCO** : performance around 90% and strong impact of rainy weather
- **MES** : large and stable reduction - more than 90% despite heavy hydraulic and organic overload
- **NTK** : we notice at the level of all the filters that, the more the load increases, the more the yields decrease.

⊙ Sizing

Study based on all data from the self-monitoring of overseas sources on stations of less than 2000 Inhabitants Equivalent (IE), which made it possible to define concentration ranges at the entrance of the stations. The concentrations correspond on average to what is observed in mainland France but it is possible to find highly charged effluents.

The sizing of the constructed wetlands is based on a daily load on the operating filter which is 350g COD / m² / day. This ratio will give a surface that will be checked to see if it is enough for all the charges applied.

These charges correspond to a theoretical surface of 0.4 m² / IE on the filter in operation, ie a total of 0.8 m² / IE for the station.

ACHIEVEMENTS AND RETURNS ON OPERATIONS

Nicolas FINA (COTRAM Sanitation Engineer)

⊙ Implementation of constructed wetlands

Some aspects are to be taken care of before construction, including the choice of materials and the optimization of the location. For the construction phase, it was, among other things, to protect works from muddy waters in the filters. The operational tasks carried out in the year on a constructed wetland are the following: control of the bucket hunt, cleaning of the bar screen, maintenance and weeding, maintenance of the surroundings, etc.

Points of vigilance: station maintenance including manual bar screen and bucket hunt. An important point to consider is the protection of the material. It turns out that the solar protection and the resistance of the materials could be insufficient on the first constructions. An adaptation has been made with the installation of IP 68 material that protects against rain, moisture, heat and dust.

OTHER APPLICATIONS (INDUSTRIAL, INDIVIDUAL DOMESTIC SANITATION, ETC.)

Pascal MOLLE (IRSTEA Researcher)

The different applications of the constructed wetlands system require, each time, adaptations in the design and dimensioning of the structures.

⊙ Individual sanitation

- Le The regulatory context requires that we work with accredited sectors on test platforms in mainland France, tests that are not representative of reality. Constructed wetlands approved sizing is between 2 to 4m² / IE.
- Need for a tropical reference system: reduction levels are relatively interesting and even very stable despite load variations. This should be adapted to tropical climate in order to have a compact and reliable individual sanitation sector.

⊙ Industrial effluents

- Many applications: agribusiness, industry (methanol and benzene treatment in the chemical industry or contaminated groundwater), oil industry, agriculture, processing of agricultural products, etc.



◉ Sludge treatment

Systems developed to initially treat activated sludge with the following objectives:

- Drying and mineralization: greater economic interest for large capacities, also suitable for the treatment of waste materials in order to have a decentralized system close to individual sanitation production units

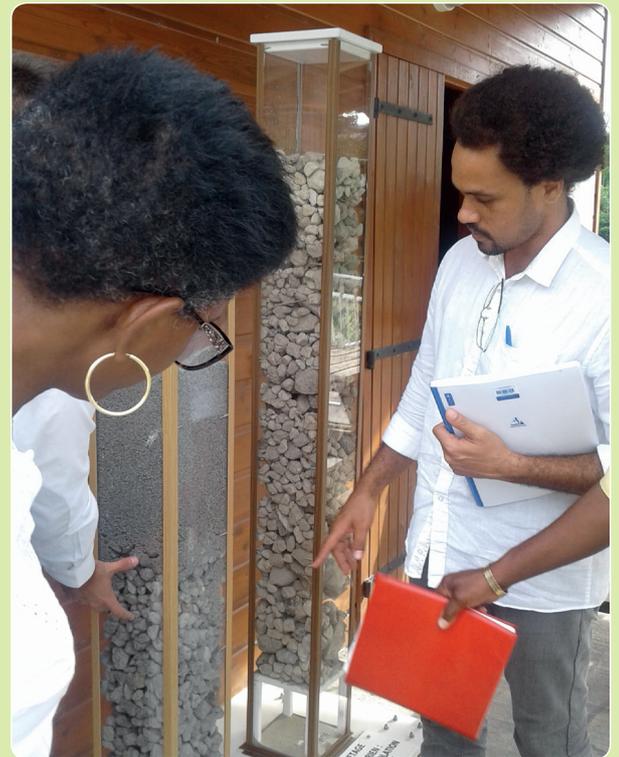
◉ Urban discharges in rainy weather

Several possibilities are offered to cope with rainy weather constraints on unitary networks:

- Make separate networks
- Adapt the sizing of constructed wetlands that treat domestic wastewater to treat rainy weather on the same structure
- Install a constructed wetland to treat weir overflows only;

Constructed wetlands are robust, reliable and flexible in their design. In terms of investment, they are not necessarily much cheaper than any other system and the cost of maintenance is low.

They have the advantage of providing good landscape integration, contributing to the creation of recreational areas, refuge zones for biodiversity in urban areas and potentially, reinventing the urban environment.





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