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“Empty lands”?

Social representations of contaminated brownfields in France

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Abstract:

What first comes to mind when you think of contaminated brownfields? The information and ideas we hold about brownfield redevelopment can strongly influence discussions on this issue, the impacts we associate with it, and the types of regulation we view as appropriate. This study makes is based on the social representations theory, a process to decode reality by analyzing social representations associated with contaminated brownfield sites in France and isolate what influences individual's behaviors and acceptance of brownfield management programs today in France. It proceeds in particular with textual analyzes from data collected through open-ended questions from a cross-sectional survey administered among 803 individuals living nearby a contaminated brownfield site. Results show awareness regarding potential contamination of brownfields sites. However, this pollution is associated to visible elements but is disconnected from main pollutants the can be found on the site. We also observe regional disparities regarding contaminated brownfields representations, which are linked to historical activities in former industrial regions. This allows us to drawn some lines of recommendation for communication and management of future brownfield redevelopment programs.

Keywords: attitudes; brownfields, IRaMuTeQ; social representations; soil contamination; textual analysis

1. Introduction

On 26 march 2014, the French law on access to housing and urban renovation, so called ALUR law, was issued. This law aims to make significant changes regarding brownfield redevelopment. Indeed, the purpose pursued by ALUR is to remove main obstacles regarding brownfield redevelopment by clarifying environmental responsibilities, introducing

information on soil contamination in the local development plan, and thus securing the transactions (Lafeuille and Steichen, 2015). In France, numerous other laws, as for example, the law of solidarity and urban renewal, so called SRU in 2000, and the Grenelle 1 and 2 in 2009 and 2010 respectively, aim to promote the regeneration of brownfields. They are “any land or premises which have previously been used or developed and are not currently fully in use” (Alker et al., 2000). In France, it represents over 100 000 hectares of brownfields sites (ADEME and QuelleVille?, 2015).

Brownfield redevelopment reduce urban sprawl (Dorsey, 2003; Paull, 2008) and its negative consequences such as for example carbon emissions, unnecessary land consumption (Johnson, 2001; Stone, 2008) and excessive public expenditures on infrastructures: hydraulic, transport, electric, etc. (Benito et al., 2010). However, most brownfields are also contaminated sites due to their previous activities e.g. waste disposal, manufacturing, chemical or industrial activities, as well as petroleum using services (Oliver et al., 2005; Van Liedekerke et al., 2014). Moreover, squatted brownfields may be at the origin of numerous accidents or injuries. Besides, squatters may damage houses and buildings in such a way that become uninhabitable and display behavior that disturb the neighbourhoods (Prujit, 2013). Besides, brownfields cause premature deaths due to soil contaminants’ exposure (Gilderbloom et al., 2014; Hollander, 2009). As a consequence, brownfields sites cause serious economic, social, health and environmental problems (Bambra et al., 2015; Gilderbloom et al., 2014; Hollander, 2009).

Thus, brownfields are not available for immediate reuse without intervention. Indeed, brownfield redevelopment is challenging because of the stigma effect (Chan, 2001; Mundy, 1992; Patchin, 1991). This effect occurs when the entire neighbourhoods of the site are avoided and lie unused and unproductive for long decades because of suspected contamination and economic and social problems (Patchin, 1991). Indeed, brownfields are often located in areas with high poverty and unemployment rates (Gilderbloom et al., 2014; Yaconove, 2011). In

France, regions that list the most contaminated sites in BASOL, the French national database for contaminated sites requiring a preventive or curative public intervention, are also the regions characterized by the higher social and environmental inequalities (Caudeville and Rican, 2016). However, once stigma associated to the site are removed, these lands can become very attractive to developers who return them to a productive use (Bond, 2001; Eisen, 2015; Taylor et al., 2016).

Although stigma's impact on property value has been widely studied over the last decades (Eisen, 2015; Guntermann, 1995; Kiel, 1995; Kiel and McClain, 1996; Kiel and Williams, 2007; McCluskey and Rausser, 2003; Messer et al., 2006; Roddewig, 1999, 1996; Schwarz et al., 2017; Taylor et al., 2016), little has been done regarding social representations of contaminated brownfields. Besides, social representations theory (SRT) has been barely applied in urban studies (Hubbard, 1996; Raynor et al., 2016).

Thus, the aim of this paper is to analyze the relative importance of the stigma effect in social representations regarding contaminated brownfields. Stigma effect may persist even after remediation process (Broto et al., 2010; Kim and Miller, 2017; McGee, 1999; Slovic et al., 1991). Therefore, an analysis of social representations of contaminated brownfields can help to better identify the dynamics governing individuals' behaviors and thus to most appropriate public communication strategies. In other words, it would be possible to define brownfield redevelopment projects that would be socially acceptable by improving communication about brownfields redevelopment projects. We focus our study on French municipalities impacted by at least one contaminated brownfield site using data from BASOL. Once these municipalities were identified, we have developed and administered a questionnaire survey among citizens who are living near a polluted brownfield site projects that is to say that are concerned by at least one contaminated brownfield. We used open-ended questions to analyze social representations of contaminated brownfields. Results were analysed using textual analysis.

The paper proceeds as follows: the next section presents the SRT framework and its relevance to study social representations regarding contaminated brownfields. Section 3 focuses on the materials and methods used. Section 4 presents results. We discuss our results in the light of the existing literature in section 5. In section 6, the paper concludes and gives some insights for future research directions and enhancements.

2. Theoretical framework of social representations theory

We first present the SRT (1) and more specifically the structural approach developed by Jean-Claude Abric (Abric, 2001; Abric and Tafani, 1995). Then we show of SRT was used to analyze economic phenomena in the literature (2).

1. The structural approach of social representations

A representation is the “product of processes of mental activity through which an individual or group reconstitutes the reality with which it is confronted and to which it attributes a specific meaning” (Abric, 2003; Chalmers et al., 1992). They are the map of meaning used for making sense of one’s life (Abric, 2001). They are socially constructed and hence collectively shared. Indeed, social representations are a “form of socially elaborated and shared knowledge that has a practical aim and is concurrent with the construction of a common reality by a social group” (Jodelet and Moscovici, 1989). It corresponds to a form of common natural and naïve knowledge that gather opinions, beliefs, attitudes, etc. (Sales-Wuillemin et al., 2004) and allow people to interpret the world (Mannoni, 2016; Rateau and Lo Monaco, 2013). Social representations influence how individuals understand and behave in relation to specific issues. Thus, SRT aims to analyze the system of meaning and interpretation that individuals express at a given time in relations to its environmental and cultural context (Mannoni, 2016; Rateau and Lo Monaco, 2013).

According to the structural approach (Abric, 2001; Abric and Tafani, 1995; Flament, 2003) every social representation is structured around a central core that gives the representation its meaning and coherence. The core is the most stable element of the representation because it is the most resistant to change. It reflects normative components derived from the system of individuals' values, and norms and their social characteristics and practices (Abric and Tafani, 1995). Identification of the core plays a crucial role in the analysis of social representation. The way the components are organized has to be considered because two different representations may contain the same elements but can never be organized the same way (Abric, 2001; Flament, 2003).

2. Social representations theory in economic study: a brief literature review

SRT is derived from both social psychology and sociology (Kouira, 2014).

However, SRT was used in numerous economic study. For instance SRT was applied to study social representations regarding tax evasion (Kirchler et al., 2003), financial crisis (Jeziorski et al., 2012; Roland-Lévy et al., 2010), the euro (Meier and Kirchler, 1998).

The SRT may help to a better understanding of pro-environmental behaviors (Weiss et al., 2011; Weiss and Girandola, 2014). For instance, it has been applied to study: the adoption of renewable energy technologies (Batel and Devine-Wright, 2015; Zbinden et al., 2011); energy savings (Roussiau and Girandola, 2002; Souchet and Girandola, 2013); the link between place identification, pro-environmental behavior and environmental buildings (Ajdukovic et al., 2012). SRT was also implemented to analyze representations of pesticides among 77 students and farmers living in PACA, Languedoc-Roussillon, Bretagne or Martinique in France (Zouhri et al., 2016). In urban studies, SRT was applied to identify and understand representations associated with urban consolidation in 449 articles published in Brisbane newspapers between 2007 and 2014 (Raynor et al., 2016). In most of the case, social representations are analyzed using textual analysis or discourse analysis (Chartier and Meunier, 2011; Fairclough, 2003).

Textual analysis was used to examine business leaders' perceptions on sustainable development and their expectations about local governments using questionnaire data from 32 French business leaders (Musson, 2012). It was also used to examine the different strategies of agricultural advice used by two French farmers' cooperatives (Del Corso et al., 2015). Discourse analysis was employed to identify determinants of local land-use policy in South-Eastern France (Delattre et al., 2015). This method was also used to examine how scientific discourse has evolved since 1989 by processing 6 237 abstracts of articles published in four peer-review journals (Plumecocq, 2014).

3. Materials and methods

This section exposes the way data were obtained using BASOL (1), the survey that was developed and administered (2). It then turns on the methods used to analysed data collected (3) and the descriptive statistics of our sample (4).

1. Data collection strategy

Data were collected from a questionnaire administered to the resident population living near a contaminated brownfield listed in Basol. Data were extracted from Basol on 27th October 2015. There were 6 294 contaminated sites, and among them 6 168 were located in the metropole. Brownfield sites were identified using the site status variable which differentiate industrial sites still used or reused and industrial brownfields. According to this variable, there were 2 133 contaminated brownfield sites. This represents nearly a third of contaminated sites listed in 2015. They are located in 1 375 municipalities. Among them, 503 municipalities were surveyed; it is nearly the half of the impacted municipalities.

To obtain a geographically targeted panel, a quota on the number of individuals to be surveyed in each municipality impacted by a contaminated brownfield has been established

from the data of the 2015 Census from the National Institute of Statistics and Economic Studies (INSEE). Besides, quotas for sex and age were included and checked by a professional panellist³ to ensure that the data are representative. The choice of such sample ensured that the survey targeted individuals concerned by a contaminated brownfield site.

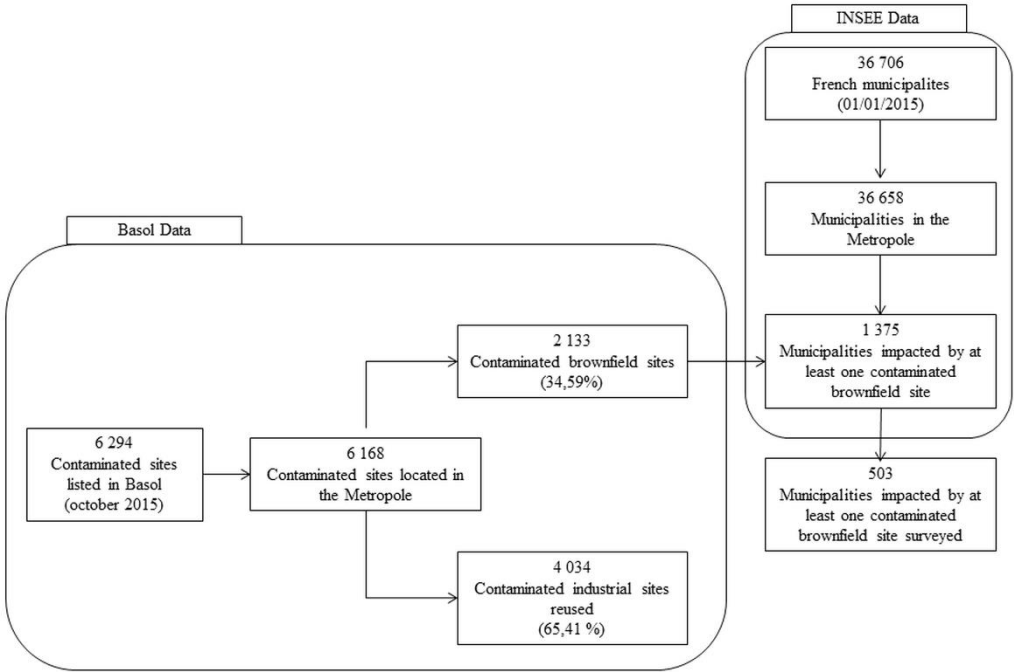


Figure 1: Geographically targeted panel obtained from BASOL and INSEE Data

2. Questionnaire survey design and administration

Data were collected by a survey questionnaire (see supplementary data) administered online using Limesurvey™. The questionnaire was composed of five parts: the first part focused on soil contamination. The second part dealt with brownfields sites. The third part concerned individual preferences and expectations for numerous brownfield redevelopment projects. The fourth part was about trust in institutions and the modalities of participation wished by individuals. Finally,

³ SSI – Survey Sampling International, LLC, 6 Research Drive, Shelton, CT, 06484, United States.

the last part consisted of a socio-demographic questionnaire. The survey was designed to be completed in about 20 minutes. It was administered online using Limesurvey™⁴

Two open-ended questions were used to analyse social representations regarding contaminated brownfields. The first open-ended question, posed at the beginning of the questionnaire, focused on soil contamination's representations of individuals living nearby a contaminated brownfield whereas the second open-ended question focused on brownfield sites. Thus, the analysis relied on two open-ended questions with spontaneous evocations.

3. Analyzing social representations with textual analysis

Textual analysis is a method used to describe and interpret characteristics of a message. It offers a rapid and efficient solution to describe content, structure and function of messages contained in texts. It provides statistical indicators and visual charts for analyzing the complex information contained in texts (Lebart and Salem, 1994). Besides, it supports the interpretation of the phenomenon on quantitative and objective criteria (Garnier and Guérin-Pace, 2010). Hence, this avoids biases resulting from the thematic post-codification stage. Indeed, thematic post-codification excludes unusual responses even if they are an important detail to understand the phenomenon.

Moreover, this technique is well-suited to analyze and understand individual or social representations (Abric, 2003; Beaudouin and Lahlou, 1993; Kalampalikis, 2005; Negura, 2006). Textual data analysis enables the analyst to go through texts and identify the main representations. Grammar and lexicon are vectors of representation (Harré, 2003). They may show individual attitudes and behavior (Doise, 2003). In our study, textual analysis were carried out to analyze and understand individual representations associated to the term brownfield by free association of ideas using two open-ended questions. Thus, we constituted two text

⁴ Limesurvey™ is an open source PHP web application to develop, publish and collect responses to online and offline surveys (Schmitz, 2015). We would like to thank Jean-Marc Rousselle (INRA-LAMETA) who administered the survey on Limesurvey™ with the quotas previously defined.

corpuses: a first corpus related to soil contamination and the second related to brownfield. For each open-ended question, individuals could give a maximum of five words or expressions.

Textual analyzes were performed using the Alceste method of classification and similarity (Reinert and Roure, 1993) with the software Iramuted version 0.7 alpha 2 which is the R interface for multidimensional analysis of texts and questionnaires (Baril and Garnier, 2015; Ratinaud and Déjean, 2009). We present some general statistics about these two corpora in Table 1 below.

	Brownfields corpus	Soil contamination corpus
Texts number	539	723
Occurrences numbers	1 368	2 087
Means of occurrences	2.54	2.89
Active forms number	1 148	1 967
Supplementary forms number	220	120
Hapax number	245	346

Table 1: Corpuses description

The number of texts corresponds to the number of responses collected. The corpus included the transcribed and translated (from French) responses of 723 out of 803 surveys (90.03 %) regarding soil contamination and 541 out of 803 (67.37%) completed responses. For the first open-ended question, 80 responses were excluded whereas for the second open-ended question, 262 responses were excluded because of poor response⁵. This number is increasing for the second open-ended question, as we observe a wearisome effect towards the survey.

The occurrences number indicates the number of words used. Individuals used on average 2.54 words about brownfields and 2.89 to deals with soil contamination. Hapax are words, which have a unique occurrence all over the corpus.

Out of all forms, active forms carry more sense than others do. They can be verbs, nouns or adjectives while supplementary form are composed of functional words.

⁵ Some respondents did not succeed to provide even a single word or expression to these open-ended questions. These respondents have just typed random letters on their keyboard to move on to the next question. Their responses are meaningless and were not kept in the analysis.

4. Population

Data were collected in December 2015. 1 089 questionnaires were returned and 803 were complete and valid. It represents a response rate of 76.58 %. The sociodemographic characteristics of the participants are presented in Table 2. 52.30 % of our sample were female. The mean age of our sample was 44 years, and 69.49 % were employed. The panelist has selected individuals from previously defined quotas (in terms of localization, gender and age). Therefore, this sample is representative of the French population.

Variable	N = 803	%
Gender	383	47.70
Male	383	47.70
Female	420	52.30
Age, mean (standard deviation)	44.12 (12.93)	
Education		
Without diploma or primary school only	39	4.86
Vocational training	158	19.68
Baccalaureate	190	23.66
University degree (Bac + 2)	201	25.03
Master's degree (Bac + 3 or 4)	215	26.77
Employed	558	69.49
Socio-professional category		
Farmers	3	0.37
Skilled manual workers, shopkeepers, company owners	19	2.37
Senior managers and higher managerial, administrative and professional positions	101	12.58
Intermediate managerial, administrative positions	132	16.44
Salaried	249	31.01
Semi-skilled and unskilled workers	54	6.72
Inactive	245	30.51
- <i>retired</i>	93	11.58
- <i>students</i>	30	3.74
- <i>unemployed</i>	46	5.73
- <i>others inactive (invalidity, housewife/man, etc.)</i>	76	9.46
Married	497	61.89
Regions		
Ile de France	139	17.31
Centre Val de Loire	44	5.48
Bretagne	28	3.49
Pays de la Loire	31	3.86
Provence-Alpes Côte d'Azur (PACA) + Corse	34	4.35
Hauts de France	122	15.19
Auvergne Rhône Alpes	108	13.45
Nouvelle Aquitaine	64	7.97
Bourgogne Franche-Comté	35	4.36
Grand-Est	111	13.82

Occitanie	39	4.86
Normandie	47	5.85
TOTAL	803	100.00

Table 2: Sociodemographic characteristics of the 803 individuals surveyed

4. Results

In this section, we present results obtained from the corpus related to soil contamination (1) and brownfield (2).

1. Results regarding soil contamination

First, we seek to identify the elements that could be part of possible social representations of soil contamination using textual statistics and similarity analysis. Table 3 below shows the 10 active forms according to their frequency in the corpus. Figure 2 represents results obtained from similarity analysis. Similarity analysis shows how the words are connected to each other's. It studies the overall relationship between words used in the same context. Thus, it helps to identify the structure of a text corpus. It is based on graph theory (Flament, 1981). A connected graph without circling represents the network of the words frequently used together in the same context (i.e. in the same text segment). Thickness of the line between two words represents how often those two words are used together. Only strongest connections between words are kept.

We observe that soil contamination is associated to visible and material elements (plastic, cigarette stub and wastes). Besides, individuals express concerns regarding water contamination (nitrate, wastewater) and air pollution (fumes, gas, hydrocarbon, fuel). They consider agriculture as the main pollutant activity (pesticide, fertilisers, intensive farming).

Form	Count	Form	Count	Form	Count
Pesticide	188	Intensive farming	21	Wastewater	13
Waste	79	Weed killing	20	Fuel	13
Fertilizer	63	Plastic	18	heavy metals	12
Chemical products	50	Industry	18	Gas	12
Agriculture	42	Water	17	Soil	11
Manufacturing plant	39	Human	17	Cigarette stub	11
Nitrate	31	Hydrocarbon	16	Agricultural	11
Industrial	30	Contamination	16	Disease	10
Pollution	23	Landfill	15	Waste	10

Fume	22	Petroleum	14
Chemical	22	Dirt	14

Table 3: Active forms regarding soil contamination with at least 10 occurrences in the corpus (translated from French)

To confirm this interpretation, we performed a descending hierarchical classification (DHC). It provides a classification of words representing semantic contexts (Table 4). We name each category according to subjects and characteristics treated. Each of these categories gathers terms, which have a common meaning.

Category 1 (61.91 %)			Category 2 (20.35 %)			Category 3 (17.74 %)		
Pollutants			Activity sectors			Consequences		
Forms	χ^2	p	Forms	χ^2	p	Forms	χ^2	p
Pesticide	134.33	< 0,0001	Agriculture	87.18	< 0,0001	Soil	52.0	< 0,0001
Waste	23.75	< 0,0001	Industrial	54.83	< 0,0001	Dirt	51.81	< 0,0001
Fertilizer	17.73	< 0,0001	Industry	53.86	< 0,0001	Health	45.9	< 0,0001
Nitrate	13.25	0.0002	Water	41.55	< 0,0001	Disease	36.42	< 0,0001
Plastic	10.12	0.001	Human	34.04	< 0,0001	Destruction	32.86	< 0,0001
Hydrocarbon	10.12	0.001	Manufacturing plant	33.57	< 0,0001	Environment	32.86	< 0,0001
Weed killing	9.62	0.004	Agricultural	26.15	< 0,0001	Factories	31.72	< 0,0001
Petroleum	6.9	0.008	Incivility	23.73	< 0,0001	Dangerous	31.72	< 0,0001
Pig manure	5.62	0.017	Groundwater	22.57	< 0,0001	Bad	31.72	< 0,0001
Trash	4.99	0.025	Farming	22.57	< 0,0001	Planet	23.39	< 0,0001
Acid rain	4.99	0.025	Chemical	21.19	< 0,0001	People	23.39	< 0,0001
Gasoil	4.36	0.036	Intensive farming	10.0	0.001	Degradation	23.39	< 0,0001
Fuel	4.0	0.045	Landfill	6.58	0.010	Concentration	23.39	< 0,0001
Phytosanitary products	3.73	0.053	Products	3.99	0.045	Danger	22.44	< 0,0001
Carbon dioxide	3.73	0.053	Nuclear	3.99	0.045	Groundwater contamination	18.68	< 0,0001

Table 4: Descending hierarchical classification regarding soil contamination (translated from French)

79.53 % of the words used in the corpus are listed in three groups. The percentages represent the distribution of classed words for each category e.g., category 1 garners 61.91 % of words used. Assigning a given term to a group was evaluated using a chi-squared test

(significance level set at 3.84 that is to say a 0.05% that a word was assigned to a group randomly). A tree diagram (dendrogram) illustrates this analysis (Figure 3 hereafter).



Figure 2: Similarity analysis regarding soil contamination

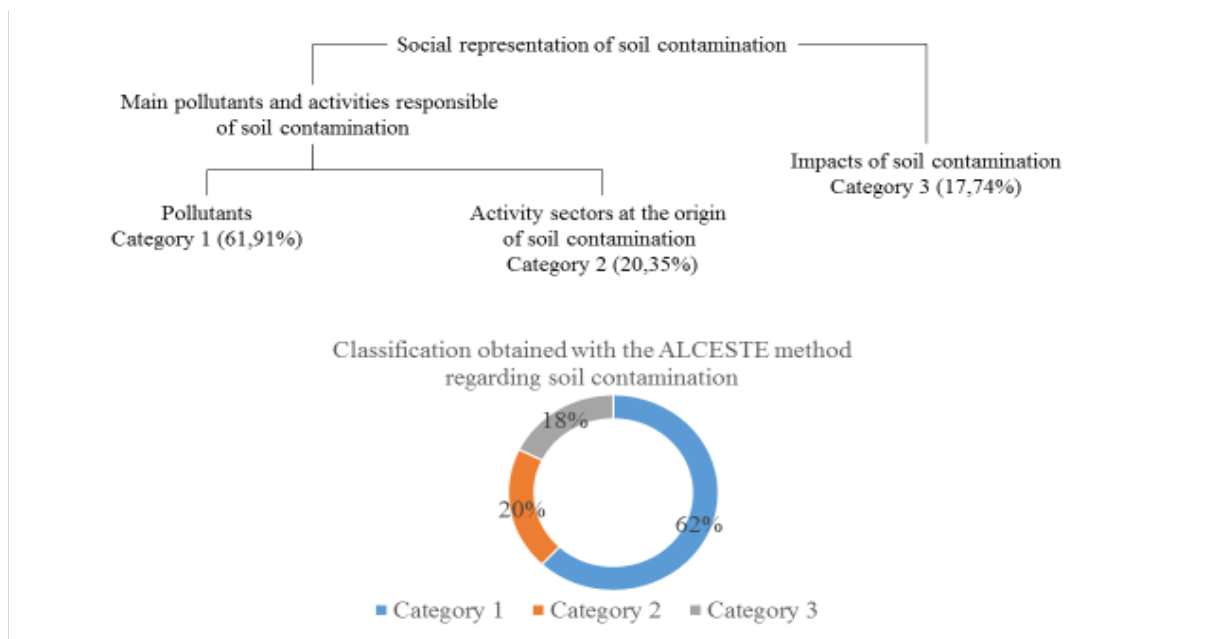


Figure 3: Dendrogram associated with DHC of soil contamination

The first category deals with pollutants such as pesticide, waste, hydrocarbon, plastic, fertilizer, and weed killing. The second category is about activity sectors that may generate soil contamination. Although they are aware that they may have a part of responsibility, mainly agricultural and industrial activities are mentioned. The consequences of soil contamination correspond to the third category. Health and environmental consequences are mostly evoked.

A prototypical analysis was conducted using a rank-frequency method to analyze social representation of soil contamination (Dany et al., 2015; Vergès, 1992). It reveals the most salient words based on the calculation and segmentation according to the medium rank of appearance and words' frequency (see Table 5). The central system zone of the social representation of soil contamination is composed by elements related to agriculture and industry: pesticide, fertilizer, chemical products, weed killing, manufacturing plant, heavy metal.

Other references to these component are in the potential change zone and in the peripheral system zone: intensive farming, water, pig manure, cigarette stub, etc. It reveals that individual misunderstood what soil contamination is. They refer to tangible and visible (waste, cigarette stub, garbage fumes) elements.

Frequency	Association appearance ranking	
	Low (≤ 2.03)	High (> 2.03)
High (≥ 8.37)	Pesticide Car Manufacturing plant Fertilizer Chemical product Nitrate Fumes Weed killing Industry Dirt Heavy metal Agricultural Wastewater Wastes Disease	Agriculture Industrial Intensive farming Chemical Water Plastic Hydrocarbon Human Petroleum Landfill Fuel Cigarette stub Gas Farming Pig manure
Low (< 8.37)	Phytosanitary product Diesel Chemical fertilizer Earth Destruction Detergent Danger Detritus Water contamination Toxic waste Chewing gum Dust Garbage	Factories Acid rain Industrial waste Environment Health Household waste Contaminated water Global warming Trash Gasoil Carbon dioxide Tar Oil

Table 5 : Structure of social representation of soil contamination (translated from French)

Finally, a factorial analysis is carried out to identify regional disparities regarding social representations (Table 6). We observe that in Brittany and Pays-de-la-Loire regions soil contamination is closely related to nitrate, fertilizers, and intensive farming. These two French regions are vulnerable with respect to nitrate according to the European Directive 91/676/EEC issued on 12th December 1991 (known as “Nitrate Directive) due to intensive farming (Direction régionale de l’Environnement, de l’Aménagement et du Logement Centre-Val de Loire, 2017; Forged et al., 2011; Loyon, 2017). This result may indicate that people are aware that pig manure due to intensive farming cause water contamination by nitrate and eutrophication. This corresponds to words included in the peripheral system , that is to say to representation related to group members’ individual experiences.

	Grand-Est	Nouvelle Aquitaine	Bourgogne Franche-Comté	Bretagne	Centre-Val-de-Loire	Île-de-France	Occitanie	Normandie	Hauts-de-France	PACA	Pays-de-la-Loire	Auvergne-Rhône-Alpes
Agricultural	0,36	0,21	-0,20	-0,18	0,32	0,25	-0,24	-0,25	-0,84	0,44	0,47	0,68
Agriculture	-0,47	-0,27	0,61	-0,71	0,66	0,25	-0,18	0,43	0,28	0,63	-0,28	-0,39
Chemical	-0,36	0,26	1,23	0,24	0,44	-0,31	-0,15	-0,51	0,32	0,22	0,24	-0,45
Chemical products	-1,31	-0,34	0,38	-0,20	0,89	1,38	-0,31	1,03	-0,46	-0,62	-0,20	-0,36
Cigarette stub	-0,25	-0,41	-0,20	-0,18	0,89	0,57	-0,24	0,35	0,26	-0,20	-0,18	0,31
Contamination	-0,19	-0,60	-0,30	0,34	-0,42	0,96	0,73	0,70	-0,61	-0,29	0,93	-0,53
Dirt	-0,36	-0,17	-0,26	0,38	0,25	-0,53	-0,31	-0,32	1,24	-0,25	0,38	0,48
Disease	0,88	0,24	0,46	-0,17	-0,26	-0,79	-0,22	-0,23	-0,29	0,47	-0,17	0,78
fertilizers	0,63	-0,62	0,42	0,47	0,25	0,35	-0,72	0,30	-0,66	0,43	-0,18	0,29
Fuel	0,28	-0,49	-0,24	-0,22	0,27	0,43	-0,29	-0,30	-0,99	-0,23	0,41	2,21
Fumes	0,82	0,26	-0,41	-0,37	0,44	-1,02	-0,15	-0,16	0,57	0,22	-0,37	0,40
Gas	-0,28	-0,45	-0,22	0,44	-0,31	-0,42	-0,27	0,33	0,22	0,41	-0,20	1,69
Heavy metals	0,70	0,19	0,40	-0,20	-0,31	-0,95	0,34	0,33	0,53	0,41	-0,20	-0,34
Human	0,41	-0,23	-0,31	-0,28	-0,44	0,87	-0,38	-0,39	0,28	0,83	-0,28	0,34
Hydrocarbon	0,45	0,86	0,31	-0,27	-0,42	-1,27	0,73	0,24	-1,22	0,31	-0,27	1,16
Industrial	0,45	-0,27	0,91	-0,16	0,28	-0,37	0,35	-0,27	0,27	0,47	-0,50	-0,46
Industry	-0,53	-0,68	-0,33	-0,30	-0,14	1,20	0,22	0,21	-0,37	0,79	0,85	-0,30
Intensive farming	-0,33	0,28	0,23	0,74	0,46	-0,28	0,55	-0,49	0,36	-0,38	-0,35	-0,20
Landfill	2,08	-0,57	0,33	0,36	0,23	-0,59	-0,33	0,75	-0,25	-0,27	0,36	-1,03
Manufacturing plant	0,62	-0,82	-0,73	-0,24	0,40	-0,46	0,23	0,49	1,46	-0,28	-0,65	-0,31
Nitrate	0,68	-0,28	0,88	-0,17	0,58	-0,41	-0,27	0,67	-0,62	-0,19	0,98	-1,34
Pesticide	-0,64	0,42	-0,33	0,85	-0,34	0,33	0,93	0,29	-0,81	-0,30	0,60	-0,28
Petroleum	-0,36	0,99	-0,26	-0,23	-0,36	0,38	-0,31	-0,32	-0,22	0,36	0,38	0,48
Plastic	-0,24	0,35	-0,33	-0,30	1,09	-0,77	-0,40	0,21	0,25	-0,32	-0,30	1,45
Pollution	-0,19	-0,38	-0,43	0,23	-0,60	0,77	-0,51	-0,18	0,83	0,21	-0,38	0,36
Soil	0,78	0,21	-0,20	-0,18	-0,29	-0,37	0,37	-0,25	0,26	-0,20	1,22	-0,29
Wastes	0,41	-0,38	-0,18	-0,17	0,35	0,65	-0,22	-0,23	0,31	-0,18	0,50	-0,25
Wastewater	-0,32	-0,49	-0,24	1,98	0,27	-0,47	0,31	0,30	-0,18	0,38	-0,22	0,23
Water	-0,48	-0,64	-0,31	-0,28	0,58	-0,35	2,10	0,22	0,54	-0,30	0,32	-0,26
Weed killing	-1,23	0,30	1,34	0,77	-0,17	1,01	-0,45	0,56	-0,45	-0,36	0,27	-0,73

Table 6: Factorial analysis regarding soil contamination by French regions (translated from French, in bold the most significant terms)

2. Results regarding brownfields

Table 7 indicates words frequencies regarding brownfields' corpus see table 6 below. Brownfields are perceived as unused abandoned area (desert, abandoned buildings, uninhabited, empty) that remain unmaintained (ruin, abandoned buildings). This interpretation is confirmed by similarity analysis (Figure 4). This analysis also reveals some confusions about brownfields because some respondents identified them to fallow that is to say to uncultivated agricultural land. It corresponds to the etymological meaning of brownfield. Besides, brownfields are negatively considered because of weeds growing on brownfield site. Furthermore, problems of pollution and waste disposals are mentioned as well as the presence of uninhabited building when people are resigned leaving behind a degraded district.

Form	Count	Form	Count	Form	Count
Abandoned	73	Garbage	13	Garden	8
Abandoned area	64	House	11	Dumpsite	8
Wasteland	38	Weeds	10	Soil	7
City	36	Unused	10	Old manufacturing plant	7
Manufacturing plant	34	Nature	10	Free space	7
Fallow	31	Industrial	10	Empty	7
Pollution	23	Unmaintained	9	Contaminate	7
Closed down	23	Ruin	9	Abandoned buildings	7
Waste	20	Landfill	9	Urban	6
Land	18	Ruin	9	Space	6
Urban area	16	Zone	8	Old industry	6
Area	15	Uninhabited	8	Insalubrious	6
Building	14	Uncultivated land	8	Desert	6

Table 7: Active form with more than 5 occurrences in the corpus regarding brownfields (translated from French)

We complete these results with a descending hierarchical classification (Table 9). The dendrogram is composed of four categories (62.34 % classified) as show Figure 5. Category 1 listed the types of activities that may generate a brownfield according to their past activities. This category is linked to the third category that contains terms describing unused urban areas (unused; unexploited; unmaintained; deindustrialization; remediation). Category 4 gathers words referring of different kind of empty spaces (such as uninhabited areas like for example

slums or ruins). Finally, the category 4 contains terms addressing the problem of waste disposals (waste, dumpsite, trash) encountered on many brownfields site.

The prototypical analysis (Table 8) confirms that brownfield are mainly represented as fallow and uncultivated land characterized by vegetation growth and weeds. It correspond to the etymological sense of the terms brownfield. Besides, these results show that individuals are aware that this king of land may be contaminated. They evoke garbage and wastes' contamination.

Frequency	Association appearance ranking	
	Low (≤ 1.64)	High (>1.64)
High (≥ 5.15)	Abandoned area Wasteland Fallow Abandonment Closed down Waste City Weeds	Pollution Manufacturing plant Garbage Unmaintained Dumpsite Ruin Landfill
Low (< 5.15)	Garden Free space Deindustrialization Brownfield Demolition Unbuilt area Desert Detritus Deforestation	Dirt Poor maintenance Nature Environment Ground Danger Housing Squat Vegetation

Table 8 : Structure of social representation of brownfield (translated from French)

Regional disparities observed (Table 10) indicate differences regarding former industrial regions such as Grand-Est and Hauts-de-France (significant words are manufacturing plant and industrial) as well as regions characterized by an extensive and fast urban development such as Île-de-France (Antoni, 2013). Grand-Est and Hauts-de-France were regions characterized by coal and steel industries in the past and nowadays, Île-de-France region is characterized by an important urban growth. This may explain these regional disparities.

5. Discussions

The aim of this paper was to analyze social representations regarding contaminated brownfields among individuals impacted by such site. To identify brownfield sites, we relied on data extracted from BASOL. In France, it is the unique database on contaminated sites and in particular on contaminated brownfields. Hence, generalization of our results should be made with caution because we focus only on contaminated brownfields and thus exclude other situations (i.e. non-contaminated brownfields). However, this allowed us to analyze social representations associated to homogeneous sites. We classified responses according to their appearance ranking; not their level of importance. Abric 2003 showed that words that appear first are not necessarily the most important. Nevertheless, by combining both content analysis and prototypical analysis our results are more accurate and potential biases are reduced.

Our results show that individuals misunderstood soil contamination. They make confusion between soil, air and water contamination as well as with wastes. They consider only tangible, material elements (such as for example cigarette stub or dog mess) and visible components such as air pollution generated by fumes. This was also observed on a preliminary study regarding perceptions of soil contamination among 141 French individuals living in the Occitanie region (Angignard, 2006; Angignard and Ferrieux, 2007). However, this study was not focused on contaminated brownfield. Besides the sample used is not representative neither of the French population nor the residents of individuals living in the six municipalities surveyed: Agde, Calstelanau-le-Lez, Ceilhes and Rocozels, Fabrègues and Montpellier (Angignard, 2006). Contrary to Angignard (2006), the choice of our sample ensured that the survey targeted representative individuals impacted by contaminated brownfields.



Figure 4: Graph of similarities applied to the whole corpus related to brownfield (translated from French)

Category 1 (32.14%)			Category 2 (34.82%)			Category 3 (16.37%)			Category 4 (16.67%)		
Past industrial areas			Issues of garbages			Unused areas			Location if urban area		
Forms	χ^2	p	Forms	χ^2	p	Forms	χ^2	p	Forms	χ^2	p
Manufacturing plant	73.09	< 0,0001	City	51.93	< 0,0001	Land	51.66	< 0,0001	Abandoned area	237.42	< 0,0001
Wasteland	64.07	< 0,0001	Abandonment	46.71	< 0,0001	Area	51.32	< 0,0001	Urban are	26.9	< 0,0001
Closed down	52.12	< 0,0001	Pollution	36.03	< 0,0001	Soil	36.52	< 0,0001	Brownfield	25.38	< 0,0001
Abandon	40.45	< 0,0001	Waste	33.93	< 0,0001	Space	31.21	< 0,0001	Suburb	15.14	0.0001
Building	18.01	< 0,0001	Garbage	25.31	< 0,0001	Unoccupied	25.93	< 0,0001			
Contaminate	15.08	0.0001	Nature	13.83	0.0002	Unmaintained	25.11	< 0,0001			
Old industry	12.9	0.0003	Free space	13.38	0.0002	Unexploited	15.01	0.0001			
Industrial	11.51	0.0006	Abandoned buildings	13.38	0.0002	Poor maintenance	15.01	0.0001			
Zone	11.51	0.0006	Urban	11.43	0.0007	Unused	14.33	0.0001			
Demolish	10.72	0.001	Desert	11.43	0.0007	Unbuilt	7.06	0.007			

Table 9: Descending hierarchical classification regarding brownfield

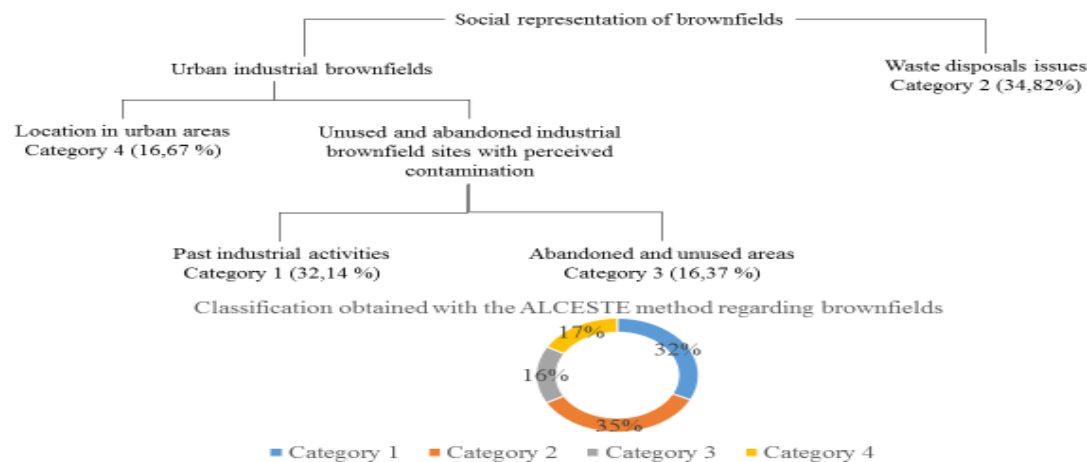


Figure 5: Dendrogram associated with brownfield

	Grand-Est	Nouvelle Aquitaine	Bourgogne Franche-Comté	Bretagne	Centre-Val-de-Loire	Île-de-France	Occitanie	Normandie	Hauts-de-France	PACA	Pays-de-la-Loire	Auvergne-Rhône-Alpes	Grand-Est
Abandoned area	-0,56	0,69	0,78	-1,04	0,25	0,27	0,45	-0,84	0,39	-0,52	-1,10	0,84	-0,06
Abandonment	-0,96	0,44	0,42	0,61	-0,20	-0,45	0,86	-0,91	1,09	-0,14	0,57	-0,76	-0,03
Area	0,97	-0,53	0,28	-0,23	1,00	0,39	-0,32	-0,15	-0,45	-0,24	-0,24	-0,22	-0,01
Building	0,60	-0,15	-0,30	-0,21	-0,15	-0,20	0,31	0,19	-0,94	-0,23	0,39	0,83	-0,01
City	-1,37	0,53	-0,32	0,45	0,27	0,51	-0,78	-0,59	-0,39	0,42	0,42	1,12	-0,03
Closed down	-0,37	-0,34	-0,15	-0,36	-0,34	-0,54	-0,15	1,77	0,68	-0,38	0,24	0,33	-0,02
Fallow	0,25	0,36	1,31	-0,48	-0,25	0,47	0,36	-0,47	-0,26	-0,16	-0,16	-0,55	-0,03
Garbage	-0,30	0,58	-0,27	-0,20	-0,46	-0,95	-0,27	0,21	-0,36	0,41	1,12	1,48	-0,01
House	0,82	0,23	-0,23	0,49	0,69	-0,32	0,38	-0,35	-0,73	0,47	-0,18	-0,31	-0,01
Industrial	-0,59	0,26	-0,21	-0,15	0,76	-0,73	0,42	0,28	0,81	-0,16	-0,16	0,34	-0,01
Land	0,40	-0,64	-0,38	0,33	0,39	0,90	0,23	-0,58	0,32	-0,29	0,31	-0,33	-0,02
Manufacturing plant	0,92	-0,30	-0,29	-0,17	-0,30	-0,42	-0,29	0,68	0,27	0,93	-0,19	-0,67	-0,03
Nature	0,44	0,26	-0,21	0,53	0,26	-0,28	-0,21	0,82	-0,67	0,51	-0,16	-0,27	-0,01
Pollution	-0,72	1,04	-0,15	0,74	-0,82	0,32	-0,49	-0,29	0,68	0,24	-0,38	0,33	-0,02
Unused	0,44	-0,35	0,42	0,53	-0,35	-0,28	0,42	0,28	-0,24	-0,16	-0,16	0,34	-0,01
Urban area	-0,17	-0,56	0,27	-0,25	-0,56	1,62	1,47	-0,52	-0,22	-0,26	0,35	-0,56	-0,02
Waste	0,33	-0,27	-0,43	0,29	-0,27	-0,20	-0,43	0,80	0,26	0,80	-0,33	-0,19	-0,02
Wasteland	1,06	-0,37	-0,34	-0,60	0,81	0,26	0,26	0,56	-0,73	-0,23	-0,64	-0,33	1,09
Weeds	-0,20	-0,35	0,42	0,53	0,26	0,33	-0,21	-0,32	-0,24	-0,16	1,33	-0,27	-0,01

Table 10: Factorial analysis regarding brownfield using the variable regions (translated from French; in bold the most significant terms)

Main pollutants mentioned by individuals are pesticides, wastes (including radioactive wastes), hydrocarbons, heavy metals, oils and nitrates. It should be noticed that pesticides and weed killing that are frequently evoked by respondents are not main pollutants on contaminated sites. Indeed, in 2016 pesticides represented only 0.63 % of pollutants on BASOL (Antoni, 2013). In terms of public communication, an emphasis should be put on definition of soil contamination, the pollutants and the modalities of transmission.

Concerning brownfields, the majority of our respondent are aware of the potential danger brownfield sites may generate. In particular, they mentioned the problems of waste disposals and of pollution. Similar results were found in a study conducted in the Czech Republic (Kunc et al., 2014). They found individuals referred to atmospheric pollution in the two former mining cities surveyed (Brno and Ostrava). Furthermore, our results show individuals linked brownfield to fallow, which is its etymological sense, and to unmaintained urban green spaces. This is similar to other study regarding non-contaminated brownfields (Laforteza et al., 2008; Rouay-Hendrickx, 1991; Vaseux, 2014; Wintz and Dersé, 2012). Furthermore, this kind of land may negatively be perceived due to illegal activity that may occur (Bogar and Beyer, 2015; Hofmann et al., 2012). However, as brownfield are considered as informal urban green spaces, in terms of public communication an emphasis could be put on the benefits brownfields may yield in terms of biodiversity (Bonthoux et al., 2014; Carrus et al., 2015; Hunter, 2014)

6. Conclusion

The information and ideas we hold about brownfield redevelopment can strongly influence our discussion of this issue, the impacts we associate with it, and the types of regulation we view as appropriate. Based on the structural approach of SRT we identify elements that may belong to the core of social representations of contaminated brownfield. We carried out textual

analysis using data obtained from two open-ended questions from a cross-sectional survey among 803 representatives' individuals living nearby a contaminated brownfield. We show that both SRT and textual analysis are relevant to examine individuals' representations of contaminated brownfields. We show that individuals are aware that brownfield sites may be polluted. They mainly consider wastes and garbage's pollution. Therefore, soil contamination is clearly misunderstood as individuals refer to tangible components and visible elements such as atmospheric pollution. We observe some regional disparities regarding contaminated brownfields. They are linked to the historical activities of former industrial regions. This analysis of social representations aimed to better identify the dynamics governing of individuals' behaviors and thus to most appropriate public communication strategies. In terms of public communication, soil contamination knowledge has to be improved. Concerning brownfield an emphasis should be put regarding the benefits their biodiversity may generate which has not be done yet. Furthermore, brownfield redevelopment yield compact city. It could be wise in further study to analyze social representations associated with compact or dense city (Cook et al., 2013).

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8. Supplementary data

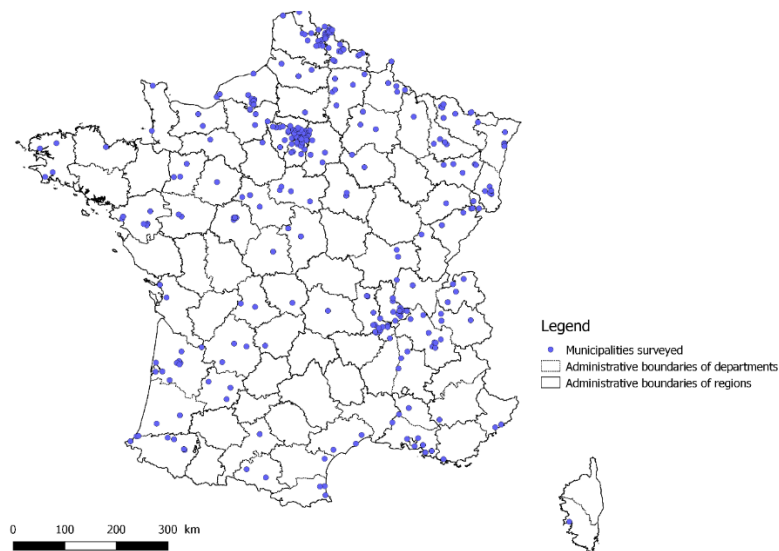


Figure 6: Map of the municipalities of the survey (QGis; source: authors)

1. Preview of the corpus related to brownfield

```
**** sexe_f age_2539 reg_npc
pollution / indifference / dirt / uninhabitable / measure
**** sexe_f age_4059 reg_rha
zone closed_down
**** sexe_h age_2539 reg_idf
wasteland fallow
**** sexe_f age_4059 reg_idf
garden
**** sexe_f age_1924 reg_npc
Waste
```

2. Preview of the corpus related to soil contamination

**** sexe_f age_2539 reg_npc
 indifference / contamination / dirt / cost / measure
 **** sexe_f age_2539 reg_als
 car, manufacturing_plant, gaz, urban transport
 **** sexe_f age_4059 reg_rha
 old gas_station asbestos
 **** sexe_h age_2539 reg_idf
 pesticides, carbon dioxid, waste
 **** sexe_f age_4059 reg_idf
 dirty, not_good; destruction

3. Supplementary data regarding soil contamination's corpus

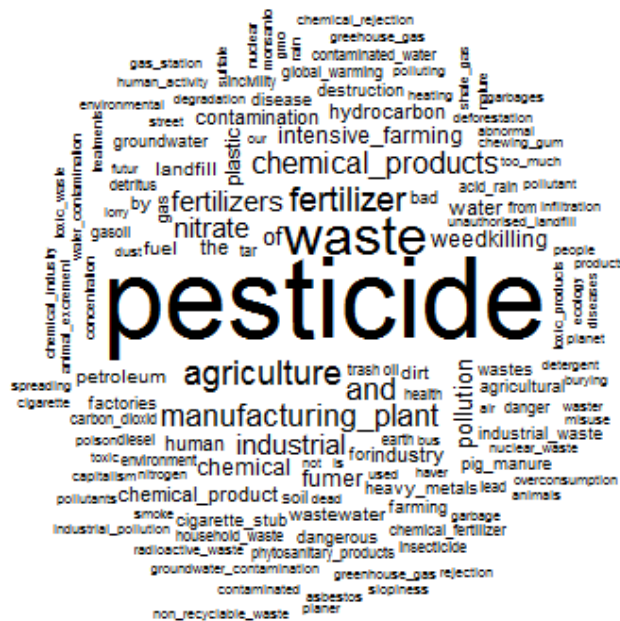


Figure 7: Word-cloud of soil contamination (N = 723)

