

EVALUATION OF THE R&D PROGRAM OF THE FRENCH ENVIRONMENTAL AGENCY (ADEME) ON SANITARY LANDFILLS – REVIEW AND FOCUS ON ONE OF THE TOP PRIORITIES: POST-CLOSURE CARE

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SUMMARY: The French Environmental and Energy Management Agency (ADEME) has allocated €3.5 million for research programs on sanitary landfills over a period of 7 years (2000 – 2007). In 2008, the Agency decided to conduct program evaluation in order to make judgments about the way research was carried out; identify the role and value of ADEME in the network in place; assess the results achieved; and, lastly, set up a policy as well as methodological and operational recommendations for future research programs in order to promote new approaches and new research themes. A commission of evaluation was constituted whose recommendations are summarised in the present paper. Moreover, following this evaluation, a call for projects was launched by the Agency on the theme of landfill Post-Closure Care (PCC) which had been identified as a top priority. Seven projects (introduced hereafter) have been launched to date on this Program.

1. INTRODUCTION

The external evaluation of public policies is a practice that is becoming increasingly widespread today. For the French Environmental and Energy Management Agency (ADEME), this approach has clearly become a priority. In particular, a Commission of evaluation has been constituted to assess the research program 2000 - 2007 related to the storage of non-hazardous domestic and industrial wastes, in order to promote new approaches and new research themes. Although the research program on sanitary landfills is limited, the economic and environmental challenges are considerable: around 23 million tons of non-hazardous waste stored each year in France.

The objectives of this evaluation were the three following:

- making judgments about the way landfill research is conducted and identifying the role and value of ADEME in the network in place.
- assessing the results achieved and the recovery plans in addition to identifying and quantifying the benefits of the related scientific and economic activities.
- setting up a policy as well as methodological and operational recommendations for future research programs.

2. PRESENTATION OF THE RESEARCH PROGRAM

2.1 Some facts and figures about the research program

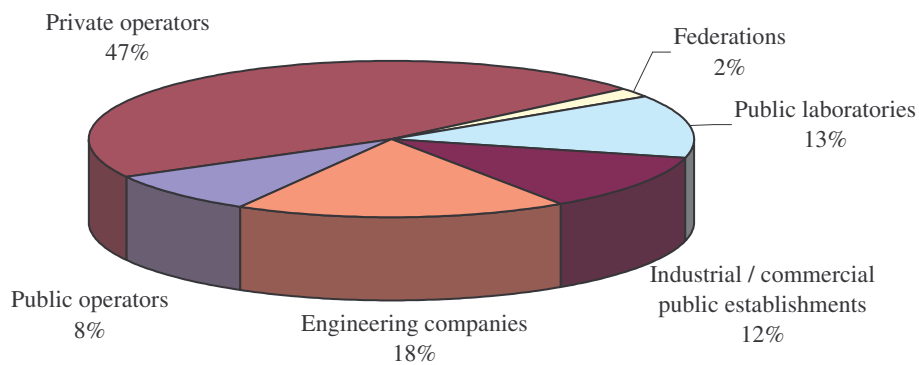


Figure 1. Distribution of aids from ADEME by type of recipients (doctoral thesis excluded).

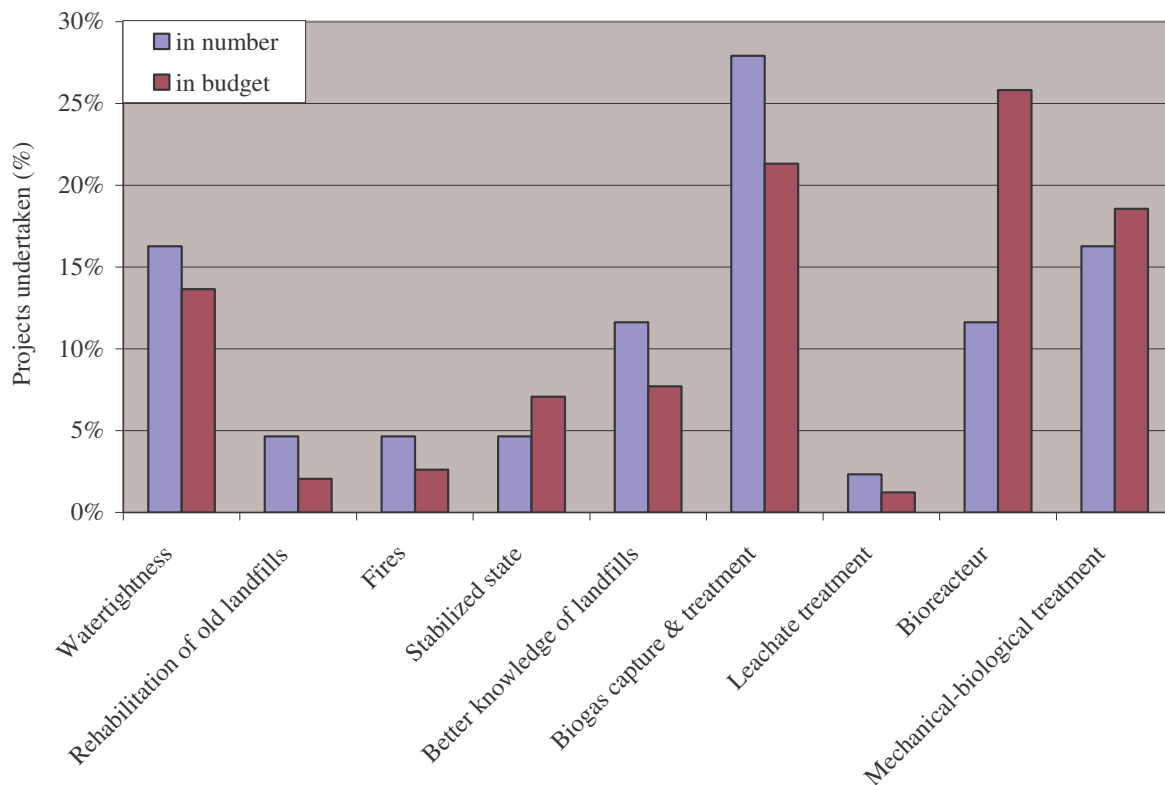


Figure 2. Research themes explored in the program (in percentage).

The research program in question has represented over the period 2000 - 2007 a financial aid of € 3.5 million for an overall collaborative research of € 6.9 million (financed by the Agency up to 49 % for research contracts and 58% for doctoral theses). 43 research contracts as well as 10 doctoral theses were signed in partnership with local public authorities and industrial operators.

This aid was distributed as follows: private operators (47%), public operators (8%), engineering companies (18%), industrial/commercial public establishments (12%), public laboratories (13%), federations (2%) (Figure 1). On the whole, 9 research themes were explored in the program as depicted in Figure 2.

3. METHODOLOGY OF THE EVALUATION

3.1 Description of the ADEME evaluation protocol for R&D activities

ADEME has been involved in piloting and guiding research and development activities for many years, in the fields related to the Agency's domains of action. With the double objective of increasing the effectiveness of the Agency's support to R&D and more clearly highlighting its added value in research, ADEME has decided in 2000, in liaison with its oversight authorities, to develop evaluation procedures to ensure that its programmes are relevant and effective, and to facilitate assessment of their impacts.

While drawing upon evaluation methodologies already in use in similar organisations, the methodology chosen to evaluate ADEME's research activities had to be grounded in the Agency's own identity, which is characterised by the following features:

- as a goals-oriented Agency, ADEME does not possess in-house research resources but plays a specific role in guiding and piloting research, particularly aimed at reinforcing capacity;
- a very broad scope of action (research, decision-making aids, information and awareness schemes, expertise for the elaboration and implementation of major national programmes, advice on project design and management, observation, etc.);
- interactions between central departments and regional offices;
- implementation of technological partnerships with major actors in leading sectors;
- actions on transversal and cross-disciplinary issues.

Taking all these factors into account, an evaluation process of the Agency's R&D activities, known as the "Evaluation Protocol", has been set up. This protocol had been elaborated jointly by the Agency's programming and evaluation divisions and had been applied prior to the present evaluation for evaluating two other programs ("Bâtiment 2010" and "Agrice"). As depicted on Figure 3, the evaluation protocol is based upon six closely related components (framing, organisation, selection, monitoring of ongoing work, analysis of results and building value), according to the French standard AFNOR FDX 50-551.

The flow chart of the ADEME protocol for the evaluation of R&D activities is presented on Figure 4. It is essentially based on a retrospective report written by the workteam piloting the R&D program that is being evaluated. The architecture of this report follows the six headings listed in the AFNOR standard.

The evaluation itself is conducted by a Commission composed of and presided by external referees (6 to 9 persons at the most). The Commission meets three or four times in the course of the evaluation that may last 6 to 8 months. The commission's work is based on the information compiled in the retrospective report and on interviews conducted with qualified experts in the sector. To supplement these sources a consultant team may be called upon to gather more data.

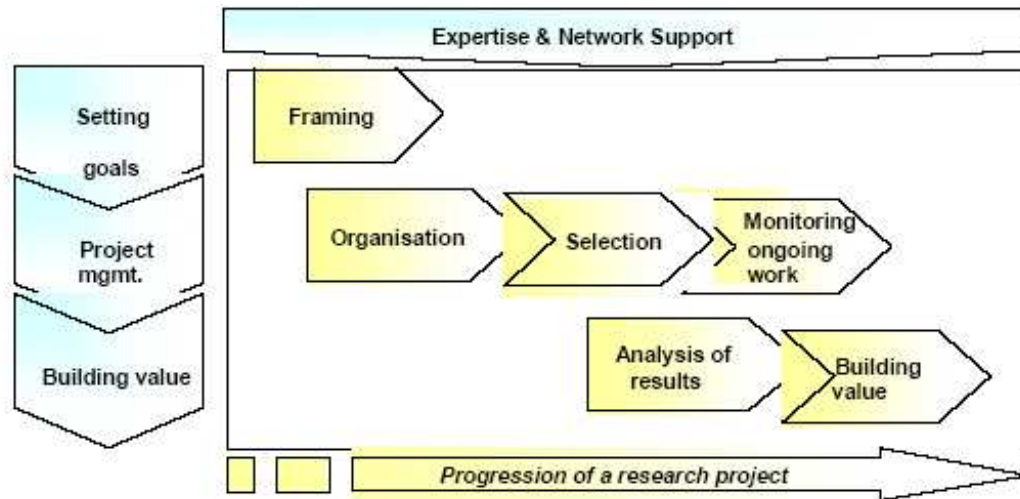


Figure 3. Articulation of the six research activities in the course of a research project.

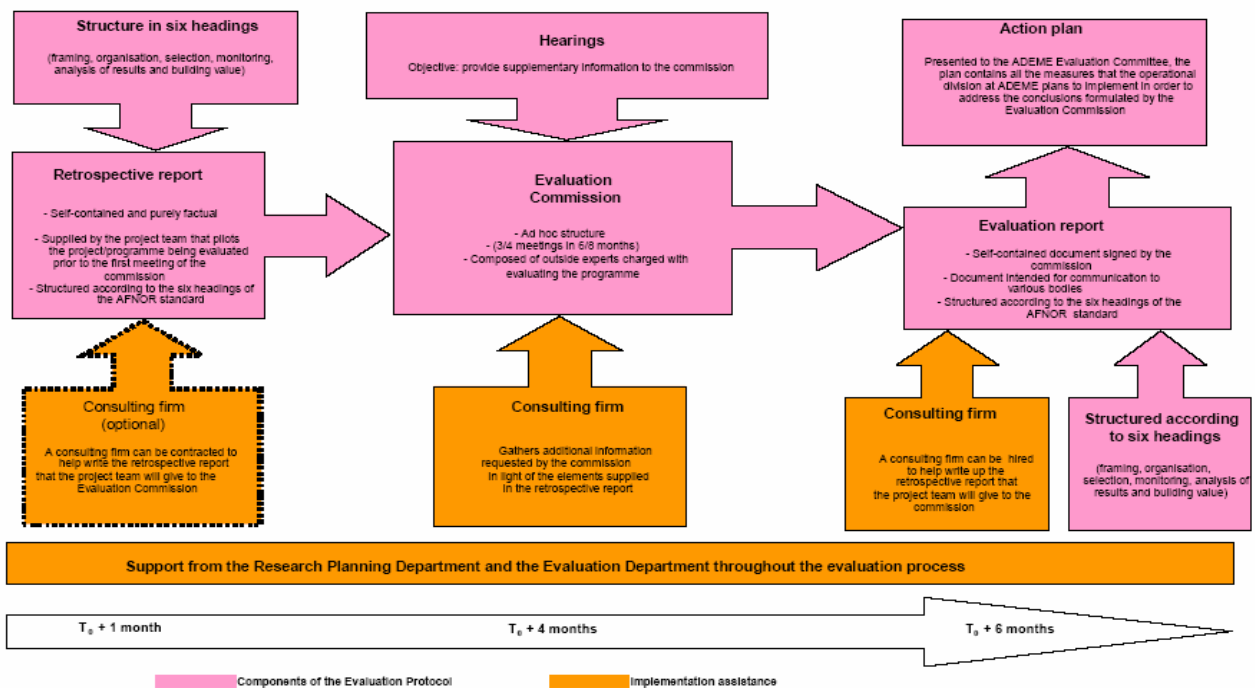


Figure 4. Flow chart of the ADEME evaluation protocol.

The evaluation report written by the Commission provides background information, opinions and recommendations for each of the six headings that make up the research programme. This report is signed by the chair of the Commission and submitted to the operational division that oversees the R&D programme being evaluated, for further dissemination and drawing up of a plan of action. This plan follows up on the works of the Commission and must be submitted to the internal Evaluation Committee of the Agency. It specifies the steps that the project team plans to implement and gives a timetable for their execution.

3.2 Application of the protocol of evaluation to the sanitary landfill program.

The commission of evaluation of the R&D program on sanitary landfills, that met three times in 2008, was composed of nine experts from different backgrounds (a former president of the the French BRGM acting as president, two representatives of the Ministries of research and environment, two representatives of industrial public research establishments, two university professors and two representatives of private operators) and was also assisted by a consultant.

Three engineers from the Programmation, the Observation and the Animation Divisions of ADEME were also involved in the evaluation process, providing methodologic support and guidance.

Also, the commission based its works on the following two essential documents:

- a retrospective report on the R&D activities of the Agency from 2000 to 2007 (drafted by the engineer in charge of the sanitary landfill program);
- a synthesis of opinions and suggestions from ten French landfill actors (public and private operators, researchers and engineering consultants).

3.3 Success and limits of the evaluation of the R&D program on sanitary landfills

The scope and limitations of the assessment result as to the qualities and intrinsic limitations of the assessment protocol and the specific experience of the present evaluation are detailed hereafter:

- The evaluation covers the entire life cycle of the research program

Structuring the evaluation in six phases according to the Ademe protocol made possible the assessment of the entire life cycle of the research program. The findings, then the Commission's opinions and recommendations were indeed made for each phase of the project. This choice to cover all phases of the program has obviously influenced the implementation process not being able to fulfill each as required. Indeed, the timing of the evaluation was relatively short (6 months including 3 meetings). This could be a weakness in the protocol as it does not allow the Commission to take necessary steps back in view of the information and data made available. On the other hand, it would reveal difficult to mobilize external (unpaid) personnel for a longer period of time.

- The evaluation represents a significant learning opportunity for the Ademe project team

Beyond the evaluation work carried out by the Commission, the evaluation process was an opportunity for the Ademe project team to step back and question its own practice. As such, it was largely appreciated by by the project team, although the full process requested an important time investment.

- The quality of the evaluation process depends on the coherence of the composition of the Commission, comprising domain expertise and project management skills

The composition of the commission was a critical phase of the implementation of the Protocol. It required finding people both sufficiently expert in the evaluated domain to have a relevant outlook on the program and to be relatively neutral. Besides, it was equally important to have non-experts in the Commission (its president presently) and/or personnel from foreign countries (i.e. two persons from Switzerland and Germany). This ensured the necessary distance from the evaluated program and the impartiality of the decision rendered by the Commission.

Also, the Commission had to make recommendations at both operational and strategic levels. This was a challenge for the members of the Commission, who were sometimes more or less involved in the program and could therefore feel non-legitimate to make recommendations of strategic nature. It was the duty of the president / consultant to create a climate of confidence and

to conduct open discussions with the aim of “unlocking” the imagination.

- The quality of the evaluation depends also on the synergy between the president of the Commission and the consultant

In the present case, mutual understanding has led to quality work within a very short time. The choice of the President and the accompanying consultant proved to be key elements for a successful evaluation.

4. RESULTS OF THE EVALUATION

The commission came up with advice and recommendations on the R&D program of the French Environmental and Energy Management Agency (ADEME) related to the management of sanitary landfills. Main recommendations are developed hereafter. For complete details, one should report to Ademe-Ecogeos (2008).

4.1 Analysis of the program management: observations, opinions and recommendations

4.1.1 Definition of projects

- Strengthen the operational capacity of ADEME.
- Foster a better overtone on social sciences and humanities.
- Intensify international relations in order to better share available expertise and skills and influence the evolution of public policies on waste management.

4.1.2 Organisation of projects

- Engage in work agreements with the French ANR - PRECODD program.
- Ensure coordination between local public authorities.
- Create network exchange at the European scale and reinforce the relations of ADEME with the U.S. Environmental Agency (USEPA).

4.1.3 Selection of projects

- Formalise in writing the selection criteria of research contracts and draft guidelines including contractual aspects of industrial property.

4.1.4 Follow-up on projects

- Ensure a more regular follow-up on projects and hold regular seminars/workshops with scientists and doctoral researchers.
- Establish external monitoring committees for large research programs.

4.1.5 Analysis of project resultats

- Evaluate more systematically scientific advances from the perspectives of both scientists and landfill operators.

4.1.6 Valorization of project resultats

- Improve the capitalisation of results and the diffusion of technical notifications.
- Develop a website dedicated to sanitary landfills, containing technical and legal information and post the summaries of studies funded by the Agency on this website in order to increase the capacity of ADEME to inform and educate.

- Encourage doctoral students to write an evaluation summary for diffusion via the Internet.
- Continue the English translation of ADEME guides, basically the most relevant and strategic ones.
- Participate regularly in international conferences in order to better inform about research programs conducted in France.

4.2 Orientations 2008 – 2011 of the ADEME research program

4.2.1 Orientations of the French Environmental Agency prior to the evaluation

In the present context characterized by strong concerns in relation with energy issues, increasing awareness about the environmental impacts of sanitary landfills and an increasing number of landfills in post-operation, the top priorities of the French Environmental Agency have been defined as follows:

- Reduction of green house effects from landfills: identification, measurement, analysis of pollutants, and means to implement to reduce emissions to the atmosphere;
- Post-closure care: definition of waste stability, levée des garanties financières landfill mining, long-term impacts;
- Acceptability of sanitary landfills and associated sociologic issues.

Other topics are also of interest for the Agency although less strategic: the treatment of leachate and odors, the blowing of litter and plastic bags and the presence of animals on sites.

4.2.2 Orientations suggested by the Commission

Some research orientations were suggested by the Commission in order to further improve the management of sanitary landfills, especially:

- Biogas capture and treatment: measurement of diffused emissions and biogas treatment prior to valorization.
- Bioreactor landfills: continuation of on-going research works and development of a ‘light’ Mechanical-Biological Treatment (MBT) adapted to the French context.
- Life Cycle Analysis: development of reliable decision tools + cost / benefit analysis to demonstrate the strengths of landfills by the integration of waste processing techniques before and during storage.
- Setting-up of Post-Closure Care (PCC) termination criteria: identification of relevant waste stabilisation criteria and prospects for landfill mining.
- Sustainability of landfill covers: continuation of on-going research works on the behaviour of mineral and synthetic cap covers.

Moreover, monitoring of sanitary landfills lasts over thirty years minimum to cover their entire period of post-operation. Therefore, the relative short duration of ADEME projects (typically 2 to 3 years) is sometimes not sufficient enough to reach a deep understanding of certain phenomena. Following the example of research works carried out in France on the storage of CO₂, the Commission has therefore suggested to conduct, in parallel to short-term projects, other long-term projects (over 10 to 30 years) on well-documented selected sites in order to get a large database. Prior to its implementation, this approach would require the development of a specific methodology (and the definition of parameters to monitor). In a second step, a review of several landfills could be developed in collaboration with their owners, in order to better assess the long-term effectiveness of various waste treatment processes and motivate the decisions of post-closure care termination at the end of the 30 years period.

5. ACTION PLAN FOR 2009 – 2011: FOCUS ON LANDFILL POST-CLOSURE CARE

6.1 Contents of the ADEME Action Plan 2009 - 2011

Based on the recommendations of the Commission of evaluation, ADEME elaborated an Action Plan for 2009 - 2011. The main points of this plan can be summarised as follows:

- regarding the definition and organisation of projects: development of research monographs on pilot sanitary landfills and development of life cycle analysis, launching of calls for projects on specific themes.
- regarding the valorization of project results: organisation of frequent scientific seminars, on-line publishing of research findings, translation of most relevant works into English, development of a website dedicated to sanitary landfills, participation in the IWWG meetings, publishing of scientific papers, participation to international conferences.

6.2 ADEME research program on landfill Post-Closure Care (PCC)

6.2.1 Context and objectives of the program, selection criteria of new projects

Despite recognizing the relevance of “mutual agreement” in contractualisation, the Commission of evaluation emphasized that calls for projects should be launched on key research themes such as landfill Post-Closure Care (PCC). Consequently, ADEME has launched at the end of 2008 a project call on landfill PCC focusing particularly on 3 aspects, i.e. stability of waste, collection and treatment of biogas and management of leachate.

This program aims at:

- proposing "rustic" technologies that can meet the needs identified in terms of biogas / leachate treatment performances and more generally respect of the environment;
- defining a methodology susceptible to answer increasingly pressing questions on how and when definitively closing a sanitary landfill after the PCC period.

A board of examiners was composed of two engineers from the Agency as well as three researchers and one member of the Ministry of Environment. Each project (of a duration lower than 3 years) was evaluated according to the following criteria: general interest of the project (are the results of the project relevant for several landfills?), its technico-economical feasibility on the industrial scale (is the methodology / technology proposed applicable to other landfills?), involvement of the tenderer in the sector of sanitary landfills and its capacity to develop partnerships, means of the tenderer to formalize and develop the results obtained.

Altogether, five projects were selected in addition to two other projects launched earlier by the Agency on this theme of PCC: one about biofiltration of biogas and a second one focusing on a methodological approach in relation with the termination of PCC.

4.1.4 Description of landfill PCC projects

ADEME is currently supporting 7 projects about landfill PCC. These projects represent a financial aid from the Agency of 920 k€ for an overall collaborative research budget of around 2350 k€. ADEME's partners on those projects are:

- public laboratories : Insa (Lyon / Toulouse), Lthe
- industrial/commercial public establishments : Brgm, Ineris
- public landfill operators: Castres-Mazamet Collectivity and Organom,
- private landfill operators: Coved, Suez Environnement, Veolia Environment
- engineering companies: Antea, 3C, Ecogeos, Riquier Etudes Environnement, Serpol, Sint and Valdech

These projects are introduced hereafter including their objectives and expected results.

Project # 1 (“Roseaulix”): Adaptation and optimization of reed bed filters for the treatment of leachate from sanitary landfills during operation and post-closure care.

Manager: SERPOL (engineering compagny) - jeanluc.mangiacotti@serpol.fr

Many small sanitary landfills approaching the end of their lifetime or older sites in remediation produce leachate difficult to treat by conventional techniques. Indeed, their geographical location as well as the limited budgets available from the public operators do not facilitate the management of leachate in rural or slightly urbanized areas. The present research project aims at developing a leachate treatment process adapted to post-closure care conditions using reed bed filters. It is anticipated that this rustic technique will make it possible to treat leachate at low cost of implementation / operation while respecting the environment with regard to landscape integration, minimal electricity consumption and so on. Experiments will be conducted at laboratory and field scales. In particular, a field pilot (at scale 1) will be developed at a landfill approaching the end of its operation and managed by Organom public local authority.

Project # 2 (“Flixiplant”): Treating leachate from an old landfill by means of vertical reed bed filters: follow-up on a pilot installation at Pioch de Gaix landfill.

Manager: 3C (engineering compagny) - chassagnac.3C@gmail.com

Similarly to the preceding project, the present project aims at studying a real-scale field installation designed for the treatment of old leachate using reed bed filters. After reviewing the bibliography available on the subject, some experiments will be carried out at Pioch de Gaix landfill, currently in progress of remediation under the authority of Castres-Mazamet local public operator. The project will particularly focus on the abatement of nitrogen which is known for remaining at high concentrations in old leachates. The installation will include a succession of aerobic vertical filters and anaerobic horizontal filters, allowing the nitrification and denitrification of the effluent. The installation will be followed up during one year.

Project # 3 (“Antelix”): Monitored Natural Attenuation of residual leachate emissions from landfills during the post-closure period.

Manager: BRGM (industrial/commercial public establishment) - d.guyonnet@brgm.fr

Following the regulatory thirty-year monitoring period of a closed non-hazardous waste landfill, the decision regarding interruption of monitoring and the possibility to waive financial guarantees will need to rely on a demonstration that the landfill does not represent a risk for the environment and in particular for groundwater. Such a demonstration cannot rely solely on model calculations of the potential impact of the landfill on groundwater, due to the typically conservative nature of models which generally neglect a variety of attenuation mechanisms (in particular co-precipitation). It will therefore be necessary to demonstrate that natural attenuation processes are at work in the groundwater in the vicinity of the landfill and the scientific evidence for this will need to be collected during the thirty-year monitoring period. The objective of the ANTELIX project is to provide the tools and methodology for such a demonstration. It aims at transposing the concept of Monitored Natural Attenuation, developed in the context of contaminated soils, to the context of landfills, for an efficient control of residual leachate emissions during the post-closure period. It will rely in particular on the use of complementary tracer tools, isotopic and chemical, in order to highlight the natural attenuation processes.

Project # 4 (“Paraphyme”): Importance of physico-hydro-mécanical parameters as indicators of MSW stabilization and their impact on post-closure care and cap cover strategies.

Manager: COVED (private operator) - bjean@coved.fr assisted by ECOGEOS (engineering company) - franck.olivier@ecogeos.fr

In addition to traditional biochemical parameters, the project will attempt to quantify physical (drainage porosity, induced polarization, heterogeneity), hydraulic (water retention, permeability) and mechanical characteristics (settlement, embankment creep) of MSW of advanced age, those parameters being susceptible to serve as direct or indirect indicators of waste stabilization and criteria for assessing the long-term impact of sanitary landfills, in relation with various capping scenarios (permeable or impervious covers made of natural or mixed natural / synthetic materials). Experiments will involve 4 pilot landfills expected to become an observatory on Post-Closure Care (PCC), supplemented by 4 other sites covering a large range of configurations with regard to the morphology of landfill sites, the climatic conditions, the composition and age of the waste (up to 29 years). Methodological recommendations for the instrumentation and the monitoring of post-operation landfills will also be proposed. More details on this project may be found in Marcoux et al. (2009).

Project # 5 (“Methalix”): Landfill gas and leachate management during the after care period – Assessment of methane oxidation methods and leachate treatment by natural attenuation.

Manager: SUEZ Environnement (private operator) - Anna.AKERMAN@suez-env.com

The management and treatment of landfill gas and leachate during the after-care period becomes more and more difficult when the quantities and flows decrease and because of the absence of permanent staff on the site. The METHALIX project proposes to address these issues through the use of sustainable and performing treatment methods using natural attenuation. As for LFG treatment, the project will focus on the phase of transition from active treatment (collection, then flaring or recovery) to passive treatment (oxidation within the cover), and then also on the phase of passive treatment of all the LFG (oxidation in the cover or bio-windows). As for leachate treatment, the performance of a natural attenuation treatment method (wet land, phyto treatment) will be studied, taking into consideration the long-term evolution of leachate quality. The project will be carried out based upon bibliographical reviews, experience feedback and in-situ pilot trials.

Project # 6: Active biofiltration of biogas at three landfills.

Manager: Riquier Etudes Environnement (engineering Co.) - riquier.biogas@wanadoo.fr

This project builds on a bibliographical study which demonstrated the interest of experimenting the active biofiltration of residual biogas in France through a technology (based on a pumping unit) that has not yet been adapted to landfill conditions. This technology seems particularly adapted to landfills characterized by low flow discharges and/or concentrations of methane lower than 20 - 25%. Pilot tests will be initiated on three landfills operated by private companies and located in various climatic zones. They will be monitored during one year. The main objective of the project is to acquire information data on the technique developed, including a feedback in terms of limits of functioning and optimization of operating as well as technical parameters.

Project # 7: Evaluation of the functional stability of closed landfills.

Manager: SUEZ Environnement (private operator) - marion.crest@suez-env.com

In implementing the European Landfill Directive, Member States may propose a methodology for making a determination regarding landfill completion and release from the duty of aftercare. Very few Member States already proposed criteria and methodology to end aftercare. In order to demonstrate that a closed site no longer poses a threat to human health and the environment in the absence of some or all active aftercare, the “Evaluation of Post-Closure Care (EPCC)

Methodology” was developed in the USA. This methodology also allows to optimize aftercare activities to focus specifically on providing a level of aftercare consistent with site-specific characteristics (leachate and landfill gas quantity and quality, performance of landfill control systems, sensitivity of the surrounding environment...). In this study, the EPCC Methodology is applied to several closed or inactive landfill units at sites in France, Italy, and the UK in order to assess its applicability and validity in the EU regulatory context. In addition, this project should allow to identify shortcomings in landfill monitoring programs. It would also provide site specific recommendations on optimization of aftercare monitoring and more general considerations on the best design and operation practices for limiting the aftercare duration.

7. CONCLUSIONS

The external evaluation of public policies has nowadays become an increasingly widespread practice. And being one of the priorities of the French Environmental and Energy Management Agency (ADEME), it was important to evaluate its research programs on sanitary landfills conducted over the period 2000 – 2007. Despite the limitations of the exercise, this evaluation has been an opportunity not only to make a judgment on the results achieved but also to identify the role and value of ADEME in the network in place and to set up a policy as well as methodological and operational recommendations for future research programs. Moreover, based on the recommendations of the Commission that had been constituted to this end, the French Environmental Agency has set up an Action Plan whose first objective was launching a call for projects on the theme of landfill Post-Closure Care (PCC). Seven projects have been initiated to date, on the treatment of leachate and biogas as well as on the difficult issue of waste stabilization.

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REFERENCES

- Ademe - Ecogeos (2008) Evaluation du programme R&D ADEME 2000 – 2007 sur les installations de stockage de déchets non dangereux. *Download from* : www.ecogeos.fr/ref
- Ademe (2007) Evaluation protocol for R&D activities piloted by ADEME. 31 p.
- Afnor (2003) FD X 50-551 : Qualité en recherche - Recommandations pour l'organisation et la réalisation d'une activité de recherche en mode projet notamment dans le cadre d'un réseau. Ed Afnor.
- Marcoux M.A., Jean B., Gourc J.P., Guyonnet D., Ouvry J.F. and Olivier F. (2009) The importance of physico-hydro-mechanical parameters as indicators of MSW stabilization and their impact on post-closure care and cap cover strategies. *Proceedings Sardinia 2009, 12th International Landfill Symposium*, Cagliari, Italy.