

PHYSICAL AND HUMAN GEOGRAPHY OF THE FRENCH LANDFILL NEIGHBOURHOODS

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SUMMARY: Landfills are often prone to controversies like other locally unwanted land uses. Several studies examined the location and siting of those types of semi-desirable infrastructures in order to better grasp the issue but much less was done concerning the operation phase of such facilities. Instead of focusing only on the siting issue, this investigation aimed at identifying indicators of the presence of conflicts during the operation phase. Some assumptions could be made concerning the physical proximity of landfills to their hosting communities as well as on the environmental justice issue in the French landfills neighbourhood's context. A multidisciplinary approach helped broaden the scope of the study and deepen the findings.

1. INTRODUCTION

Countries use various scenarios for the final treatment of non-hazardous waste: some are based mainly on incineration, others mainly on landfilling and the remaining ones follow balanced scenarios. This is the case in France, where nearly 40% of residual non-hazardous waste is landfilled. This represents nearly 300 sites currently in operation, from which a growing part has already been closed or is scheduled to close for a minimum 30 year of post-closure care. This will contribute to the forecasted shortage of outlets for waste treatment (Begnaud, 2010). Despite waste reduction and sorting/recycling policies, landfilling may always remain necessary for the treatment of residual wastes (Soulage, 2010), regardless of the low acceptability context associated with the implementation of new projects, frequently subjected to conflict (Rocher, 2006; Subra, 2007) and even more when long term land use is involved.

Landfills are typically locally unwanted land uses (LULU) and semi-desirable utilities which have to cope with physical as well as cultural proximity to the local population (Méry and Mtibaa, 2009). This led to several North American and a few European theoretical and field studies in environmental sociology and economics, which will be summarized later in this paper in order to analyse the context in which our research evolved.

Based on those facts, this research, supported by the French Environmental Agency (ADEME), aimed at providing a holistic view of the territorial insertion of landfills, through an analysis of the French waste governance issues in the overall landfill siting procedure (Figure 1).

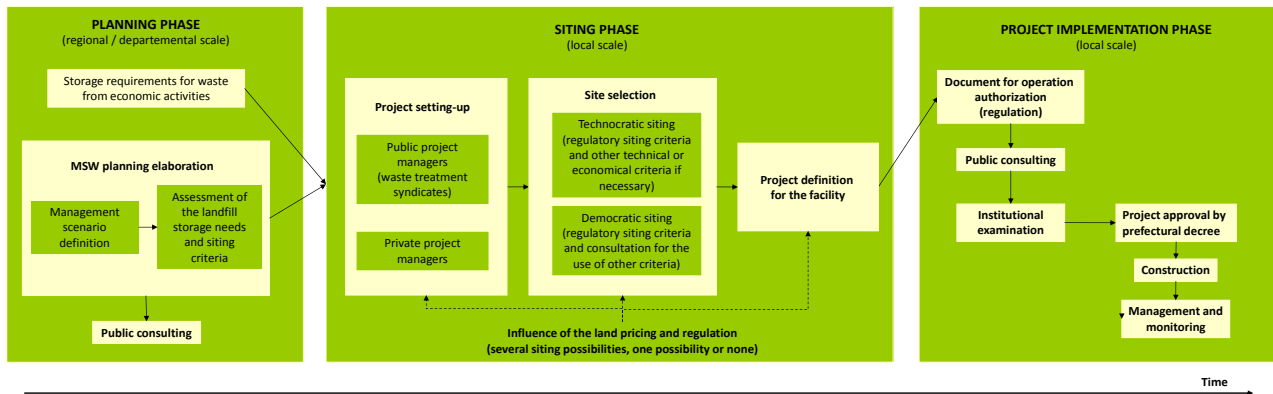


Figure 1. French landfill siting procedure

The analysis was carried out considering three complementary levels, which led to the specific geographical analysis of the landfill neighbourhoods:

- At the (inter)national level: a trace history on the territorial governance of landfills
- At the county level: an investigation focusing on the French waste management planning instruments (PDEDMA - departmental plan for the disposal of municipal solid waste) and including interviews with the public environmental planning engineers, which helped to draw up an inventory on landfill acceptability
- At the local level: a database for each landfill (on the considered counties) including geographical data as well as socio-economic and also a description of past and present conflicts.

2. FUNDAMENTALS CONCERNING LANDFILL NEIGHBOURHOODS

2.1 Overview on the issues at stake

Landfills are not only technical equipments, they also comprise high stakes in terms of:

- Geopolitics: they offer resilience to the waste management chain since they can adapt to variable flows and the facility implementation on the territory can be managed depending on the local needs but also on the level of conflict triggered (Subra, 2007)
- Symbolism for local officials and residents of hosting communities: refusal to be the "garbage of others" (particular aspect studied in France in the late 1990s by Lhuillier and Cochin (1999) or by Harpet (1998)), hence the difficulty to locate new facilities and manage local nuisances from the existing ones
- Environmental issues: due to the diversity of potential impacts caused by these facilities, at a time particularly sensitive to life style and environmental preservation
- Local Economics: in terms of waste management including equipment and transportation costs (due to the growing distance from the inhabitants to the facilities), but also in terms of the impact on real estate, land value and the attractiveness of the territories concerned.

2.2 Review of the controversies regarding landfilling facilities

Difficulties to implement landfills and other LULU have been the subject of many researches since the 1980s in North America. In particular, the question of the location of these kinds of facilities, even before the development of potential nuisance during operation, has been the

subject of numerous empirical and theoretical studies leading to a facility siting credo (Kunreuther and Susskind, 1991). Moreover, some case studies about facility location and siting in France were also conducted in the 2000s (Barbier and Waechter, 2001; Lecourt, 2003, Nevers and Couronne, 2004): they highlighted in most cases a lack of prior consultation of stakeholders, or the failure of it. Since then, several studies have followed, both nationally and internationally on conflicts related to the location and siting of new landfill facilities (Owens, 2004; Lisdskog, 2005; Marques and al., 2005), but also related to their operative phase. Still, this latter issue is less studied in comparison with the location and siting, hence the need to pursue the investigations on this matter. Despite the many research works on both topics, the regional daily press and the observation of the growing number of associative websites on the subject confirm the persistence of conflicts related to landfill facilities.

Concerning the projects siting, Richman and Boerner (2006) analysis suggested adapting the modes of governance (more or less authoritarian or participative) according to the characteristics of each case. They distinguish two phases: a first one (ante-decision) during which the project fate is uncertain and opponents often adopt a position consisting in fighting the project (with all possible kinds of arguments and rationalities), and do not tend to seek negotiations. A second phase (post-decision) where the opponent's strategy may change if the project becomes inevitable, hence the interest to negotiate with the promoter.

Furthermore, the explanation of the achievement (or cancellation) of a landfill project depends also on the stakeholder's interactions. Those raise a main issue on the representativeness of each one concerned and on the way each assesses and weighs the pros and cons of decisions, depending on stakeholder's rationalities. In most cases, citizens, particularly when organized in groups of opponents, appear to be decisive in the acceptance of a proposed new landfill site, as their ability to publicize, mobilize and add a juridical component to these conflicts can be significant. This can also be the case during the operating phase of a landfill facility. Indeed, episodes like surface extensions or changes in the management (type of waste accepted, types of treatment performed on site which can influence the odour level, etc.) may also prove to be relevant in terms of conflict rising, all the more when the facility already carries a controversial past.

3. IDENTIFICATION OF CONFLICTS ON LANDFILL NEIGHBOURHOODS

3.1 Site selection and database establishment

The selection of the landfills covered in this investigation was made in accordance with the waste management planning instruments studied in the second part of the research. Their selection was based on two main criteria: the approval date (only the most recent ones from 2005 to 2010 were selected) and the document status (the ones under review were put apart). As a result, the specific geographical analysis included 136 landfills in operation (of which 56 suffer controversies) and focused on the census of two different types of data:

- The local state of controversy as displayed on the Internet (especially associative websites) and newspaper sources (local or regional, etc.) that enable to gather qualitative pieces of information on the conflicts
- Technical and managerial characteristics of each landfill that were made available from an existing database managed by ADEME as well as socio-economical and geographical data that were obtained via the French statistics institute (INSEE) and the Geoportail sites (Table 1).

Table 1. Indicators used in the geographical analysis of the landfill neighbourhoods

<i>Socio-demographic data</i>	<i>Geographic and environmental data</i>	<i>Technical and managerial data</i>
Population age; Activity rate; Share of pensioners; Unemployment rate; Average income; Real estate prices; Share of owners; Share of individual housing; Household age in the community	Proximity of transport infrastructures; Proximity to protected/touristic sites; Distance to the first point of surface water; Visual barrier; Landscape types	Acceptance of non-hazardous industrial waste; Landfill gas collection; Biogas recovery; On site leachate treatment; Presence of CLIS (Local Comity for Information and Control)



Figure 2. Example of a Satellite image of a landfill (Géoportail)

About one half of the French landfills receiving non-hazardous waste were taken into account. The most South-East coastal counties (from Montpellier to Nice) were not included since important evolutions in terms waste treatment schemes occurred between 2005 to 2010, which might have biased or at least complexified the analysis of the (sometimes high) conflictuality.

All the selected landfills were identified and their location confirmed via satellite images taken from Geoportail, as illustrated on Figure 2. This task proved to be laborious as some landfills may have been partly rehabilitated, which means that some cells that have reached their maximum capacity may already have been covered and vegetated. As a consequence, these facilities were less distinguishable on satellite images. Nonetheless, this was an essential step in order to measure the distance from the facilities to the first buildings and the first town halls.

A survey grid was established to record the relevant information concerning each landfill which was then stored in a spreadsheet database. The grid underwent many changes until an optimized model in terms of relevance and feasibility was achieved. The filling of the database was carried out afterwards and subsequent analysis was made in order to compare all indicators with the local state of controversy and observe potential correlations.

3.2 Correlation between the identified indicators and the level of controversy

3.2.1 Physical geography indicators

The most intuitive, crude and easy to get explanatory factor for opposition to landfills is the euclidean distance to the inhabitants. This is the reason why many tentative evaluations to get the perceived external costs of landfills tried to link the decrease of house prices (supposedly induced by the presence of a landfill) to the distance to the landfill and showed a strong decrease in the first hundred meters, followed by a lower decrease up to 5 km (but never beyond, except the specific case of nuclear waste disposal). Based on this, the most important European study on this topic (held in the U.K. and following many north American ones) concluded to an external cost of disamenities of about 3 €/ton (DEFRA, 2003).

Table 2. Conflict analysis based on the mean distances to the first building (d) and first town halls (D)

	d (m)	Coefficient of Variation	D (m)	Coefficient of Variation
Presence of conflict	350	0.9	1610	0.5
Absence of conflict	460	0.9	1760	0.5

For our study, we considered the distance (d) to the first building (not necessarily inhabited, which explains why this distance is sometimes less than the French minimum requirement of 200 m for human neighbourhood) and the mean distance (D) to the first town hall. To our knowledge, these elementary pieces of data had never been collected, gathered and analysed for France, and perhaps anywhere else. Where conflicts were identified, both distances d and D are lower than in cases showing no conflict (Table 2) but the dispersion of values remains quite large, even for D (range from 300 m to 4000 m). This can be explained by the different geographical settings encountered, from peri-urban areas to rural ones.

The comparison of the mean values of d and D between the cases without conflict and the cases in conflict is consistent with the hypothesis that the physical proximity favours conflictuality. It is worth noting that the mean value of d (460 m) characterizing the absence of conflict is twice higher in comparison to the 200 m French minimum legal distance for inhabited buildings. This means that the flexibility for siting facilities is not so high, which, combined with the still growing urbanism, may become more and more problematic for settling or expanding landfills in the future.

No evidence of the impact of the proximity of any transport infrastructure (highway, county road, local road, railway, etc.) could be established. This could be due, among other reasons, to the small sample considered. For example, only 5 landfills were close to railways. The same was found for the proximity to protected/touristic sites: no clear trend emerged from the conflict analysis. Therefore, the expected importance of this indicator was not confirmed. Also, the results showed that the distance from the first point of surface water had no significant impact on the development of conflicts. Conversely, the effect of the visual barrier is not negligible as the visibility of the landfill site can be one of the causes of conflict development. Indeed, on the 74 landfills equipped with a visual barrier, 34% were the target of conflicts while the remaining 62 (from the overall 136 landfills included in the study) were subjected to 50% of conflicts.

Finally, concerning the types of landscapes considered (mountains, hills, plains or valley bottoms), only hills and plains were significant enough to be considered. The proportion of conflicts for each shows that landfill neighbourhoods located in hills presented more conflicts than the ones in plains. This point should require a refined analysis since at a first glance, flat areas favours the view of landfills, while for hilly areas it may depend on the more or less monotonic character of the slopes. Excavation/embankment ratios and the surrounding vegetation should obviously be taken into account for further and meaningful analyses.

3.2.2 Human geography indicators

Research on environmental sociology usually shows that LULU are more often settled in poorer areas and their associated conflictuality is higher in wealthier areas: what about French landfills? The French average income is around 21 000 € per year. Considering only the sites where the average income is clearly inferior to the national average (say under 15 000 €/year), a ratio of 38.5% of conflicts is observed, slightly inferior to the average percentage of conflicts of the total sample (41% of conflicts considering the overall 136 landfills studied). Furthermore, the average income for the overall 136 landfill neighbourhoods is somewhat lower than the national average (16 674 €/year compared to 21 000 €/year), raising the issue of the higher number of landfills

implemented in municipalities where the average income is lower than the national average. Those results would be worthy to deepen as they contribute to the environmental justice issue in France, which is not as advanced as in the USA. It should be noted that an obvious "confounding factor" is the necessarily rural (or at least peri-urban) settlement of landfills, since incomes in rural areas are less than in urban areas.

The share of owners is a wealth indicator but may also designate the local attachment of the population, which is another explanatory factor of conflictuality. The share of owners is more important indeed in the neighbourhoods presenting conflicts. Moreover, considering the overall sample, the average share of owners (71%) is much higher than the average for "provincial France" [this term from the French statistics institute (INSEE) excludes the Ile-de-France (Paris and outer suburbs) which is the most urbanized region] (59.5%) which could be explained by the rural or peripheral characteristics of those municipalities. Considering the extreme cases in our sample, the twenty municipalities with the lowest share of owners experienced conflict in 40% of cases while the ten municipalities with the highest share of owners (over 85%) were affected by conflict in 70% of cases.

The share of individual housing did not give any significant result in terms of conflict development. It only confirmed that landfills were implemented mostly in neighbourhoods presenting more individual than collective housing.

3.2.3 Technical and managerial data

The acceptance of Non-Hazardous Industrial Waste (NHIW) was also analysed as a potential source of conflict since the share of industrial waste (mainly from the private sector) may come from remote areas: landfill neighbours feel less responsible for those wastes (and their related risks) than the household ones (Méry et al., 2009). The results show that landfills accepting NHIW are more prone to conflicts (54.5%) than the others (33%) which could confirm the theory of the less accepted "garbage of others" (see 2.1).

The conflict analysis based on the gas collection indicator shows that the facilities proceeding to the collection of biogas are more subjected to conflicts (46.5%) than the others (26%). In terms of biogas recovery, it seems that the facilities which implemented it are also slightly more subjected to conflicts (46%) than the ones not opting for the recovery (37%). As for the on site leachate treatment, the same trend is observed. Indeed, landfills with a local leachate treatment are more prone to conflicts (48%) than the ones not including a local treatment (34%). Biogas collection and recovery tending to minimize odours, this trend may be explained by the presence of more facilities on site, thus more visible and potentially more controversial (see 3.2.1). Also, size could be a confounding factor since only the larger landfills are fully equipped to treat biogas and leachate. Yet, the (intuitive and theoretically consistent) influence of size on conflictuality remains pretty unclear, based on a specific research in the Ile-de-France region (Mtibaa et al., 2008).

The final indicator, which analyses the presence of CLIS, is relevant as those institutional groups are meant to link the managers to the nearest population. Surprisingly, landfills presenting a CLIS are more prone to conflict (47.5%) than the others (23%): there are more CLIS on conflicting facilities. Still, their over-representation on controversial situations may just mean that they are needed in such situations.

4. DISCUSSION AND FINAL CONSIDERATIONS

The results show that around 40% of the currently existing facilities generated proximity conflicts, due partly to the current evolution of environmental awareness and regulation in

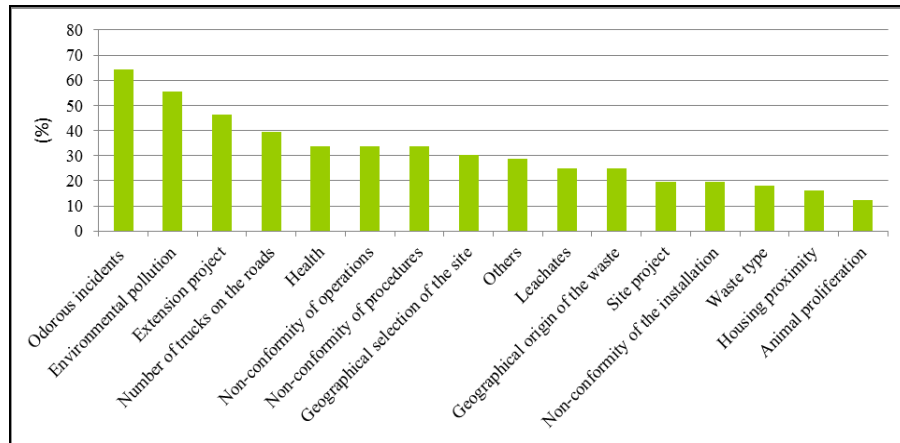


Figure 3. Distribution of main factors causing local conflicts, as displayed on Internet (associative websites and newspaper sources)

France (2008/98/CE European Waste Directive included), combined to a growing sense of belonging to a place. Indeed, even if simplified, the indicator *share of owners* showed that more controversial situations were identified on neighbourhoods with a higher share of owners. Likewise, high average income population as well as low unemployment rate also indicated more controversial neighbourhoods. In contrast, high unemployment rate and low average income neighbourhoods presented less controversy but also a higher number of facilities implemented, in line with environmental justice issues. In terms of facility management, the installation of visual barriers seemed to decrease the level of controversy whereas the acceptance of some types of wastes (NHIW especially), the gas collection and recovery as well as the leachate treatment are correlated with higher levels of controversy.

Besides the conflict analysis based on the several indicators already presented, this investigation made possible the collection of the several underlying causes of local conflict events, as stated on Figure 3 (data derived from the 56 controversial landfills).

It appears that the most frequent reasons for conflicts are the odorous incidents as they are mentioned in 64% of cases (considering the overall sample of 56 controversial situations). Considering only the landfills located within 300 m of the first housing, the factor *odorous incidents* (67%) is mentioned in a similar way than for the overall sample. Thus, the physical proximity does not seem to have a major impact. Moreover, the *housing proximity* factor is only acknowledged in 16% of the cases, although it was shown as a potential conflict indicator (see 3.2.1). This might be explained by the fact that, while in conflict, people tend to highlight more directly felt phenomena that can still be solved instead of focusing on issues that cannot be altered easily. Therefore, beyond the physical proximity of the landfills to the first housings, the cognitive proximity should also be emphasized. Finally, the dominant wind interference could also explain the fact that *housing proximity* was not mentioned that much as houses located close to the site can be spared by odorous events while further location can suffer from it, depending on the wind direction.

The data correlation analysis based on the several indicators considered (conflict level and sites characteristics) has yielded valuable information on several aspects of the landfill neighbourhoods, as well as on the main causes of local conflict events. Thus, assumptions on conflict emergence could be validated, comprising socioeconomic characteristics of the local population as well as some important findings on the issue of environmental justice. Therefore, the pursue of this investigation will carry on through the launch of a new project (Coprodix, also funded by ADEME within the Waste & Society programme) aiming at including field

campaigns based on a selection of about 8 landfills that will allow for refining the investigation on the relations between stakeholders. Ultimately, the consolidation of the overall findings is expected to contribute to define more satisfying and locally adapted territorial governance practices for siting, managing or expanding landfills.

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