Environmental discrimination through urban planning: the case of French Traveller sites

Nicolas Mondolfo[1], Antoine Leblois[2], Philippe Delacote[3], Léa Tardieu[1,4*]

[1] TETIS, INRAE, AgroParisTech, CIRAD, CNRS, Univ Montpellier, Montpellier, France.
[2] CEE-M, Univ. Montpellier, CNRS, INRAE, Institut Agro, Montpellier, and Climate Economics Chair, France.
[3] Université de Lorraine, AgroParisTech-INRAE, BETA and Climate Economics Chair, France
[4] CIRED, École des Ponts ParisTech, AgroParisTech, université Paris-Saclay, Cirad, CNRS, EHESS, Nogent-sur-Marne, France.

Abstract

Ethnic minorities are frequently confronted with environmental inequalities, as they are more likely to be exposed to hazardous and polluting facilities. However, the role of urban planning decisions in shaping these inequalities has been insufficiently explored. An emblematic illustration is the siting of Traveller sites, exemplifying how political decisions can amplify environmental inequalities in urban settings. In this context, we constructed an original database that links the siting of French Traveller sites with socio-economic and environmental data. A statistical analysis was then conducted in order to identify the factors determining the placement of sites, both between and within municipalities. Our study demonstrates that Traveller sites are more likely to be implemented in municipalities with greater disamenities and that, within these municipalities, sites are more exposed than other residential areas. Based on our findings, we discuss two potential mechanisms that may underpin this policy-induced discrimination: the opportunity cost and discriminatory preferences.

*Corresponding author: lea.tardieu@inrae.fr

1 Introduction

Recent social science literature has emphasized the critical role of environmental discrimination [1] within the broader context of environmental inequalities [2]. Ethnic minorities have been found to have reduced access to environmental benefits, such as urban green spaces, and higher exposure to environmental hazards, such as treatment, storage, and disposal facilities [3–5]. Similar disparities have been observed in low-income urban neighborhoods [5, 6].

A substantial body of literature has aimed to identify the mechanisms behind the disproportionate placement of disamenities near deprived residential neighborhoods [7, 8]. Studies in this field overwhelmingly focus on market-based dynamics pertaining to private decisions regarding the location of disamenities and residential choice [9, 10]. However, in some cases, environmental inequalities may result from government interventions, *i.e.* they may be "policy-induced" [11].

Through urban planning, local authorities can influence the environmental exposure of city residents via multiple channels. For instance, urban greening initiatives could mitigate inequalities if they effectively target vulnerable groups who have few access to urban green space[12], though they may also lead to 'heat gentrification' [13]. Similarly, local government may influence the exposure of local inhabitants to disamenities and associated health outcomes. Targeted policies of pollution reduction could mitigate race-based unequal exposure at a low cost (*e.g.* air pollution [14]).

The term environmental racism was coined to highlight the persistent pattern of policy-driven environmental inequalities disproportionately affecting ethnic minorities in the United States [15]. However, many case studies supporting environmental racism claims do not originate from policies that explicitly target the affected populations. Consequently, the environmental racism literature have been widely debated, which is reflected in the "race or class" debate[8, 16]. Quantitative studies in this field have been criticized for assuming that "racism can be [statistically] isolated from other forces and forms of difference"[17]. In contrast, analyzing a policy that directly targets ethnic minorities yields clearer findings. A well-documented example is redlining in the United States, a racially biased system of neighborhood investment ratings. This practice reinforced residential segregation, ultimately exacerbating race-based environmental inequalities[18, 19]. Yet, even in the case of redlining, estimating the quantitative effect of this policy on environmental discrimination is highly challenging, as multiple factors shape both the placement of disamenities and private residential dynamics. Thus, proving the impact of planning policies on environmental inequality is challenging due to the influence of numerous confounding factors and potential biases[11], and how policies contribute to the formation of environmental inequality remains understudied[20, 21]. To investigate how policies shape environmental discrimination, we examine a case in which urban planning decisions directly affect a minority population's exposure to environmental hazards. Specifically, we analyze the siting decisions of Traveller sites (*Aires d'accueil pour Gens du Voyage*) in France, which determine where this marginalized group is legally allowed to reside. This case offers a rare contemporary example in which decision-makers enact observable, targeted policies that restrict the residential choices of an ethnic minority, potentially leading to environmental inequalities.

"Travellers" (*Gens du voyage*) designates a variety of minority ethnic groups (Roma, Gypsies, Sinti...) whose estimated total population across Europe is 6 to 8 million [22]. In all European countries, where studies have been conducted, results reported that these minorities are particularly vulnerable. For instance, Travellers have poorer health status, they are more likely to suffer long-term illness [23, 24] and their life expectancy at birth is 7-14 years shorter than the general population in European countries [22]. In terms of education, Travellers' children start school later on average [22, 25], they have considerably high dropout rates [26] and often face hostility from both teachers and other pupils [25]. For instance, in 2019, respectively 51% and 39% of surveyed Swedish and British Travellers' children reported they had been harassed at least once at school in the past twelve months [22]. As a matter of fact, Travellers face various expressions of racism in Europe, from everyday verbal harassment to hate crimes and physical attacks [22, 27]. Prejudice against Travellers, referred to as anti-Ziganism, is deeply anchored in Europe [28]. A French survey revealed that about two-thirds of respondents believe that Travellers do not want to integrate into French society, and three-fifths believe that they mainly live off theft and trafficking [29]. Overall, Travellers in Europe are broadly underprivileged and marginalized [30]. This context makes this minority particularly sensitive to additional inequalities, such as health inequalities caused by a higher exposure to environmental hazards [31].

To analyze the interlinkage between planning decisions and Travellers' exposure to disamenities, we rely on the location of *Aires d'accueil pour Gens du voyage* (hereafter Traveller sites). Traveller sites are enclosed areas which include a limited number of plots for caravans, long-term sanitary amenities, and access to water and electricity. In France, as in most European countries, Travellers who are not sedentary must legally stay in one of these sites. We use the fact that the location of each Traveller site results from local-level planning decisions made by elected representatives – although various scales of governance influence the decision-making process and interact together (see Methods section 4). Four main features of this process may be noted. First, a federal law from 2000 coerces municipalities of 5,000 and more inhabitants – which we hereafter refer to as cities, following the French nomenclature – to participate in hosting Travellers. In practice, they have two options to fulfill this requirement: either (i) set up a Traveller site on their land, or (ii) contribute to the construction and maintenance costs of a site in another nearby municipality that has agreed to set up a site [32, 33]. A second prominent feature is that the hosting capacity needs and respective capacity targets of municipalities are evaluated upstream at the department level (which gathers groups of municipalities, see 4.1). Municipalities participate in this responsibility-sharing process and ratify it [32]. The third main feature, which motivates the objectives of this paper, is that the final decision on site location is made by elected local representatives in inter-municipal communities (see 4.1). This decision determines where Travellers will be allowed to stay and, in turn, what disamenities they will be exposed to [33, 34]. The fourth and last feature is that, among legally obligated municipalities, there is widespread noncompliance or imperfect compliance with the law mentioned above. This suggests that, for local representatives, complying might be costly because of the perceived undesirability of hosting Travellers in the municipality [32, 33]. This context echoes 'Not in my backyard' (NIMBY) issues in the specific case of human service facilities dedicated to vulnerable and marginalized groups, for instance those dedicated to homeless people or people with HIV/AIDS [35, 36].

To this day, studies on Traveller sites in Europe have noted that they are often located near a variety of environmental disamenities [22, 37], particularly in France [34, 38]. However, they do not quantify it, nor measure disproportionate exposure comparatively to other residents of urban and suburban areas. Thus, the first objective of this paper is to analyze whether Travellers living in sites are disproportionately exposed to environmental disamenities compared to other population groups. To do so, we use geospatial data on Traveller sites and environmental hazards in France, at two levels. At municipal level, we look at the distribution of sites and hazards *between* municipalities (with and without Traveller sites), while at sub-municipal level we are concerned with the distribution of sites and hazards *within* municipalities that host a site.

Beyond quantifying Travellers' disproportionate exposure to environmental disamenities as a direct result of targeted urban planning decisions, we investigate the mechanisms underlying these discriminatory outcomes. We distinguish between two potential mechanisms: one leading to unintentional discrimination and the other to intentional discrimination. The first mechanism, commonly examined in the economics literature on environmental inequalities, focuses on market-based processes that result in discriminatory outcomes [7, 10, 20]. In the case of Traveller sites, this corresponds to siting decisions driven by cost minimization objectives, leading to the clustering of sites near environmental disamenities. The second mechanism, typically associated with the literature on environmental racism, interprets these outcomes as the result of deliberate discrimination by policymakers [17]. In this case, Traveller sites are intentionally located near disamenities. We conclude that these two mechanisms are not mutually exclusive and may, in practice, reinforce one another.

To sum up, our study is a rare analysis of policy-induced discrimination, while being the first study in Europe that aims to demonstrate the disproportionate exposure of Travellers to environmental hazards in an entire national context

2 Results

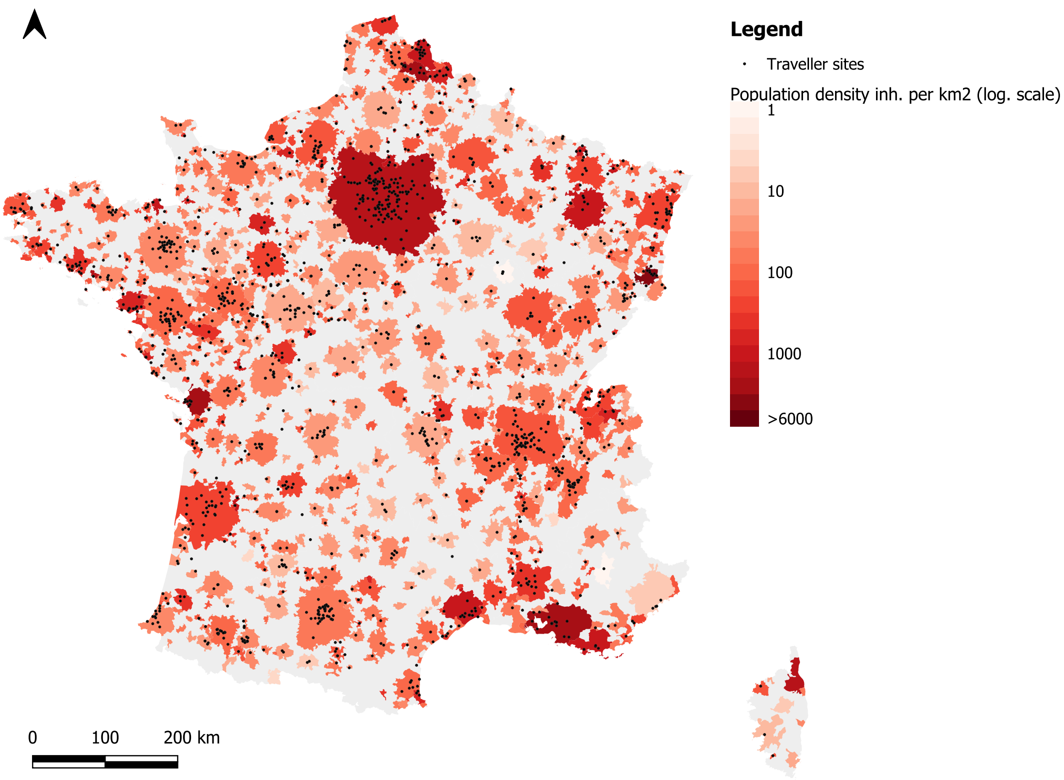
2.1 Traveller sites are located in municipalities with more disamenities

2.1.1 Traveller sites' spatial distribution is shaped by legal context

According to the French law, since 1990, cities — *i.e.* municipalities of 5,000 and more inhabitants (see 4.1) — are required to contribute to the hosting of Travellers. As a consequence, although cities only represent 6% of municipalities in France, Traveller sites are predominantly located in cities (79.1%, $n =$ 1,238). A majority of sites are located in municipalities slightly above the 5,000 inhabitants threshold – typically 5,000 to 20,000 inhabitants – because the number of municipalities is relatively small beyond this point (see Supplementary Figure 1). Figure 1 shows that sites tend to be concentrated in larger urban areas, near France's largest cities. It also illustrates that very few sites are located outside of an urban area. In total, 95 % of sites ($n =$ 1,486) are either located in a city, or in a town — *i.e.* a municipality of less than 5,000 inhabitants — belonging to an urban area. These facts suggest that the siting of Traveller sites is in most cases a planning decision that involves urban and suburban municipalities, which face land availability constraints.

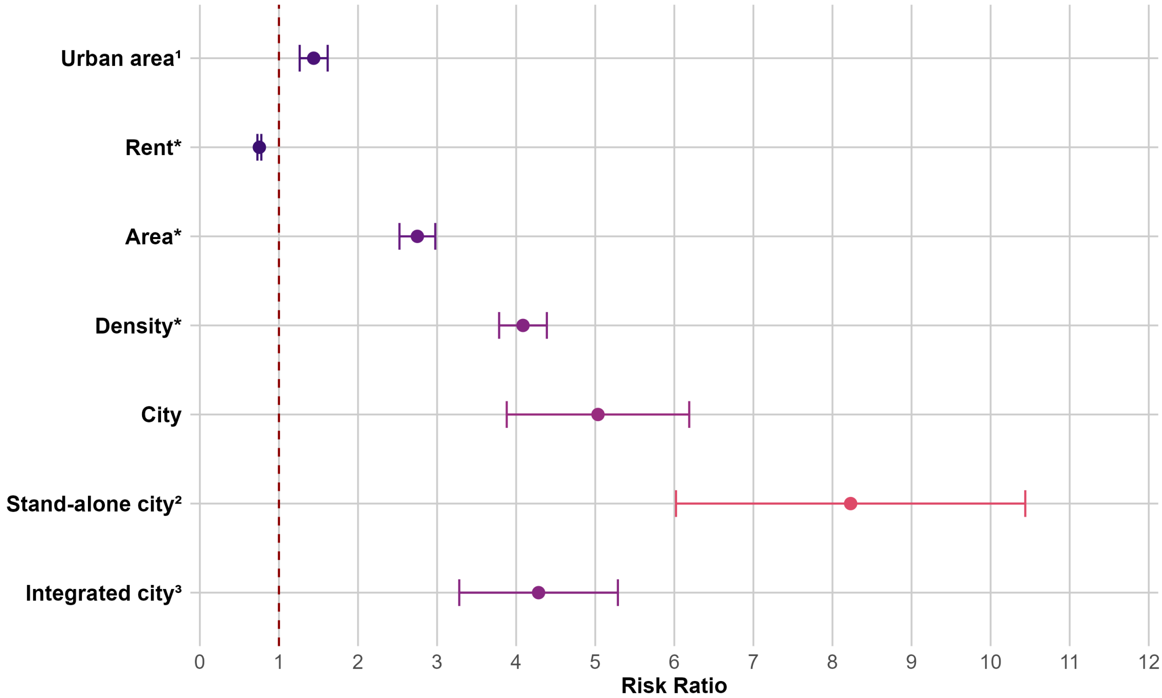
A statistical analysis confirms this tendency (Supplementary Table 10). Using a probit model, we estimate the likelihood that municipalities host a Traveller site, depending on socio-demographic and urban context variables. Then, we compute the risk ratios of the likelihood of hosting a site associated with each variable (see Figure 2 for the results and 4.3.1 for the methods). We find that belonging to an urban area (see Definitions 4.1) increases the likelihood that a town or a city hosts a site by 50%. Additionally, municipality density and area are both significantly associated with a higher likelihood of hosting a site, meaning that a municipality's likelihood of hosting a site increases with its population size. Despite controlling both for population density and area, we find that cities are 5 times more likely to host a site than towns (Figure 2). This fact confirms the existence of a specific threshold effect at 5,000 inhabitants in terms of likelihood of hosting a site, aligning with the legal obligations imposed on municipalities (see Methods). Furthermore, in line with the governance context, we observe that the magnitude of this threshold effect varies depending on whether cities are part of the same inter-municipal community as others (see Definitions 4.1). Since all cities are legally obligated, integrated cities (*i.e.* cities which belong to an inter-municipal community in which at least one other municipality is a city, see Definitions 4.1) are able to negotiate with other cities and might agree to set up sites only in one municipality. In contrast, stand-alone cities (*i.e.* cities which belong to an inter-municipal community in which no other municipality is a city, see Definitions 4.1) have fewer opportunities to negotiate with other municipalities. In turn, stand-alone cities are 8 times more likely to set up a site than towns, while integrated cities are only 4 times more likely. Additionally, cities where the rental value of housing is higher are less likely to host a site. As the rental value reflects the housing market conditions, this suggests that higher land pressure is correlated to a reduced probability of hosting a site. However, the mechanisms behind this relationship remain unclear, and we discuss these in the discussion section (3).

Figure 1: Location of Traveller sites and urban areas in France, by size of urban area



Note: Each dot corresponds to the location of a single Traveller site. Each colored area corresponds to the span of a single urban area (according to the French definition – see Definitions 4.1). The red gradient represents the average population density in each urban area.

Figure 2: Risk ratios of socio-demographic and urban context variables on the municipalities' likelihood of hosting a Traveller site



Note: The risk ratio is the average marginal effect calculated as the ratio between two chosen contrast levels. For binary variables, the contrast levels correspond to the two possible states (0 and 1). For continuous variables, the contrast levels correspond to one standard deviation from the mean. Risk ratios are computed from the between-municipalities probit regressions (see Supplementary Table 10). The dots represent the estimated risk ratio of the likelihood that a municipality hosts a site. The error bars represent the 95% confidence intervals. As an example, Cities (municipalities with a population above 5,000) are, on average, 5 times more likely to have a Traveller site compared to Towns (municipalities with a population below 5,000).

**Variables marked by a star are continuous.*

[1]Urban area *indicates whether the municipality belongs to an urban area,* i.e. *"a group of touching municipalities, without pockets of clear land, encompassing an urban centre (urban unit) providing at least 1,500 jobs, and by rural districts or urban units (urban periphery) among which at least 40% of employed resident population works in the centre or in the municipalities attracted by this centre".*

[2]*A* Stand-alone city *is a city which belongs to an inter-municipal community in which all other municipalities are towns.*

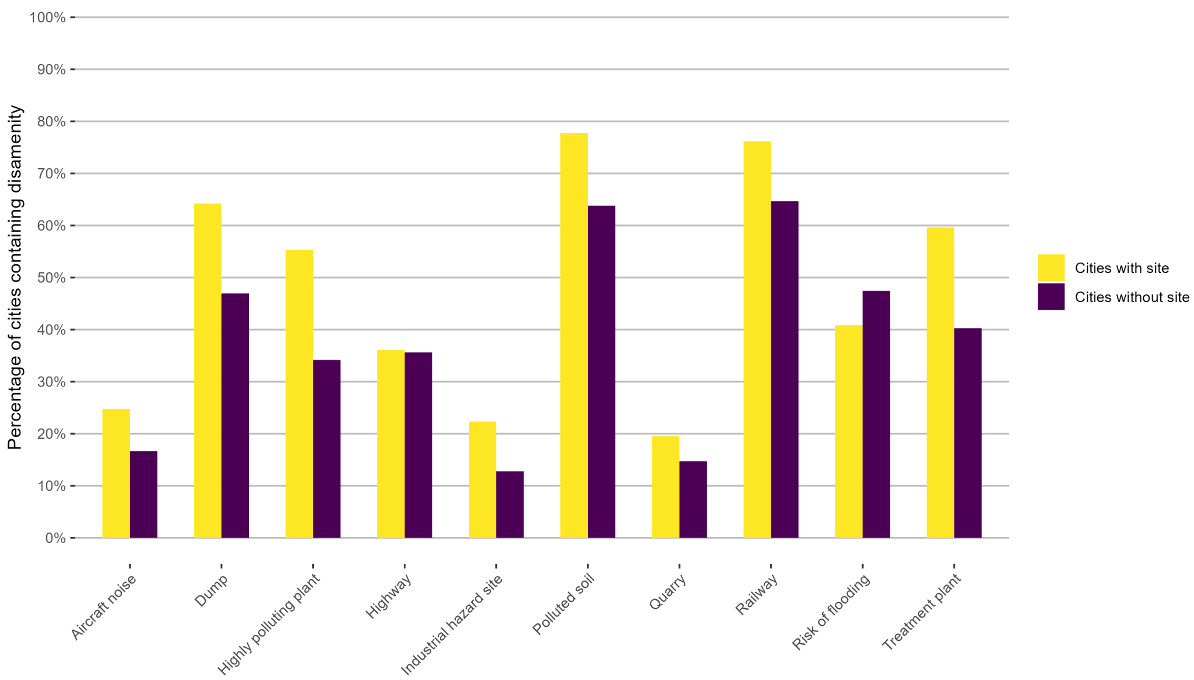
[3]*An* Integrated city *is a city which belongs to an inter-municipal community in which there is at least one other city.*

2.1.2 Disproportionate exposure to disamenities in cities hosting a Traveller site

On average, cities that host a site (n = 1,070) contain more disamenities than cities that do not (n = 1,033) (Fig. 3). This statement is true for all types of disamenities, except for the risk of flooding. The gap is particularly significant for some types of disamenities. Among cities, those hosting a site are more likely to contain a highly polluting plant (55.3% vs. 34.2%), a treatment plant (59.6% vs. 40.3%), and a dump (64.2% vs. 47%).

One could argue that disproportionate exposure is biased by the fact that cities hosting a site are larger on average. However, when controlling for the municipalities' population size and area (separately), overexposure in cities hosting a site remains significant for most disamenities (see Supplementary Table 11 and 13). The same pattern is also observed for towns (see Supplementary Table 12 and 14 and Supplementary Figure 2). The fact that cities hosting a site are more exposed to environmental disamenities is a first indication of environmental inequalities, as Travellers are more likely to be hosted in cities with poorer environmental conditions.

Figure 3: Percentage of cities exposed to various types of disamenities, among cities hosting a site and cities not hosting a site.



Note: This figure displays the percentage of cities containing at least one disamenity of each type, within cities that contain a site ("Cities with site", n = 1,070) and within cities that do not contain a site ("Cities without site", n = 1,033). All municipalities that are not considered as cities – i.e. *towns – are therefore excluded from this figure. For a similar figure for towns, refer to Supplementary Fig. 1. Example of interpretation: Approximately 60% of cities with a site have a treatment plant in their territory, compared to 40% of cities without a site.*

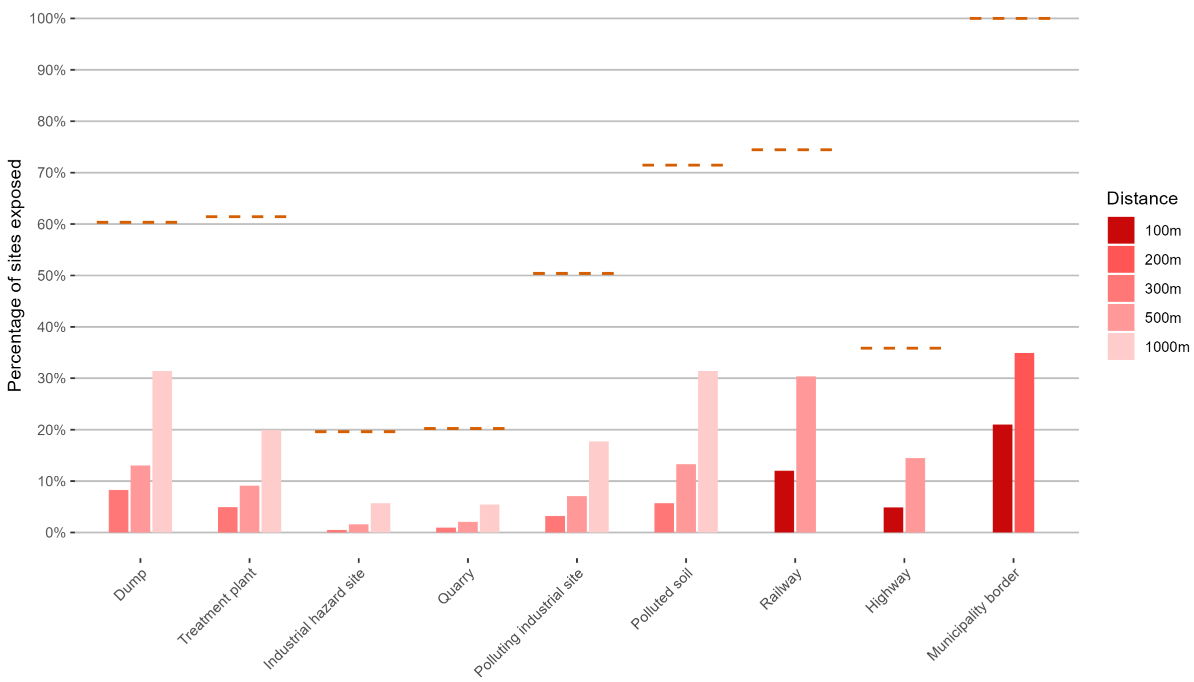
2.2 Distribution of Traveller sites within municipalities

2.2.1 Proximity between sites and disamenities

Proximity between Traveller sites and disamenities, depending on the distance, is displayed in Fig. 4. We find that 35% of the sites are within 200m of a municipality border. Many sites are located within 1000m of a dump (31.4%), a polluted soil (31.4%), or within 500m of a railway (30.3%). Using a 300m buffer, sites are mainly located near dumps (8.2%), followed by polluted soils (5.7%), treatment plants (4.9%) and polluting plants (3.2%). In contrast, they are more rarely located near quarries (0.9%) and industrial hazard sites (0.5%). The share of sites exposed is consistently high across all disamenities compared to the proportion of potentially exposed sites. For instance, nearly one sixth of sites located in a municipality containing a railway are within 100m of the railway (12% out of 74.5%).

Overall, these statistics confirm that Traveller sites are often located in the urban fringe, near disamenities. However they do not provide information about possible environmental inequalities: whether neighborhoods with sites are significantly closer to disamenities than other neighborhoods within the same municipality remains to be assessed.

Figure 4: Percentage of Traveller sites located near disamenities and a municipality border, depending on the distance



Note: Bars represent the percentage of Traveller sites within a given distance of each type of disamenity. The distance is indicated by shades. Dashed orange lines correspond to the percentage of sites potentially exposed to this type of disamenity, i.e. *the percentage of sites located in a municipality where this disamenity is present. An implicit assumption is that sites are only exposed to disamenities in their own municipality. Exposure to aircraft noise and the risk of flooding are excluded from the figure, because the measurement of exposure was not based on distance. Statistics are available in Supplementary Table 10. Example of interpretation: 60% of sites are located in a municipality which contains a dump. More than half of them (31.4% of all sites) are located within 1000m of a dump.*

2.2.2 Statistical analysis of Travellers' overexposure to environmental hazards within municipalities

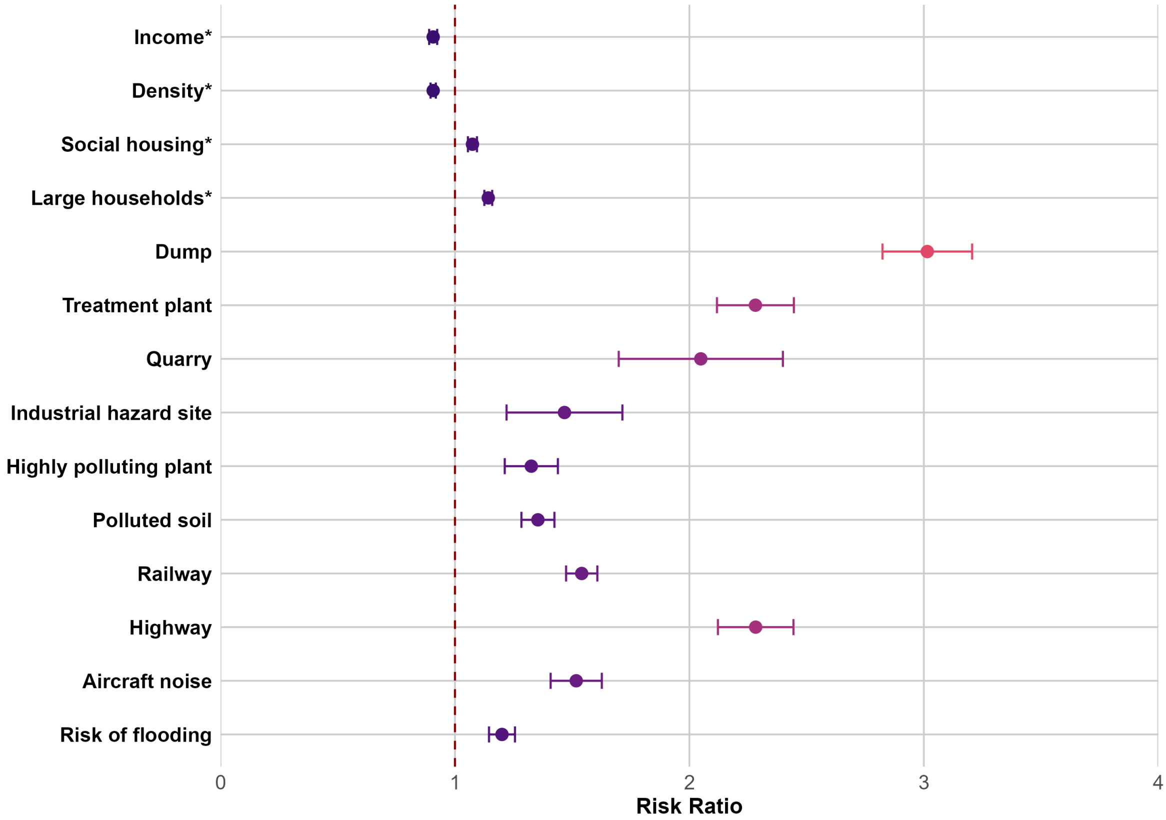
In order to appraise the existence and the extent of overexposure of Travellers to disamenities, we use a grid of 200m cells across cities that host a Traveller site. We compare the exposure to disamenities in cells near a Traveller site with that in cells farther away, while controlling for the cells' socio-demographic characteristics (see Methods section 4). Risk ratios of the likelihood of hosting a site associated with each variable are computed from the sub-municipal level regressions results (reported in Supplementary Table 13). They are reported in Fig. 5 (see 4.3.2 for the methods).

Cells that are near a site have specific socio-economic characteristics. We find that in these cells, average income is lower, while the percentage of large households — a proxy measure of low education level and high proportion of immigrants (see Supplementary Information 1) — is higher. To a smaller extent, a higher percentage of social housing also increases the likelihood of being near a site. These differences coincide with lower density in cells located near a site. Overall, sites are more likely to be located near underprivileged neighborhoods which are less densely populated.

In terms of environmental exposure, all variables are significantly and positively correlated with the proximity of a site. In particular, proximity with a dump or a treatment plant (distance <300m) multiplies the likelihood of proximity between a cell and a site by 3 and 2.2 respectively. Similarly, proximity with a highway (distance <100m) multiplies this likelihood by 2.2. Other types of disamenities are less strongly correlated with the proximity of a site,. For instance, proximity with a highly polluting plant or a polluted soil (distance <300m) increases the likelihood of proximity between a cell and a site by 30-40%.

Exposure-related variables are significant despite the simultaneous inclusion of socio-economic variables. This fact indicates not only that sites tend to be implemented in economically disadvantaged areas, but also that, within those areas, they are more likely to be implemented in locations with higher exposure to disamenities. This result suggests that local representatives decide to locate Traveller sites in neighborhoods with greater environmental nuisance exposure, although the underlying mechanisms may be both market-based and discrimination-based.

Figure 5: Risk ratios of socio-demographic and environmental exposure variables on the cells' likelihood of being located near a Traveller site



Note: The risk ratio is the average marginal effect calculated as the ratio between two chosen contrast levels. For binary variables, the contrast levels correspond to the two possible states (0 and 1). For continuous variables, the contrast levels correspond to one standard deviation from the mean. Risk ratios are computed from the within-municipalities probit regressions (see Supplementary Table 13). The dots represent the estimated risk ratio of the likelihood that the cell is near a site. The error bars represent the 95% confidence intervals. As an example, cells within 300m of a dump are 3 times more likely to be near a site than other cells.
**Variables marked by a star are continuous.*

2.3 Sensitivity analyses

Multiple sensitivity analyses were performed at both between-municipalities and within-municipalities levels (see Methods 4.4). The significance in the between-municipalities regression is insensitive to the clustering of standard errors for all variables, while the significance in the within-municipalities regression is insensitive to the clustering of standard errors for most variables. Additionally, both the coefficients and their significance in the within-municipalities are relatively insensitive to a change in the set of observations, and to a change of the buffer distance used to characterize the proximity between cells and disamenities.

3 Discussion

This study demonstrates how urban planning decisions – specifically regarding the location of Traveller sites – can result in environmental discrimination, thereby disproportionately exposing Travellers to environmental hazards. Not only do sites tend to be situated in municipalities with a higher concentration of disamenities, but they also tend to be located closer to these disamenities than other neighborhoods. Our statistical analysis reveals that both socio-economic factors and environmental disamenities are significant in explaining the siting of Traveller sites. Specifically, our findings indicate that sites are often constructed (1) in lower income neighborhoods where population density is lower, and (2) in areas where exposure to disamenities is heightened – especially with respect to dumps, treatment plants and highways. Socially disadvantaged neighborhoods are often disproportionately exposed to environmental disamenities. However, when socio-economic and environmental variables are both considered, the average marginal effects of environmental variables are higher than those of socio-economic variables. This suggests that overexposure to environmental disamenities cannot be attributed solely to the fact that such sites are located in disadvantaged neighborhoods. Instead, it reveals that policymakers often choose locations with the highest levels of disamenities, highlighting a clear case of environmental discrimination resulting from urban planning decisions.

The fact that the siting of Travellers site leads to discrimination by outcome does not necessarily mean that those discriminations are intentional. Indeed, two mechanisms that might influence decision-makers' choices regarding the location of sites arise. First, discriminatory outcomes may not be the consequence of intentions by decision-makers, who might only seek to minimize the monetary cost of setting up a site, leading them to construct sites in areas where relatively more land remains disposable and land value – i.e. the cost that the municipality will bear to acquire the land, or the opportunity cost of using it for site construction if it already owns the land – is relatively lower. Second, discriminatory outcomes may be the result of intentions related to racism against Travellers. Given the widespread marginalization of Travellers in France, decision-makers might seek to minimize the political cost of setting up a site. This could be done either by willingly minimizing proximity between sites and residential neighborhoods, or by willingly minimizing the expected presence of Travellers on municipal ground through an undesirable location choice. be prejudiced against Travellers or fear such prejudice from voters, resulting in environmentally racist choices.

3.1 Detrimental siting may result from cost minimization of the policy

The first mechanism involves the financial costs associated with establishing a site. Our analysis shows that higher rental prices are linked to a lower probability of establishing a site, indicating that the likelihood of site implementation decreases when the opportunity cost of land is higher. Since land acquisition is a significant component of the overall implementation costs, along with construction and maintenance, local representatives often cite limited land availability as a major obstacle to site establishment[32]. This factor may also explain why high-density regions are most delayed in meeting their hosting capacity prescriptions[39]. However, some authors argue that citing low land availability might be used as a convenient excuse by municipalities that are both unwilling and legally obligated to host a site[33].

Municipalities that decide to set up a site may also choose its location with the objective of minimizing the (monetary) opportunity cost. Neighborhoods located near many disamenities typically have a lower land value — or lower property value[40],[41] —, which is supported by the fact that their inhabitants are generally less well-off and that the proportion of social housing is slightly higher. Lower population density in these areas might also suggest that relatively more land remains available. Consequently, it might be relatively less costly for the municipality to set up a site in these neighborhoods.

In practice, strong land pressure and urban planning constraints have sometimes been cited to justify the construction of sites near disamenities and in remote locations [32]. While decision-makers in urban environments do face such constraints, some may use this argument strategically to keep Travellers away from the city center and residential neighborhoods[33]. This is supported by the fact that the decision of setting sites far away from the city center often entails costly public works[32].

3.2 Detrimental siting may result from policymakers' willingness to keep Travellers away

The second mechanism is related to environmental racism against Travellers[34]. It has been shown that local representatives and some residents often view Traveller sites as an undesirable facility. There have been numerous instances of hostile rhetoric from local representatives towards Travellers or against the establishment of Traveller sites[33]. These discourses often stem from concerns that Travellers might cause harm or have already harmed the local community[32], and reflect widespread prejudice against Travellers in France and more generally in Europe[29],[22]. In some cities, local residents have actively opposed the construction of these sites[32]. Thus, the distribution of sites between municipalities can generate NIMBY [42–44] conflicts while negotiating in the inter-municipal communities, resulting in potential non-cooperation between them. This might yield two alternative results. Either municipalities will not comply at all, or they will minimize the political cost associated with the construction of a site.

Minimizing the political cost of setting up a site might result in a harmful location choice for two distinct reasons. The first reason would be an attempt to minimize proximity between Travellers and local inhabitants. It should imply to set up the site on the urban fringe, as far as possible from existing residential neighborhoods, and possibly at the cost of clustering the Traveller site with other locally unwanted facilities – including environmental disamenities. This mechanism cannot be ruled out, as our results underline that sites are more likely to be located in low income, low density areas with greater proximity to disamenities. Additionally, the critical literature has mentioned that deliberately keeping Travellers away from residential neighborhoods and city centers through site location is a common practice[33],[34].

The second potential mechanism linked to minimizing the political cost would be an attempt to minimize the Travellers' presence in the municipality. Indeed, local representatives might place sites in locations they consider undesirable to discourage Travellers from settling on their municipality's land. Neighborhoods where environmental disamenities are concentrated typically may be considered undesirable locations. It has been reported that the occupancy rate of sites is often low and varies significantly from one site to another[32], which might suggest that Travellers tend to avoid certain sites. However, there is no evidence that (1) Travellers specifically avoid sites that are more exposed to disamenities or that (2) decision-makers believe that locating sites in undesirable neighborhoods believe this might deter Travellers from settling in the municipality. Therefore, this rationale should be used with caution.

Overall, both the opportunity cost and the NIMBY mechanism are closely intertwined. The NIMBY mechanism, often compounded by related racism, suggests that hosting a Traveller site may pose a political risk for the politicians in charge. The perceived opportunity cost of setting up a site in residential neighborhoods may thus be distorted by discriminatory preferences, leading local representatives to choose more remote locations for these sites. Conversely, the well-being of Travellers may be undervalued by policymakers due to their low level of electoral participation. In turn, Travellers are more likely to seek to minimize the cost of implementing a site, possibly at the cost of detrimental siting. The literature has underlined the role of negotiation and conflict in environmental inequalities formation[21]. In the case of Traveller sites, Travellers have limited participation in siting decisions, and their ability to engage in conflict is reduced because of their vulnerability and marginality. These two mechanisms can lead policymakers to overlook the needs of these populations, resulting in a "disproportionate siting"[10] of Traveller sites in neighborhoods which have traditionally been chosen to host other NIMBY facilities, such as treatment plants and dumps. It is likely that this political incentive coincides with a monetary incentive linked to a smaller land acquisition cost in such neighborhoods. Prejudice and costs incentives might interact and shape urban planning decisions regarding sites, resulting in a detrimental location and thereby increasing environmental inequalities.

As a conclusion, from a research perspective, our work raises several questions for further investigation. These include (1) the electoral participation of Travellers and its potential influence on urban planning decisions that affect them, (2) how electoral dynamics shape such decisions, and (3) the health impacts of environmental discrimination. From a policy perspective, this paper highlights the need for heightened vigilance regarding the sources and patterns of environmental discrimination in an urban context, as well as political coordination among discriminated populations to counteract the dynamics that lead to such overexposure.

4 Methods

4.1 Definitions

Traveller sites: In France, Traveller sites (*Aires d'accueil pour Gens du voyage*) are enclosed areas which include a limited number of plots for caravans, long-term sanitary amenities, and access to water and electricity. Travellers who are not sedentary legally have to park in a site.
Urban area: An urban area is a group of touching municipalities, without pockets of clear land, encompassing an urban centre (urban unit) providing at least 1,500 jobs, and by rural districts or urban units (urban periphery) among which at least 40% of employed resident population works in the centre or in the municipalities attracted by this centre.
Inter-municipal community: In France, inter-municipal communities (*établissements publics de coopération intercommunale*) are administrative groups in which a set of municipalities share powers. Each municipality is member of exactly one inter-municipal community. In practice, community counsillors are elected among local representatives of concerned municipalities. Communities have the task of finding suitable plots for Traveller sites, in order to meet their hosting capacity target which is defined upstream in the *Schéma departemental*.
Department : A department is an administrative category, delimiting a set of municipalities and inter-municipal communities.
Schéma départemental: The *schéma départemental d'accueil des gens du voyage* is a document written at the scale of each administrative department. It evaluates the hosting capacity needs and shares the capacity targets between inter-municipalities accordingly, and has to be ratified by involved municipalities and inter-municipal communities. This document is theoretically legally binding for municipalities, although in practice many communities have not met their target to this day.
City: A city is a municipality of 5,000 and more inhabitants.
Town: A town is a municipality of under 5,000 inhabitants, as opposed to a city.
Stand-alone city: We define a stand-alone city as a city (*i.e.* 5,000+ inhabitants municipality) which belongs to an inter-municipal community in which all other municipalities are towns.
Integrated city: We define an integrated city as a city (*i.e.* 5,000+ inhabitants municipality) which belongs to an inter-municipal community in which there is at least one other city, as opposed to a stand-alone city.
Additional definitions and precisions can be found in Supplementary Information 1.

4.2 Data

4.2.1 Traveller Sites in France

We collected data on the location of Traveller Sites in France from OpenStreetMap[1] and merged this data with an existing data set dating from 2021[2]. The existing data set contained 1,351 sites. Some new Traveller sites were detected, while others were deleted. In our database 230 sites were added and 17 were removed. In the end, our database contains 1,581 sites of which 1,564 are active [45] [3]. We extracted, for each site, the name of the municipality where it is located, as well as its exact geographic coordinates. Doing so allows to use this database both at municipal and sub-municipal level.

4.2.2 Location of disamenities

Based on a previous study on the exposure to disamenities in sites[33], we considered a range of facilities which can be used to characterize the environmental properties of Traveller sites. The included types of facilities are dumps, quarries, water treatment plants, highways and railways, highly polluting plants (classified as IED sites) and hazardous industrial sites (classified as Seveso sites, see Supplementary information 1 for definitions). Additionally, we consider the exposure to aircraft noise, to polluted soils and to the risk of flooding. For the sake of simplicity, we also call these exposure variables "disamenities". Data sources are available in Table 1.

Type of disamenity	Data source	Year	Buffer zone distances
Risk of flooding	Géorisques, BRGM, COVADIS	2020	No buffer
Exposure to aircraft noise	GéoServices, IGN	2023	No buffer
Railways	SNCF	2020	100m, 500m
Highways	Magellium, OpenStreetMap	2020	100m, 500m
Dumps	OpenStreetMap	2023	300m, 500m, 1000m
Water treatment plants	SANDRE, OFB	2020	300m, 500m, 1000m
Quarries IED sites Seveso sites Polluted soils	Géorisques, BRGM	2023	300m, 500m, 1000m

Table 1: Data sources for variables related to exposure to disamenities

4.2.3 Data on municipalities' characteristics and exposure to disamenities

To obtain data on French municipalities, we compiled multiple INSEE data sets. Density and area were collected from *Structure et évolution de la population 2019.* The belonging to an urban area was collected from *Base des aires urbaines 2010* (using the 2020 update). The average level of rent was extracted from *Carte des loyers 2019.* The data set containing all municipalities has 34,836 observations. Because of data availability issues, our data set contains 34,820 observations. The observations were dropped because the municipality's density was either unknown, or equal to 0. We then added data on the types of disamenities located on each municipality's land.

[1] https://www.openstreetmap.org, consulted on Nov. 2023.
[2] This layer can be found using the following link: https://www.visionscarto.net/aires-d-accueil-les-donnees.
[3] The full dataset is available at https://doi.org/10.57745/G1LWND.

Let I be the set of municipalities and D be the set of disamenities. The dummy $\mathbb{1}_{i,d}$ denoting the presence of disamenity d in municipality i is:

$$\forall i \in I, \forall d \in D, \quad \mathbb{1}_{i,d} = \begin{cases} 1 & \text{if disamenity } d \text{ is on municipality } i\text{'s land} \\ 0 & \text{otherwise} \end{cases} \tag{1}$$

Finally, we added data on the location of sites by creating, for all municipalities, a dummy variable equal to one if the municipality contains at least one site, zero otherwise.

4.2.4 Data on characteristics and exposure to disamenities at sub-municipal level

For sub-municipal level data, we used the INSEE *Filosofi* (2019) database which relies on a grid of mainland France with 200m*200m cells. We exclusively collected cells of municipalities containing at least one site. *Filosofi* provided us with data on each cell's density, percentage of large households, percentage of social housing, and average income. Then, using the geographic coordinates of Traveller Sites, we constructed for each cell a dummy equal to one if the cell is at most 500m away from a site, zero otherwise.

In order to compare exposure to disamenities across cells, we constructed three buffer zones (300m, 500m and 1,000m) around the cells, except for the proximity of railways and highways, for which we used 100m and 500m buffers. We constructed a dummy variable $\mathbb{1}_{c,d,b}$ indicating the proximity between a cell c and a disamenity d, within distance b. With C the set of cells, D the set of disamenities and a given threshold value corresponding to the 100m, 300m, 500m or 1,000m buffer, the dummy variable indicating proximity between a cell and a disamenity is:

$$\forall\, c \in C,\ \forall\, d \in D,\ \forall\, b \in [100, 300, 500, 1000], \quad \mathbb{1}_{c,d,b} = \begin{cases} 1 & \text{if } \mathrm{dist}(c,d) < b \\ 0 & \text{otherwise} \end{cases} \tag{2}$$

Our strategy is to compare cells located at most 500m away from a site to cells located at least 500m away from a site. The underlying assumption is that if cells located near sites are systematically closer to disamenities than other cells, then sites are systematically closer to disamenities than other neighborhoods.

4.3 Statistical analysis

4.3.1 Distribution of sites between municipalities

We first perform a between-municipalities probit regression, to identify the determinants of the distribution of sites across cities. Municipalities are indexed by i. The dependent variable $Site_i$ is a dummy variable equal to one if a municipality contains at least one site. We control for the demographic characteristics X_i of municipalities, using log density and log area. Additionally, following the French legal context regarding Traveller sites, we estimate the effect of the 5,000 inhabitants threshold on the probability of hosting a site. $City_i$ is a dummy equal to one if the municipality has 5,000+ inhabitants. $log(Rent)_i$ is the log of the average rent price per m^2 in the municipality. $Urban\,area_i$ is a dummy equal to one if the municipality belongs to an urban area. Therefore, with ϵ_i being the error term, we estimate Equation 3:

$$Site_i = \alpha + \beta X_i + \gamma_1 City_i + \gamma_2 log(Rent)_i + \gamma_3 Urban\,area_i + \epsilon_i \tag{3}$$

We aim to account for the effect of being able to bargain with other legally obligated municipalities on the probability of hosting a site. In Equation 4, $City_i$ is replaced by two dummies, $Stand-alone\,city_i$ and $Integrated\,city_i$. $Stand-alone\,city_i$ is equal to one if the municipality is categorized as a *Stand-alone* *city*, *i.e.* if it has over 5,000 inhabitants and belongs to an inter-municipal community in which there is no other city. $Integrated\,city_i$ is equal to one if the municipality is categorized as an *Integrated city*, *i.e.* if it has over 5,000 inhabitants and belongs to an inter-municipal community in which there is at least one other city. Therefore, these categories are exclusive, and the reference category is Towns (municipalities below 5,000 inhabitants). Following our framework, these variables provide information on whether a municipality will be able to negotiate and cooperate with other legally obligated municipalities in order to construct a site. We estimate the following equation:

$$Site_i = \alpha + \beta X_i + \gamma_1 Stand-alone\,city_i + \gamma_2 Integrated\,city_i + \gamma_3 log(Rent)_i + \gamma_4 Urban\,area_i + \epsilon_i \quad (4)$$

The results of these regressions are reported in Supplementary Table 10. We then compute a risk ratio for each variable, that is the average marginal effect calculated as the ratio between the two contrast levels. Risk ratios are computed from the results of the Equation 3 regression, except for two variables: $Stand-alone\,city$ and $Integrated\,city$, which are computed from the Equation 4 regression. This does not induce any inconsistency in the estimated marginal effects, as other coefficients were insensitive to the changes. For any binary variable X_1 (among $Urban\,area$, $City$, $Stand-alone\,city$ and $Integrated\,city$), the risk ratio is computed as follows :

$$RR(X_1) = \frac{\mathbb{P}(Site = 1 \mid X_1 = 1)}{\mathbb{P}(Site = 1 \mid X_1 = 0)}$$

For any continuous variable X_2 among *Rent* and *Area*, with mean μ_2 and standard deviation σ_2, we compute the following average marginal effect of a standard deviation:

$$RR(X_2) = \frac{\mathbb{P}(Site = 1 \mid X_2 = \mu_2 + \frac{\sigma_2}{2})}{\mathbb{P}(Site = 1 \mid X_2 = \mu_2 - \frac{\sigma_2}{2})}$$

. The variable *Density* is a particular case, as its mean μ_d is low and its standard deviation σ_d is high. Therefore, $\mu_d - \frac{\sigma_d}{2}$ is lower than zero. As a consequence, we compute the marginal effect of a standard deviation above the mean:

$$RR(Density) = \frac{\mathbb{P}(Site = 1 \mid Density = \mu_d + \sigma_d)}{\mathbb{P}(Site = 1 \mid Density = \mu_d)}$$

4.3.2 Distribution of sites within municipalities

The within-municipalities data set contains all cells of municipalities which host at least one site. Therefore, the objective is to compare cells located near a site to all other cells, across all municipalities. We use a probit model to estimate Equation 5:

$$Site_c = \alpha + \beta Z_c + \gamma_1 log(Income)_c + \gamma_2 log(Density)_c + \gamma_3 Social\ housing_c + \gamma_4 Large\ households_c + \epsilon_c \quad (5)$$

Cells are indexed by c. $Site_c$ is a dummy indicating the proximity of a Traveller site to the cell (distance <500m). Z_c is a vector of dummy variables corresponding to exposure to listed types of disamenities, measured with the smallest possible buffer (100m for railways and highways, 300m for all other disamenities). In addition to exposure variables, we include $log(Income)_c$ the log of average income in the cell, $log(Density)_c$ the log of population density in the cell, $Social\ housing_c$ the proportion of social housing in the cell and $Large\ households_c$ the proportion of households containing at least five inhabitants in the cell. ϵ_c is the error term. There are two underlying assumptions. First, a higher proportion of social housing, on average, might indicate that a higher proportion of inhabitants in the corresponding cell is underprivileged. Second, a higher proportion of large households in a cell might indicate the same fact, as large households are disproportionately families of immigrants and/or with lower education[46].

The results of this regression are reported in Supplementary Table 13. We then compute the average marginal effects from these results. All exposure variables are binary. Therefore, for any exposure variable Z_1, the average marginal effect is:

$$RR(Z_1) = \frac{\mathbb{P}(Site = 1 \mid Z_1 = 1)}{\mathbb{P}(Site = 1 \mid Z_1 = 0)}$$

In contrast, all socio-demographic variables are continuous. Therefore, for any other variable Z_2 with mean μ_2 and standard deviation σ_2, we compute the following average marginal effect of a standard deviation:

$$RR(Z_2) = \frac{\mathbb{P}(Site = 1 \mid Z_2 = \mu_2 + \frac{\sigma_2}{2})}{\mathbb{P}(Site = 1 \mid Z_2 = \mu_2 - \frac{\sigma_2}{2})}$$

4.4 Sensitivity analyses

4.4.1 Between-municipalities regressions

We clustered standard errors at French departments ($n = 96$) and French regions ($n = 13$) levels. Despite the drop in the number of clusters, the estimates remain statistically significant (Supplementary Table 14).

4.4.2 Within-municipalities regressions

The number of observations in the initial gridded dataset (with 200m resolution cells) is 356,764. However, because of confidentiality issues, the INSEE *Filosofi* database contains imputed data for some cells. One might argue that this induces a lower accuracy of our data. Therefore, to check whether this creates a bias in our results, we constructed three sets of observations by using different inclusion criteria. These criteria are based on whether socio-economic data was imputed in the *Filosofi* data base for each cell, and how it was imputed. In the most restrictive set, only 200m cells which did not undergo any data imputation were included. This set contains 154,050 observations. In the intermediary set, we also included 200m cells for which data was imputed from a 1km large cell. This set contains 298,943 observations. In the least restrictive set, we added cells for which data was imputed from a cell larger than 1km. As a consequence, all 356,764 observations are included in the least restrictive set. A summary of the three inclusion criteria can be found in Supplementary information 2.2.

In our main regression, we use the sample with all observations, although the data for some cells is less accurate. Using a set where some cells are excluded would imply to use truncated data, as the criterion for imputation is linked to confidentiality issues, which directly depend on a cell's population density (Supplementary information 2.2). We find that estimates are consistent across all three sets of observations (Supplementary Table 13).

We also checked whether changing the buffer zone for variables related to the exposure to disamenities changed the estimated penalty for cells located near a site, and found that the estimates and significance are insensitive to the choice of the buffer (Supplementary Table 15).

We also clustered the standard errors at municipality level across all three sets of observations, and found that the results remain statistically significant (Supplementary Table 16).

Finally, the share of cells in a given municipality that is near existing disamenities and Traveller sites is mechanically higher in municipalities with smaller area. Therefore, municipality area could be an omitted variable that is both correlated to the estimated exposure of cells to environmental variables, and to estimated proximity between cells and a Traveller site. In turn, this could induce biased estimates. Therefore, we controlled for municipality area. Results indicate, as expected, that in larger municipalities cells are less likely to be located near a site (*i.e.* the share of cells within 500m of a site is lower). However, we found no significant variation in the estimated overexposure to environmental disamenities (Supplementary Table 19).

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Author contributions

N.M. drafted most of the initial outline and core initial content of the paper, with A.L., P.D. and L.T. enriching the outline and text with further illustrations, references and precisions. They also thoroughly edited the text. L.T. developed the initial spatial dataset with input from A.L. and P.D. N.M. carried out the statistical analysis with input and advice from the other authors. All authors have revised the manuscript.

Competing interests

The authors declare no competing interests.

Data availability

The initial dataset on travellers sites, exposure to environmental amenities and disamenities, and access to public services is accessible here https://doi.org/10.57745/G1LWND,RechercheDataGouv,V1

1 Additional definitions

Large households: Large households are households of five or more individuals. Large households are essentially families (1,669,000 large families by 2011, and 1,768,000 large households in 2013). Large families are disproportionately families of immigrants and/or with low education level and/or living under the poverty line. For statistics, see `https://www.insee.fr/fr/statistiques/1283771#titre-bloc-8`. (Source: INSEE)

Industrial hazard site: An industrial hazard site is an industrial establishment categorized as SEVESO. SEVESO sites present risks of major incidents and engage in activities related to the manufacturing, handling, storage, or use of hazardous substances.

Highly polluting plant: A highly polluting plant is an establishment with an Industrial Emissions Directive (IED) classification.

Polluted soil: A polluted soil is an area that is classified as "*Secteur d'information sur les sols*" and/or as "*Sites et sols pollués*".

2 Summary statistics

2.1 Municipal level data

Variable	Total	%
Urban area		
... No	110	8%
... Yes	1268	92%
5,000+ inhabitants		
... No	308	22%
... Yes	1070	78%

Variable	Mean	Sd	Median	Min	Max
Mean rent (€/m^2)	11	2.6	10	6.1	26
Density (/km^2)	903	1432	431	11	20536
Area (km^2)	30	37	20	1.3	757

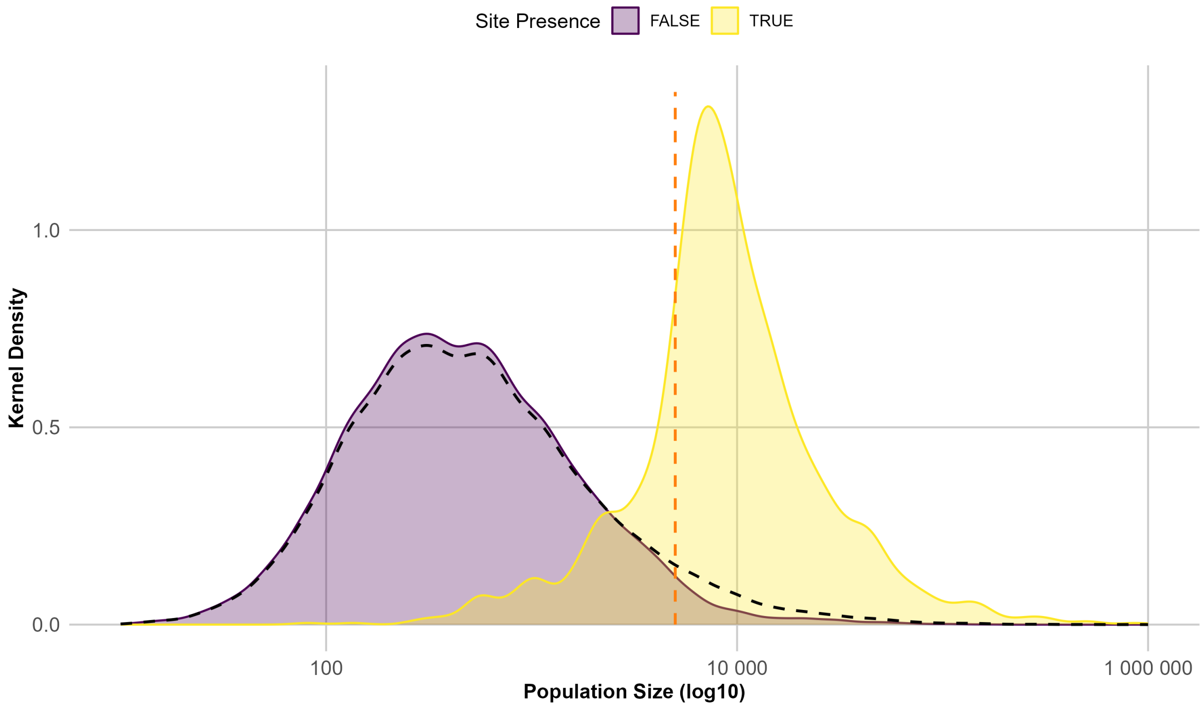
Table 1: Summary statistics for municipalities with site ($N = 1378$)

Variable	Total	%
Urban area		
... No	17203	51%
... Yes	16239	49%
5,000+ inhabitants		
... No	32409	97%
... Yes	1033	3%

Variable	Mean	Sd	Median	Min	Max
Mean rent (€/m^2)	8.7	1.9	8.3	5.7	29
Density (/km^2)	133	681	38	0.078	27386
Area (km^2)	15	16	11	0.028	456

Table 2: Summary statistics for municipalities without site ($N = 33442$)

Figure 1: Distribution of population sizes and presence of Traveller sites in municipalities



Note: Kernel density estimates of population sizes for municipalities with (purple) and without (yellow) Traveller sites. The black dashed line represents the overall population size distribution across all municipalities. The orange dashed line indicates the threshold of 5,000 inhabitants, above which municipalities are legally obligated to contribute to hosting Travellers.

2.2 Sub-municipal level data

Because of confidentiality issues, each 200m or 1km cell's socio-economic data is imputed from a larger cell if it does not meet the requirement of containing at least 11 households. For further information on the data imputation process in *Filosofi*, see `https://www.insee.fr/fr/metadonnees/source/operation/s2069/documentation-methodologique`. Based on this methodology, we constructed three inclusion criteria, of which we provide a summary in Table 3 below.

	Cell included in the data set		
Type of imputation for the cell's socio-economic variables	Most restrictive	Intermediary	Least restrictive
No imputation, true values displayed	Yes	Yes	Yes
Values imputed from a 1km cell	No	Yes	Yes
Values imputed from a cell larger than 1km	No	No	Yes
Observations	154,050	298,943	356,764

Table 3: Summary of the inclusion criteria for cells at the sub-municipal level

2.3 Exposure in Traveller sites

Table 4: Complete summary statistics for sub-municipal level variables in the least restrictive set ($N = 356764$)

Variable	Total	%
Site 500m		
... No	341897	96%
... Yes	14867	4%
Dump 300m		
... No	349825	98%
... Yes	6939	2%
Treatment plant 300m		
... No	349544	98%
... Yes	7220	2%
Quarry 300m		
... No	355422	100%
... Yes	1342	0%
Hazardous industrial site 300m		
... No	355054	100%
... Yes	1710	0%
Highly polluting plant 300m		
... No	348310	98%
... Yes	8454	2%
Polluted soil 300m		
... No	328966	92%
... Yes	27798	8%
Railway 100m		
... No	319768	90%
... Yes	36996	10%
Highway 100m		
... No	349408	98%
... Yes	7356	2%
Aircraft noise		
... No	345371	97%
... Yes	11393	3%
Risk of flooding		
... No	318156	89%
... Yes	38608	11%

Variable	Mean	Sd	Median	Min	Max
Income (€/year)	24693	4721	24222	8646	79961
Density (km^2)	1770	3854	450	25	164138
Social housing (%)	0.065	0.19	0	0	1
Large households (%)	0.069	0.067	0.057	0	0.71

Table 5: Comparing cells near a site with cells not near a site using the least restrictive set

Proximity of a site (500m)	No ($N = 341897$)	Yes ($N = 14867$)	Yes − No
Mean income (€/yr)	24728	23902	-826^{***}
Mean density (/km^2)	471	423	-48^{***}
% social housing	0.063	0.088	$+0.025^{***}$
% large households	0.068	0.081	$+0.013^{***}$
Dump 300m	0.017	0.066	$+0.049^{***}$
Treatment plant 300m	0.019	0.049	$+0.030^{***}$
Hazardous industrial site 300m	0.005	0.011	$+0.006^{***}$
Quarry 300m	0.004	0.008	$+0.004^{***}$
Polluting plant 300m	0.023	0.042	$+0.019^{***}$
Polluted soil	0.076	0.120	$+0.044^{***}$
Railway 100m	0.101	0.169	$+0.068^{***}$
Highway 100m	0.019	0.053	$+0.034^{***}$
Aircraft noise	0.031	0.049	$+0.018^{***}$
Risk of flooding	0.107	0.142	$+0.035^{***}$
Note: Significance of the difference		*p<0.05; p<0.01; ***p<0.001	

Table 6: Complete summary statistics for sub-municipal level variables in the intermediary set ($N = 298493$)

Variable	Total	%
Site 500m		
... No	285643	96%
... Yes	12850	4%
Dump 300m		
... No	292254	98%
... Yes	6239	2%
Treatment plant 300m		
... No	292539	98%
... Yes	5954	2%
Quarry 300m		
... No	297449	100%
... Yes	1044	0%
Hazardous industrial site 300m		
... No	297029	100%
... Yes	1464	0%
Highly polluting plant 300m		
... No	291236	98%
... Yes	7257	2%
Polluted soil 300m		
... No	272103	91%
... Yes	26390	9%
Railway 100m		
... No	264934	89%
... Yes	33559	11%
Highway 100m		
... No	292162	98%
... Yes	6331	2%
Aircraft noise		
... No	288352	97%
... Yes	10141	3%
Risk of flooding		
... No	263633	88%
... Yes	34860	12%

Variable	Mean	Sd	Median	Min	Max
Income (€/year)	24819	4891	24366	8646	79961
Density (km^2)	2065	4137	675	25	164138
Social housing (%)	0.075	0.2	0	0	1
Large households (%)	0.068	0.065	0.057	0	0.71

Table 7: Comparing cells near a site and cells at distance from a site using the intermediary set

Proximity of a site (500m)	No ($N = 285643$)	Yes ($N = 12850$)	Yes − No
Mean income (€/yr)	24866	23903	-963^{***}
Mean density (/km^2)	620	497	-123^{***}
% social housing	0.074	0.095	$+0.021^{***}$
% large households	0.068	0.081	$+0.013^{***}$
Dump 300m	0.019	0.066	$+0.047^{***}$
Treatment plant 300m	0.019	0.050	$+0.031^{***}$
Hazardous industrial site 300m	0.005	0.011	$+0.006^{***}$
Quarry 300m	0.003	0.008	$+0.005^{***}$
Polluting plant 300m	0.023	0.043	$+0.020^{***}$
Polluted soil	0.087	0.127	$+0.040^{***}$
Railway 100m	0.110	0.169	$+0.059^{***}$
Highway 100m	0.020	0.052	$+0.032^{***}$
Aircraft noise	0.033	0.049	$+0.016^{***}$
Risk of flooding	0.116	0.148	$+0.032^{***}$
Note: Significance of the difference		*p<0.05; p<0.01; ***p<0.001	

Table 8: Complete summary statistics for sub-municipal level variables in the most restrictive set ($N = 154050$)

Variable	Total	%
Site 500m		
... No	148055	96%
... Yes	5995	4%
Dump 300m		
... No	150810	98%
... Yes	3240	2%
Treatment plant 300m		
... No	152002	99%
... Yes	2048	1%
Quarry 300m		
... No	153600	100%
... Yes	450	0%
Hazardous industrial site 300m		
... No	153301	100%
... Yes	749	0%
Highly polluting plant 300m		
... No	150262	98%
... Yes	3788	2%
Polluted soil 300m		
... No	134773	87%
... Yes	19277	13%
Railway 100m		
... No	133621	87%
... Yes	20429	13%
Highway 100m		
... No	151337	98%
... Yes	2713	2%
Aircraft noise		
... No	148232	96%
... Yes	5818	4%
Risk of flooding		
... No	134042	87%
... Yes	20008	13%

Variable	Mean	Sd	Median	Min	Max
Income (€/year)	24295	5484	23782	8646	79961
Density (km^2)	3827	5185	2238	275	164138
Social housing (%)	0.14	0.26	0	0	1
Large households (%)	0.066	0.064	0.052	0	0.71

Table 9: Comparing cells near a site and cells at distance from a site using the most restrictive set

Proximity of a site (500m)	No ($N = 148055$)	Yes ($N = 5995$)	Yes − No
Mean income (€/yr)	24358	23088	-1270***
Mean density (/km^2)	2457	2157	-300***
% social housing	0.134	0.181	+0.047***
% large households	0.066	0.082	+0.016***
Dump 300m	0.020	0.057	+0.037***
Treatment plant 300m	0.012	0.030	+0.018***
Hazardous industrial site 300m	0.005	0.012	+0.007***
Quarry 300m	0.003	0.006	+0.003***
Polluting plant 300m	0.024	0.041	+0.017***
Polluted soil	0.124	0.157	+0.033***
Railway 100m	0.131	0.183	+0.052***
Highway 100m	0.017	0.043	+0.026***
Aircraft noise	0.037	0.053	+0.016***
Risk of flooding	0.130	0.141	+0.011*
Note: Significance of the difference			*p<0.05; **p<0.01; ***p<0.001

Table 10: Percentage of Traveller sites located near disamenities and a municipality border, depending on the distance and relative to the share located in a municipality with each type of disamenity.

Variable	**100m**	**200m**	**300m**	**500m**	**1000m**	**Share potentially exposed**
Dump			0.0829	0.1303	0.3144	0.6034
Treatment plant			0.0493	0.0911	0.1999	0.6142
Industrial hazard site			0.0051	0.0158	0.0569	0.1961
Quarry			0.0095	0.0209	0.0544	0.2024
Polluting industrial site			0.0323	0.0708	0.1771	0.5041
Polluted soil			0.0569	0.1328	0.3144	0.7147
Railway	0.1202			0.3036		0.7445
Highway	0.0487			0.1448		0.3586
Municipality border		0.2099	0.3491			1.0000

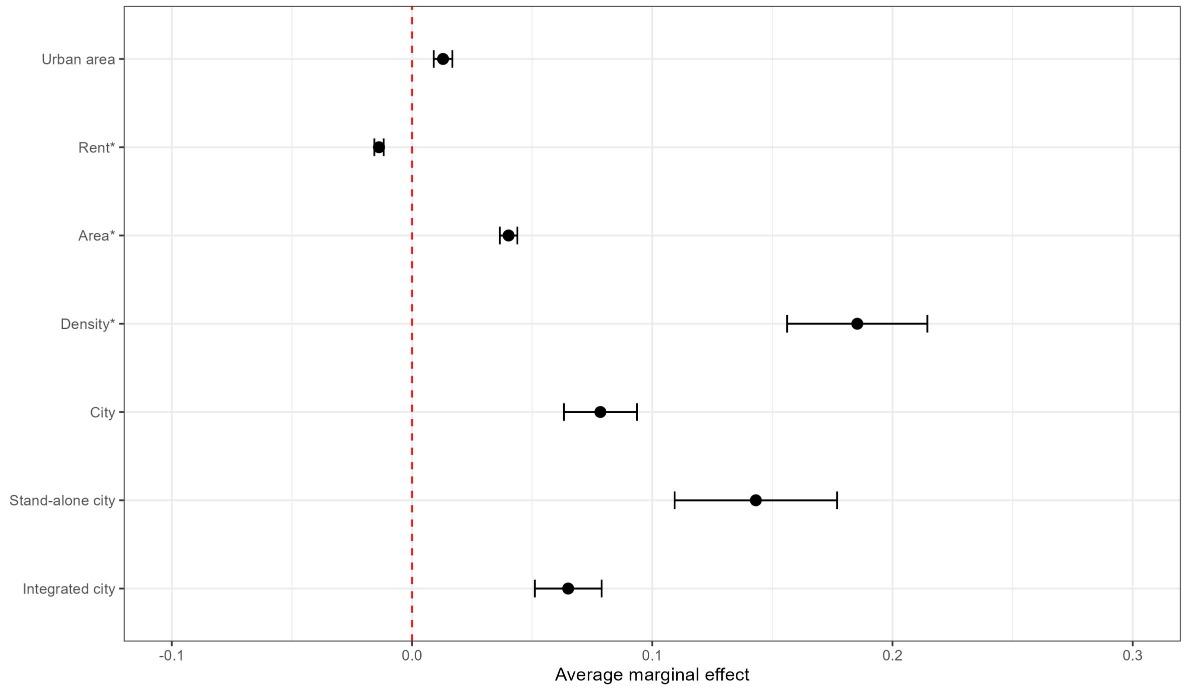
3 Regression results

3.1 Determinants of the distribution of Traveller sites between municipalities

Table 11: Determinants of the distribution of Traveller sites between municipalities

	Dependent variable:	
	Presence of a site on the municipality's land	
	probit	
	(1)	(2)
City	1.086***	
	(0.063)	
Stand-alone city		1.508***
		(0.092)
Integrated city		0.968***
		(0.066)
Log density	0.638***	0.642***
	(0.028)	(0.028)
Log area	0.732***	0.719***
	(0.032)	(0.032)
Log rent	−1.459***	−1.341***
	(0.106)	(0.107)
Urban area	0.328***	0.313***
	(0.053)	(0.054)
Observations	34,820	34,820
Log Likelihood	−2,660.328	−2,639.941
Akaike Inf. Crit.	5,332.656	5,293.881
Note:		*p<0.1; **p<0.05; ***p<0.01

Figure 2: Average marginal effects of variables for the municipal level regressions, computed as percentage point differences



3.2 Significance of the overexposure to disamenities in municipalities containing a Traveller site

Table 12: Significance of the overexposure to disamenities in cities containing a Traveller site, controlling for the cities' population size

	Dependent variable:
	Presence of a site on the municipality's land
	probit
Log population	0.172***
	(0.044)
Dump	0.254***
	(0.060)
Treatment plant	0.416***
	(0.061)
Industrial hazard site	0.099
	(0.082)
Quarry	0.012
	(0.078)
Highly polluting plant	0.277***
	(0.064)
Polluted soil	0.204***
	(0.069)
Railway	0.185***
	(0.066)
Highway	−0.112*
	(0.061)
Aircraft noise	0.265***
	(0.073)
Risk of flooding	−0.214***
	(0.059)
Observations	2,103
Log Likelihood	−1,328.796
Akaike Inf. Crit.	2,681.591
Note:	*p<0.1; **p<0.05; ***p<0.01

Table 13: Significance of the overexposure to disamenities in towns containing a Traveller site, controlling for the towns' population size

	Dependent variable:
	Presence of a site on the municipality's land
	probit
Log population	0.606***
	(0.039)
Dump	0.204***
	(0.059)
Treatment plant	0.036
	(0.054)
Industrial hazard site	−0.172
	(0.131)
Quarry	0.069
	(0.069)
Highly polluting plant	0.013
	(0.066)
Polluted soil	0.144**
	(0.059)
Railway	0.279***
	(0.053)
Highway	0.107*
	(0.062)
Aircraft noise	0.071
	(0.099)
Risk of flooding	0.087
	(0.065)
Observations	32,717
Log Likelihood	−1,315.518
Akaike Inf. Crit.	2,655.036
Note:	*p<0.1; **p<0.05; ***p<0.01

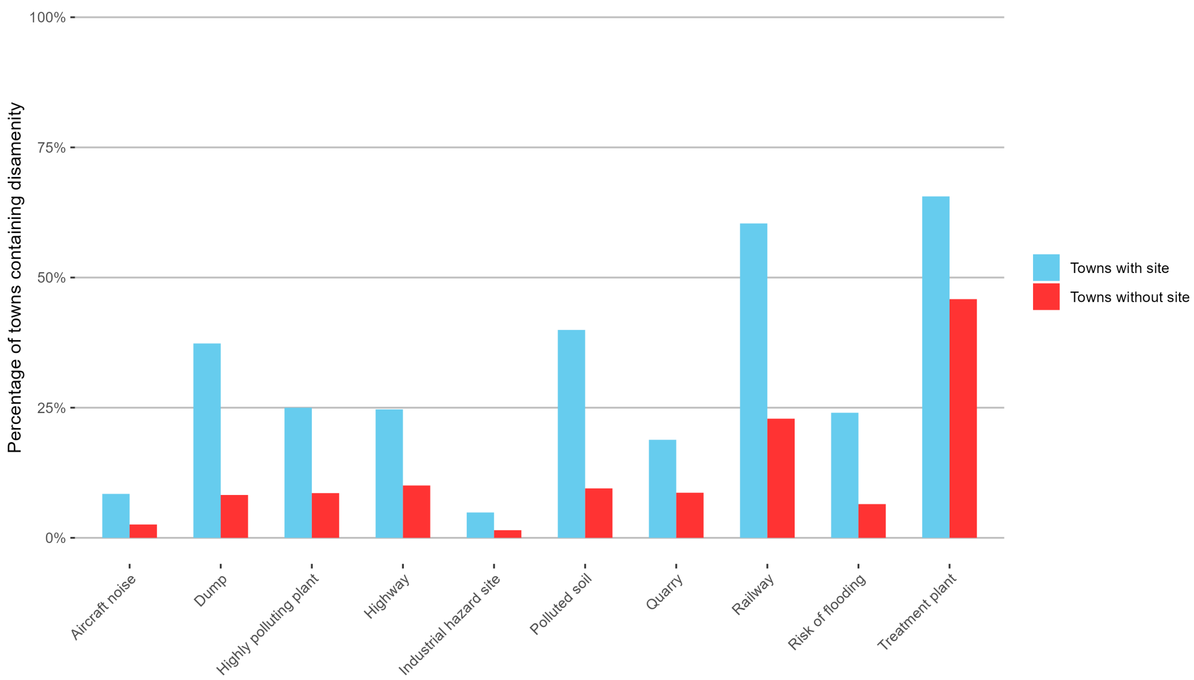
Table 14: Significance of the overexposure to disamenities in towns containing a Traveller site, controlling for the cities' area

	Dependent variable:
	Presence of a site on the municipality's land
	probit
Log area	0.239***
	(0.039)
Dump	0.194***
	(0.061)
Treatment plant	0.157**
	(0.069)
Industrial hazard site	0.108
	(0.082)
Quarry	−0.104
	(0.080)
Highly polluting plant	0.274***
	(0.064)
Polluted soil	0.257***
	(0.067)
Railway	0.244***
	(0.066)
Highway	−0.078
	(0.061)
Aircraft noise	0.311***
	(0.071)
Risk of flooding	−0.166***
	(0.058)
Observations	2,103
Log Likelihood	−1,317.176
Akaike Inf. Crit.	2,658.352
Note:	*p<0.1; **p<0.05; ***p<0.01

Table 15: Significance of the overexposure to disamenities in towns containing a Traveller site, controlling for the towns' area

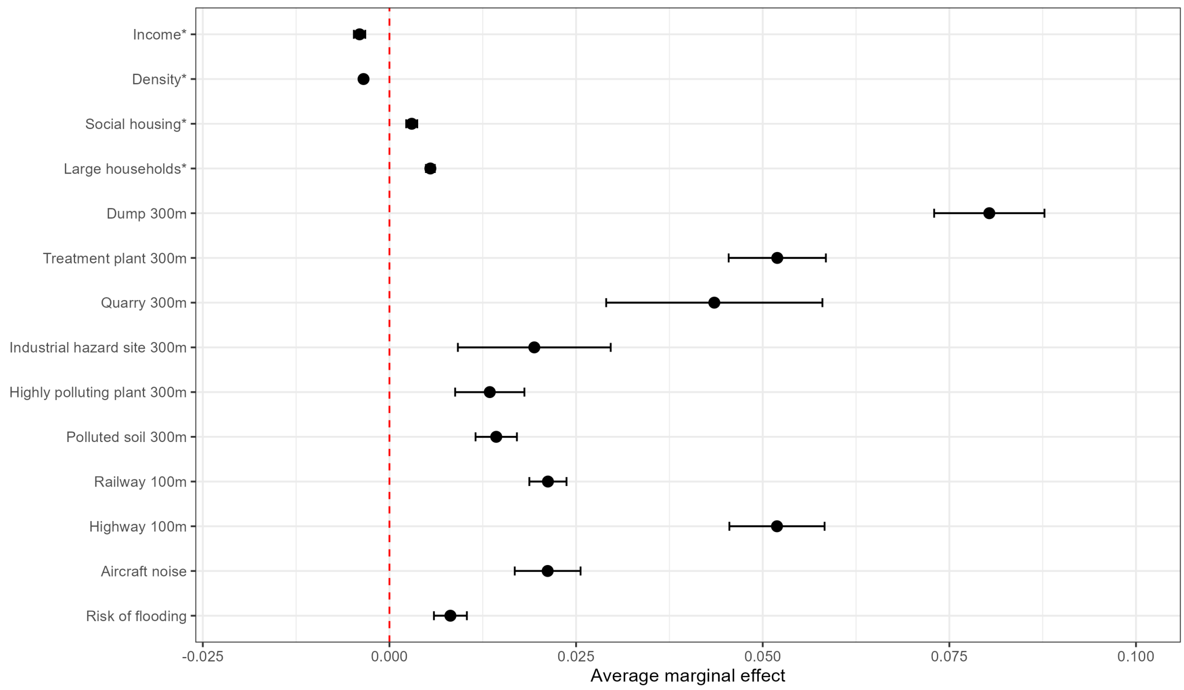
	Dependent variable:
	Presence of a site on the municipality's land
	probit
Log area	0.105***
	(0.034)
Dump	0.486***
	(0.056)
Treatment plant	0.104**
	(0.053)
Industrial hazard site	−0.122
	(0.127)
Quarry	0.104
	(0.066)
Highly polluting plant	0.152**
	(0.063)
Polluted soil	0.431***
	(0.056)
Railway	0.429***
	(0.049)
Highway	0.191***
	(0.060)
Aircraft noise	0.243**
	(0.097)
Risk of flooding	0.402***
	(0.063)
Observations	32,717
Log Likelihood	−1,474.895
Akaike Inf. Crit.	2,973.790
Note:	*p<0.1; **p<0.05; ***p<0.01

Figure 3: Percentage of towns exposed to various types of disamenities, among towns hosting a site and towns not hosting a site.



3.3 Determinants of the location of Traveller sites within municipalities containing a site

Figure 4: Average marginal effects of variables for the sub-municipal level regressions, computed as percentages point differences (rather than ratios)



	Dependent variable:		
	Site at most 500m away from the cell		
	Most restrictive set	Intermediary set	Least restrictive set
	(1)	(2)	(3)
Log income	−0.325***	−0.343***	−0.244***
	(0.035)	(0.026)	(0.024)
Log density	−0.151***	−0.057***	−0.040***
	(0.008)	(0.003)	(0.003)
Social housing	0.189***	0.134***	0.182***
	(0.028)	(0.024)	(0.023)
Large households	1.428***	1.083***	0.953***
	(0.084)	(0.059)	(0.053)
Dump	0.473***	0.544***	0.590***
	(0.031)	(0.021)	(0.019)
Treatment plant	0.343***	0.438***	0.429***
	(0.040)	(0.022)	(0.021)
Quarry	0.252***	0.382***	0.372***
	(0.091)	(0.055)	(0.049)
Hazardous industrial site	0.284***	0.178***	0.191***
	(0.067)	(0.048)	(0.045)
Polluting plant	0.124***	0.152***	0.139***
	(0.034)	(0.024)	(0.022)
Polluted soil	0.101***	0.136***	0.149***
	(0.018)	(0.014)	(0.013)
Railway	0.131***	0.173***	0.214***
	(0.016)	(0.012)	(0.011)
Highway	0.381***	0.402***	0.429***
	(0.035)	(0.022)	(0.020)
Aircraft noise	0.195***	0.188***	0.208***
	(0.028)	(0.020)	(0.019)
Risk of flooding	0.023	0.069***	0.089***
	(0.018)	(0.012)	(0.012)
Buffer	300m/100m	300m/100m	300m/100m
Observations	154,050	298,493	356,764
Log Likelihood	−24,543.110	−51,276.740	−59,848.860
Note:			*p<0.1; **p<0.05; ***p<0.01

Table 16: Determinants of the location of Traveller sites within municipalities

4 Sensitivity checks

4.1 Distribution of sites between municipalities: clustered standard errors

	Dependent variable:			
	Presence of a site on the municipality's land			
	Department		Region	
	(1)	(2)	(3)	(4)
City	1.086***		1.086***	
	(0.088)		(0.113)	
Stand-alone city		1.508***		1.508***
		(0.106)		(0.091)
Integrated city		0.968***		0.968***
		(0.091)		(0.128)
Log density	0.638***	0.642***	0.638***	0.642***
	(0.051)	(0.050)	(0.080)	(0.079)
Log area	0.732***	0.719***	0.732***	0.719***
	(0.048)	(0.047)	(0.066)	(0.065)
Log rent	−1.459***	−1.341***	−1.459***	−1.341***
	(0.250)	(0.237)	(0.332)	(0.312)
Urban area	0.328***	0.313***	0.328***	0.313***
	(0.065)	(0.065)	(0.081)	(0.082)
Observations	34,820	34,820	34,820	34,820
Number of clusters	96	96	13	13
Log Likelihood	−2,660.328	−2,639.941	−2,660.328	−2,639.941
Akaike Inf. Crit.	5,332.656	5,293.881	5,332.656	5,293.881
Note:				*p<0.1; **p<0.05; ***p<0.01

Table 17: Municipal level regressions with clustered standard errors

4.2 Distribution of sites within municipalities : using different buffers

In the sub-municipal level model, we used the smallest possible buffer for all variables linked to exposure to a disamenity. This buffer was 300m for all disamenities, except for proximity to railway and highway, for which we used a 100m buffer. Choosing the smallest possible buffer provides the best possible precision in the estimates. Furthermore, choosing a small buffer is relevant whenever proximity to a disamenity determines the extent of the harm it causes, which is the case for the disamenities we consider. However, the choice of the buffer could influence the coefficients and the significance of the coefficients. In Table 18, we report the results of regressions over the same variables, but with different buffers for variables that are related to exposure to a disamenity. Columns 1, 3 and 5 have 500m buffers for all exposure variables except railways and highways (100m), and columns 2, 4 and 6 have 1km buffers for all exposure variables except railways and highways (500m).

	Dependent variable:					
	Site at most 500m away from the cell					
	Most restrictive set		Intermediary set		Least restrictive set	
	(1)	(2)	(3)	(4)	(5)	(6)
Log income	−0.298***	−0.289***	−0.312***	−0.294***	−0.216***	−0.203***
	(0.035)	(0.035)	(0.026)	(0.026)	(0.024)	(0.024)
Log density	−0.155***	−0.164***	−0.060***	−0.073***	−0.044***	−0.061***
	(0.008)	(0.008)	(0.003)	(0.003)	(0.003)	(0.003)
Social housing	0.199***	0.204***	0.141***	0.138***	0.186***	0.179***
	(0.028)	(0.028)	(0.024)	(0.024)	(0.023)	(0.023)
Large households	1.411***	1.377***	1.062***	1.033***	0.938***	0.919***
	(0.085)	(0.085)	(0.060)	(0.060)	(0.054)	(0.054)
Dump	0.496***	0.188***	0.539***	0.270***	0.574***	0.285***
	(0.021)	(0.033)	(0.015)	(0.021)	(0.014)	(0.019)
Treatment plant	0.353***	0.123***	0.405***	0.081***	0.409***	0.069***
	(0.026)	(0.026)	(0.016)	(0.020)	(0.015)	(0.018)
Quarry	0.279***	0.010	0.390***	0.063***	0.380***	0.066***
	(0.059)	(0.016)	(0.037)	(0.011)	(0.033)	(0.011)
Hazardous industrial site	0.151***	0.056***	0.109***	0.122***	0.120***	0.141***
	(0.046)	(0.013)	(0.034)	(0.010)	(0.031)	(0.009)
Polluting plant	0.095***	0.110***	0.121***	0.135***	0.117***	0.175***
	(0.024)	(0.013)	(0.017)	(0.009)	(0.016)	(0.009)
Polluted soil	0.109***	0.318***	0.133***	0.315***	0.147***	0.325***
	(0.014)	(0.020)	(0.011)	(0.014)	(0.011)	(0.013)
Railway	0.115***	0.110***	0.155***	0.135***	0.192***	0.175***
	(0.017)	(0.013)	(0.012)	(0.009)	(0.011)	(0.009)
Highway	0.372***	0.318***	0.394***	0.315***	0.418***	0.325***
	(0.035)	(0.020)	(0.022)	(0.014)	(0.021)	(0.013)
Aircraft noise	0.206***	0.201***	0.195***	0.182***	0.214***	0.197***
	(0.028)	(0.028)	(0.021)	(0.021)	(0.019)	(0.019)
Risk of flooding	0.010	0.006	0.054***	0.038***	0.074***	0.051***
	(0.018)	(0.018)	(0.012)	(0.012)	(0.012)	(0.012)
Buffer	500m/100m	1km/500m	500m/100m	1km/500m	500m/100m	1km/500m
Observations	154,050	154,050	298,493	298,493	356,764	356,764
Log Likelihood	−24,293.670	−24,187.320	−50,713.700	−50,508.040	−59,134.040	−58,724.350
Akaike Inf. Crit.	48,617.330	48,404.650	101,457.400	101,046.100	118,298.100	117,478.700
Note:						*p<0.1; **p<0.05; ***p<0.01

Table 18: Determinants of the location of sites within municipalities : robustness check using different buffers

4.3 Distribution of sites within municipalities: clustered standard errors

Sub-municipal level estimates are relatively insensitive to the clustering of standard errors, with municipalities as a cluster. The significance of socio-economic variables, as well as some exposure variables such as proximity to a dump or a treatment plant, remains unchanged. Some other exposure variables are more sensitive. Looking at column 1, exposure to a quarry, a hazardous industrial site and a polluting plant become only weakly significant when clustering standard errors.

4.4 Distribution of sites within municipalities: controlling for municipality area

	Dependent variable:		
	Site at most 500m away from the cell		
	Most restrictive set	Intermediary set	Least restrictive set
	(1)	(2)	(3)
Log income	-0.325^{***}	-0.343^{***}	-0.244^{***}
	(0.071)	(0.066)	(0.063)
Log density	-0.151^{***}	-0.057^{***}	-0.040^{***}
	(0.014)	(0.006)	(0.006)
Social housing	0.189^{***}	0.134^{***}	0.182^{***}
	(0.043)	(0.044)	(0.043)
Large households	1.428^{***}	1.083^{***}	0.953^{***}
	(0.119)	(0.109)	(0.105)
Dump	0.473^{***}	0.544^{***}	0.590^{***}
	(0.064)	(0.050)	(0.047)
Treatment plant	0.343^{***}	0.438^{***}	0.429^{***}
	(0.072)	(0.052)	(0.048)
Quarry	0.252^{*}	0.382^{***}	0.372^{***}
	(0.142)	(0.109)	(0.097)
Hazardous industrial site	0.284^{**}	0.178^{*}	0.191^{**}
	(0.118)	(0.097)	(0.089)
Polluting plant	0.124^{*}	0.152^{***}	0.139^{***}
	(0.066)	(0.053)	(0.049)
Polluted soil	0.101^{***}	0.136^{***}	0.149^{***}
	(0.035)	(0.032)	(0.031)
Railway	0.131^{***}	0.173^{***}	0.214^{***}
	(0.032)	(0.027)	(0.025)
Highway	0.381^{***}	0.402^{***}	0.429^{***}
	(0.071)	(0.052)	(0.048)
Aircraft noise	0.195^{**}	0.188^{***}	0.208^{***}
	(0.085)	(0.068)	(0.061)
Risk of flooding	0.023	0.069^{*}	0.089^{***}
	(0.044)	(0.036)	(0.034)
Cluster	Municipality	Municipality	Municipality
Number of clusters	1,454	1,482	1,485
Observations	154,050	298,493	356,764
Log Likelihood	−24,543.110	−51,276.740	−59,848.860
Akaike Inf. Crit.	49,116.220	102,583.500	119,727.700
Note:			*p<0.1; **p<0.05; ***p<0.01

Table 19: Distribution of sites within municipalities: clustered standard errors

Table 20: Determinants of the location of sites within municipalities

	Dependent variable:	
	Site at most 500m away from the cell	
	(1)	(2)
Municipality area		-0.330^{***}
		(0.005)
Log income	-0.244^{***}	-0.495^{***}
	(0.024)	(0.025)
Log density	-0.040^{***}	-0.071^{***}
	(0.003)	(0.003)
Social housing	0.182^{***}	0.063^{***}
	(0.023)	(0.024)
Large households	0.953^{***}	0.751^{***}
	(0.053)	(0.055)
Dump	0.590^{***}	0.569^{***}
	(0.019)	(0.020)
Treatment plant	0.429^{***}	0.447^{***}
	(0.021)	(0.021)
Quarry	0.372^{***}	0.372^{***}
	(0.049)	(0.050)
Seveso site	0.191^{***}	0.107^{**}
	(0.045)	(0.046)
IED site	0.139^{***}	0.116^{***}
	(0.022)	(0.023)
Polluted soil	0.149^{***}	0.094^{***}
	(0.013)	(0.014)
Railway	0.214^{***}	0.175^{***}
	(0.011)	(0.012)
Highway	0.429^{***}	0.389^{***}
	(0.020)	(0.021)
Aircraft noise	0.208^{***}	0.118^{***}
	(0.019)	(0.020)
Risk of flooding	0.089^{***}	0.066^{***}
	(0.012)	(0.012)
Observations	356,764	349,996
Log Likelihood	−59,848.860	−56,931.660
Akaike Inf. Crit.	119,727.700	113,895.300
Note:		*p<0.1; **p<0.05; ***p<0.01

5 References on Traveller sites in France for the discussion

5.1 Information on the hosting capacity prescriptions and achievements

– [1], p.1: "By the end of 2020, the capacity in Traveller sites amounted to 27,389 spots, representing 77% of total prescriptions [...]. In 22 departments [out of 96], the prescriptions have been fully met (100%)."
– [2], p.3: The current nationwide capacity remains below the prescription. The prescriptions have decreased by 25% over the years, while the creation of new spots has considerably slowed down since 2015.

5.2 Influence of the land pressure on planning decisions regarding Traveller sites

– [1], p.3: Map of the Traveller sites hosting capacity achievements/prescriptions ratio for all French departments. 15 departments have a 0-50% achievement/prescription ratio, Among them, 7 belong to the 10 most densely populated (for information on departments' density, see `https://www.insee.fr/fr/statistiques/5544529?sommaire=5435421`).
– [3],p.265: A representative of the department of Loiret justified the delay in terms of hosting capacity: "Some municipalities with limited land availability proposed sites in flood-prone areas, which were not approved by the State due to existing regulatory frameworks"
– [3],p.283: A representative of the department of Val-de-Marne justified the delay in terms of hosting capacity: "The significant constraints on available space in a department as small and densely populated as Val-de-Marne lead to the immediate exclusion of any possibility of hosting large gatherings."
– [4], pp.123-124: The department of Eure justified its delay in terms of hosting capacity by mentioning "urban planning constraints, low land availability [and] acceptability issues". The author argues that this merely reflects "political choices" in a department where numerous instances of discrimination against Travellers have been reported.
– [3], p.335: The mayor of a city, Aix-en-Provence, justified the remote location of the site in his municipality: "Local representatives face two contradictory issues: on one hand, the need to ensure that the location of sites, often on the outskirts, does not result in their isolation from the rest of the municipal [...] territory, and on the other hand, the land availability in this territory."
– [3], p.61: "The most expensive Traveller sites all required extensive road and utility work, which is generally linked to the decision by local authorities to situate these areas away from city centers and residential areas."

5.3 Prejudice against Travellers and its consequences on planning decisions

– [4], pp.161-163: The author cites a number of examples of hostile discourses of local representatives towards Travellers.
– [3], p.264: A representative of the department of Loiret mentioned examples of damages caused by Travellers in the department, stating that it "deterred the mayors from proposing long-term solutions".
– [3], p.270: The mayor of the city of Gien mentioned examples of damages caused by Travellers in the municipality.
– [3], p.311: A representative of the department of Loire-Atlantique mentioned that in two municipalities, Carquefou and Erdre-sur-Loire, inhabitants protested against the construction of Traveller sites. – [3], p.284: The distribution of Traveller sites can be seen as a NIMBY conflict. For instance, municipalities in the department of Val-de-Marne failed to find an agreement on which cities should host a site.
– [3], p.103: The nationwide occupancy rate of Traveller sites was 58.7% by December 15, 2010. – [4],

pp.138-139: The remote location of sites often reflects the political will to keep Travellers away from residential neighborhoods and the city center.

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