



## **The PHYTENER project: development of phytostabilisation combined with energy crop production on agricultural soils highly contaminated by metals**

Bertrand Pourrut (1,2), Alain Leprêtre (3,2), Eric Therssen (4,2), Annabelle Deram (5,2), Pirouz Shirali (6,2), Fabrice Cazier (7,2), Antoine Richard (8), Renaud Scheifler (9), Jacques Blarel (10), Francis Douay (1,2), and the PHYTENER Team

(1) Equipe Sols et Environnement, Laboratoire Génie Civil et géo-Environnement, Lille Nord de France, EA 4515, Groupe ISA, 48 boulevard Vauban, 59046 Lille cedex, France (b.pourrut@isa-lille.fr), (2) Univ Lille Nord de France, 59000 Lille, France, (3) Equipe Ecologie Numérique et Ecotoxicologie, Laboratoire Génie Civil et géo-Environnement, Lille Nord de France, EA 4515, Université de Lille 1. Bât SN3, 59655 Villeneuve d'Ascq cedex, France., (4) UMR CNRS 8522 Physicochimie des Processus de Combustion et de l'Atmosphère (PC2A), Université de Lille 1, 59655 Villeneuve d'Ascq cedex, France., (5) UDSL, EA 4483, Impact de l'Environnement Chimique sur la Santé Humaine, 59000 Lille, France, (6) Unité de Chimie Environnementale et Interaction sur le Vivant, EA 4492, MREID 2, ULCO, 189 avenue Maurice Schumann, 59140 Dunkerque, France, (7) Centre Commun de Mesure, ULCO, 145 avenue Maurice Schumann, 59140 Dunkerque, France, (8) Laboratoire d'Analyses des Sols INRA, 273 rue de Cambrai 62000 Arras, France, (9) Laboratoire Chrono-Environnement, UMR UFC/CNRS 6249 UsC INRA, Université de Franche-Comté, Place Leclerc, 25030 Besançon Cedex, France, (10) Chambre Régionale d'Agriculture Nord-Pas de Calais, 56 avenue Roger Salengro BP 80039, 62051 Saint Laurent Blangy cedex, France

Soil contamination by metals is of major concern in Northern France, particularly in the former coal-mining region. Metaleurop Nord, located at Noyelles-Godault, was a major European lead (Pb) and zinc (Zn) smelter for almost a century. Despite improvements to reduce emissions since 1975, this smelter generated significant dust amounts until its closure in 2003. Around the former smelter, agricultural soil contamination by metals has been well described. It is limited to the ploughed layer where the mean concentrations of Cd, Pb and Zn are 20–50 times higher than the regional background values. On the other, in this area, Pb and Cd concentration in agricultural crops exceed threshold values for human consumption. Contaminated dusts are also a risk for human health and especially for children's health. Obviously, the remediation of these highly contaminated soils is a major preoccupation for National and Local Authorities. However, the contaminated area is too large to be remediated in an economically relevant way by the currently applied remediation techniques (dig & dump of soil). Moreover, in order to find new income sources for local farmers, a sustainable management of these polluted soils is crucial. In this context, the PHYTENER project aims to study phytostabilisation in combination with energy crop production. Two energy crops were selected:

- wood crop: an approximately-1 ha experimental site was set up in 1999 on a former agricultural field, 600 m north and downwind of the former smelter. The whole site was planted following regional practices for restoring brownfield lands with about 1800 trees of a tree mix: black locust (*Robinia pseudoacacia* L.), black alder (*Alnus glutinosa* L.), pedunculate oak (*Quercus robur* L.), sycamore maple (*Acer pseudoplatanus* L.) and white willow (*Salix alba* L.),
- Miscanthus crop: 3 approximately-1 ha experimental sites were set up in 2007 on former agricultural fields contaminated with different levels of metals. A new experimental site (approximately 1 ha) was set up in 2010 on a former agricultural site, 700 m north and downwind of the former smelter. This site aims to test different Miscanthus varieties and agricultural practices (rhizome density, fertilisation, mycorrhization).

The PHYTENER consortium is a strong region-wide network of 11 laboratories. It aims to lead the PHYTENER project in a multidisciplinary approach with three main topics:

### A) Study of the impacts of these crops on the soils and the environment

Change of land use is known to induce changes in physical, chemical and biological soil properties. Several parameters are evaluated:

- evolution of soil physico-chemical parameters,
- metal behaviour,

- metal accumulation in crops,
- environmental impact : effects on biodiversity, ecotoxicology,
- landscape impact.

#### B) Social study

Change in land use is also hypothesized to have an impact on farmers and neighbourhood population. This social study will focus on:

- farmers and neighbourhood population perception of this new management of polluted areas,
- landscape management,
- land reorganisation in the agricultural farms.

#### C) Economic study

The project aims to study crop yields as well as the valorisation of the energy crops by incineration. All the obtained information will result in an economic evaluation of the use of phytoremediation combined with energy crop production. Recommendations will be made in order to optimize the agricultural practices and the yield of the experimental multi-fuel boiler. This is necessary because the feasibility of the long term strategy of phytostabilisation has to be tested against the current remediation techniques.

The PHYTENER consortium wants to thank ADEME for financial support of this project.