# The Impact of Different Polluting Site Typologies on Residential Real Estate Values: a Systematic Literature Review

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**Abstract.** This paper presents a methodical review of the scientific literature examining the relationship between different typologies of polluting sites and residential property values. The analysis distinguishes major categories of contamination sources, including landfills, incinerators, petrochemical plants and brownfields. This allows to explore how different environmental conditions affect housing market dynamics. Such a dynamic produces a synthesis of the empirical data the report identifies as recurring patterns and differences across studies as well as the main methodological approaches adopted in the selected academic papers, highlighting the varied effects of environmental risks on property prices. In recent years increasing attention to environmental quality and public health has strengthened the relevance of this topic in policy discussion.

For this reason, the review seeks to serve as a comprehensive reference for researchers, policymakers and practitioners, offering useful insights for urban planning and policy evaluation, particularly in contexts affected by environmental risk.

**Keyword:** Polluting Sites · Property Values · Environmental Risk

## 1 Introduction

Pollution caused by environmental issues has become a very complex challenge of our time, particularly due to its impact on urban systems, human health, economics and land use. Public awareness of these topics has been increasing since the 1970s, when a number of important events and publications helped to define the first shared international environmental agenda. The publication of The Limits to Growth by the Club of Rome in 1972, alongside the United Nations Conference on the Human Environment held in Stockholm, is generally regarded as an important turning point in the international debate [1, 2]. These events contributed to raising awareness of the risks associated with unsustainable urban economic growth and underscored the urgent need to reconsider prevailing development models.

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In the following decades, issues related to sustainability and intergenerational responsibility have increasingly become relevant within international environmental policies, starting from the Brundtland Report (1987) [3] up to the Rio Conference of 1992. At European level, this process has been accompanied by more and more integrated strategies, such as the Environment 2010 programme [4], which favoured the adoption of directives on air quality, waste management and soil protection. At the same time, the advancement of scientific disciplines has contributed to a more detailed and multidimensional understanding of pollution, thanks to environmental epidemiology, urban planning, health geography and environmental economics.

Pollution is now widely acknowledged as a key determinant of public health, as highlighted by the World Health Organization (WHO) guidelines [5] and the reports of the European Environment Agency [6]. Among the most studied forms, air pollution occupies a central position due to its direct correlation with morbidity and premature mortality. Pollutants such as fine particles (PM2.5 and PM10), nitrogen dioxide ($NO_2$) and tropospheric ozone ($O_3$) have been associated with an increased risk of cardiovascular, respiratory and neurological diseases [7]. In response to this evidence, the WHO has updated its standards in 2021 [5], proposing more restrictive thresholds, that have been implemented by the European Union with the 2024 Directive [8], foreseeing a realignment to the standards by 2030.

At a territorial level, the impact of pollution is highly uneven. Polluting industrial sites – such as steel plants, petrochemical facilities, coal-fired power plants, landfills and incinerators – constitute localised sources of environmental pressure, whose effects spread persistently over time and space. In Italy, studies such as the SENTIERI Project [9] and HEAPSS [10] have highlighted an excess of mortality and morbidity in the territories adjacent to Sites of National Interest (SIN) for environmental remediation [11], with significant correlations between exposure to contaminants and serious pathologies. Within the socio-economic and territorial context of Southern Italy, the city of Taranto can be considered as a paradigmatic case: over time, the long-standing presence of the former ILVA steel plant has contributed to a combination of environmental degradation, public health issues and social tensions, making it a relevant context for examining the interactions between environment, health and urban systems [6].

From a larger perspective, European experiences show different models for the management and regeneration of contaminated sites. In Germany the *Brachflächen* - that is, abandoned or underutilized brownfield sites - have been the focus of systematic reconversion strategies thanks to the cooperation between public institutions and private actors. Similarly, in the Netherlands, the *Nota Bodembeheer* program, introduced in the 1990s, anticipated the integration of environmental land registries with urban planning instruments, laying the groundwork for more coordinated land-use policies and sustainable redevelopment processes. The case of the city of Bilbao, in Spain, is often cited

as a relevant example of urban and environmental regeneration, with the transformation of the Nervión river, that crosses the Basque Country, from a degraded industrial area to an attractive hub [12], highlighting the role of long-term, multi-level governance approaches. By contrast, within the Italian context— particularly in Southern Italy— persistent structural issues remain, mainly related to regulatory fragmentation, the lack of unified governance frameworks and long procedural timelines. Significant examples include the so-called Land of Fires in Campania, the Sulcis area in Sardinia, several industrial zones in Sicily, and numerous SINs across the "Mezzogiorno" (Southern Italy).

Within this context, the concept of environmental justice plays a key role in understanding the unequal distribution of pollution. Originating in the United States in the 1980s [13], environmental justice concept highlights how the most vulnerable communities are often those more heavily exposed to environmental risks. This unequal exposure does not only affect health and social conditions but also has significant economic repercussions, particularly influencing the real estate market. In most cases, the presence of a polluting source is associated with a reduction of the residential attractiveness of an area, generating a decrease in property values that reflects the perception of danger, the loss of urban quality and landscape degradation [14].

This effect is not only related to physical contamination, but also to social risk perception, influenced by media coverage, direct experiences, community-based knowledge flows, and, more recently, the increasing availability of online data [15].

In line with these dynamics, younger generations - who tend to display greater sensitivity to environmental issues - are increasingly inclined to favour contexts perceived as healthier, even when this entails trade-offs with other housing attributes, such as price or dwelling size. At the same time, technological developments have increased environmental transparency: geoportals, air quality maps, environmental registries and open data platforms have made information widely accessible, thereby profoundly modifying housing demand patterns and influencing real estate price dynamics [16]. In this energetic context, information transparency emerges as an economic variable, affecting price formation to the same extent as the intrinsic characteristics of properties. To assess the impact of environmental factors on real estate values, urban economics has developed specific analytic tools. Among these, hedonic regression models [17] allow the breakdown of market prices into the contributions of individual property attributes, including environmental ones. Furthermore, the integration of these models with geospatial data via Geographic Information Systems (GIS) allow the accurate representation of the effects of proximity to polluting sources, highlighting market depreciation gradients and tolerance thresholds [18].

From a regulatory and urban planning perspective, the presence of a contaminated site has a significant impact on urban dynamics. Directive 2004/35/EC [19], transposed into Italian law by Legislative Decree 152/2006, introduced the so- called '*polluter pays*' principle, which governs the characterisation and remediation of contaminated sites. This regulatory framework imposes constraints on construction activity and urban regeneration strategies, requiring an economic assessment of environmental impacts to guide public policy decisions.

## 2 Aim

Within the above outlined context, this paper examines the existing literature on the impact of polluting sites on residential real estate values, with particular attention to spatial proximity, the type of pollution source and the perception of environmental risk in shaping market prices. The analysis is organised to differentiate findings according to the typology of polluting sites, making it possible to better understand how different sources of contamination - such as landfills, incinerators, thermoelectric power plants, petrochemical plants, brownfields, river and marine pollution, other polluting sources - affect property values and local housing markets.

The study draws on a set of international scientific contributions to outline the current state of knowledge regarding the consequences of major environmental hazards on real estate prices, encompassing both empirical findings and methodological approaches.

The analysis also aims to identify similarities and differences across studies, to highlight recurring interpretative frameworks and to uncover gaps and limitations in the literature for further investigations.

More specifically, this paper provides a consolidated reference for researchers, policymakers and practitioners by providing an overview of the relationship between environmental risk, market dynamics and urban planning. By integrating evidence from diverse geographic and regulatory contexts, the analysis not only maps existing knowledge but also identifies directions for future research, with potential implications for more informed and sustainable decision-making.

The following part of the paper is organised as specified below. Section 3 describes the methodology developed for the systematic analysis of the relevant literature, with the aim of selecting the contributions that discuss the main aspects of the topic in the various geographical contexts with reference to the different polluting site typologies.

Section 4 is dedicated to the presentation of the main outcomes and to a summary of the main issues outlined by the different Authors. Finally, in Sect. 5 the conclusions and future development are discussed.

## 3 The Methodology Adopted for the Literature Review Development

This research work is based on a systematic review of the national and international scientific literature aimed at analyzing the impact of polluting sites on residential property values. The methodology adopted - following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines - allows for a comparative analysis of the empirical evidence, correlating the type of polluting site with the nature of the impact on property value, its intensity and its persistence over time. Specifically, the analysis aims to assess whether the presence of the polluting site is associated with a reduction, increase or absence of significant changes in housing prices. The intensity of the impact refers to the magnitude of the price change, expressed in different studies in percentage terms, monetary terms or through spatial gradients related to the distance from the polluting site. Finally, the persistence of the impact concerns the temporal duration of the effect and evaluates whether and to what extent the site's influence on

the real estate market is evident only during certain phases (announcement, construction, operation, etc.) or persists over time, for example, after the plant's closure, or, conversely, diminishes following remediation and regeneration interventions. For the purpose of conducting a systematic review of the scientific literature on the impact of contaminated sites on residential property values, a corpus of 60 studies [20–80] was compiled by consulting the most important academic databases, in particular Scopus, Web of Science and Google Scholar. These databases were selected according to their ability to identify studies from various disciplinary fields connected to the wider topic (urban economics, real estate appraisal and valuation, land-use planning, environmental sciences, etc.), ensuring pluridisciplinary coverage of the topic. To ensure a broad investigation consistent with the research objective, specific keywords were identified and used in the literature search: "landfill", "incinerator", "power plant", "petrochemical plant", "refinery", "brownfield", "river pollution", "property values", "housing prices", "real estate", "hedonic pricing model", "spatial analysis" and "spatial econometrics". The keywords were combined through Boolean operators such as AND and OR in order to retrieve the most relevant contributions from the selected databases.

Starting from the initial set of identified documents, a progressive screening phase was carried out based on explicit inclusion and exclusion criteria. Specifically, here are the contributions that were included in the final set of retrieved research: (i) explicitly analyzing the relationship between the presence of/proximity to a polluting site and changes in residential property values; (ii) using observed data relating to prices/market values, rents or real estate transactions; (iii) adopting an empirical-quantitative approach, with estimates attributable to hedonic models, econometric approaches (including spatial ones) or comparable statistical analyses; (iv) providing information useful for comparative interpretation of the impact (e.g., magnitude of the effect, spatial extent of influence, contextual conditions).

Contributions were excluded if: (i) exclusively theoretical or descriptive, lacking empirical results on the real estate market; (ii) focused on non-residential properties without disaggregated evidence on the housing sector; (iii) addressing to pollution or environmental risk in general terms, without quantifying the effect on real estate prices/values; (iv) not available in full text or lacking sufficient methodological information for comparison.

The described selection process led to the definition of the final set of 60 contributions. The different macro-phases of the selection process—identification, screening and inclusion—are represented in the PRISMA diagram (Fig. 1).

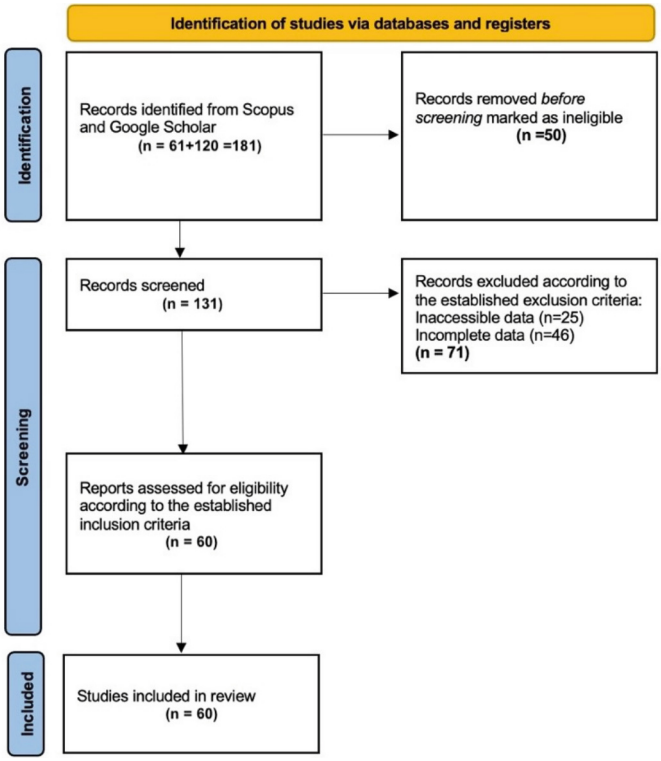


**Fig. 1.** PRISMA workflow

The selected articles were then examined to carry out a comparative analysis of the results of each collected paper. In line with the research objective, three main criteria were identified for the organization and interpretation of the literature: (i) the type of polluting site analysed; (ii) the nature of the impact on the property value, understood as a reduction, increase or absence of significant price variations; (iii) the intensity and persistence of the impact, referring respectively to the extent of the change in property values and the duration of the effect.

This methodological framework allows overcoming a mere descriptive review of case studies, providing a systematic and comparative overview of the available evidence and supporting the identification of recurring patterns, differences between site types and influencing factors (e.g., risk perception, socioeconomic context, operational life cycle, and quality of available information) that influence the capitalization of environmental impacts on the residential real estate market.

## 4 Results

On the basis of the objectives outlined above, a structured synthesis of the evidence emerging from the comparative review of the international literature is presented below.

Findings are organised according to the typology of polluting site (landfills, incinerators, thermoelectric power plants, petrochemical plants, brownfields, river and marine pollution, other polluting sources), and are examined in relation to spatial proximity, characteristics of the contamination source and the role of environmental risk perception in shaping residential property values.

### 4.1 Landfills

Landfills are one of the most studied types of polluting sites due to their impact on the real estate market. In many contexts, proximity to a landfill results in a significant reduction in property prices, due not only to direct effects – such as unpleasant odours, heavy vehicle traffic or landscape degradation – but also by the perception of environmental and health risks. The peripheries of Rome (Italy) are emblematic examples of the following observations: the Malagrotta landfill highlights the interaction between environmental mismanagement and socio-economic vulnerability. It shows that, without coordinated remediation and community engagement, property values may continue to decline over time, increasing spatial inequalities and constraining local development opportunities [20].

Looking at Franklin County (Ohio), the negative effects of landfills on nearby residential real estate prices endure over time, even after the site's closure, suggesting that environmental externalities can persist in collective memory and continue to influence property market valuation mechanisms [21].

South African academic studies have shown that the negative impact of landfills leads to progressive reductions in residential property values, with estimated loss ranging from 0.11% to 0.44% for every 100 m away from the facility, with stronger evident effects observed in more vulnerable market segments [22, 23].

Similar dynamics are also found in Romania: in fact, in a neighborhood in Bucharest suburbs, property values near the landfill declined by 31.2% [24].

In developing contexts, such as in the case of Lagos (Nigeria), different studies have shown that the impact is selective, disproportionately affecting certain market segments - often those with lower levels of protection and access to information - thereby creating spatial inequalities in property value depreciation [25]. Moreover, North American literature offers numerous confirmations: in Minnesota a reduction in prices of up to 12% has been highlighted [26], whereas in the Cleveland metropolitan area losses between 5.5% and 7.3% have been estimated, depending on the distance and the type of landfill [27]. A synthesis of these findings has been provided by a meta-analysis of 125 cases in the United States: an average loss of 13.7% has been assessed in the district of high-volume landfills, demonstrating that the intensity of the facility plays a crucial role in determining the effect on the market [28]. The composition and typology of waste also have a crucial function: in Toledo (Spain) Smolen et al. have observed that for every mile closer to a landfill containing hazardous waste, a property can lose up to USD 14,200 in value [29]. Finally, the case of Tseung Kwan in Hong Kong attests that the effect of the presence of a landfill on residential market is not uniform. By using big data techniques, the study of Li et al. [30] has detected that while apartments exposed to winds coming from the landfill suffer a depreciation, the selling price of units not affected by the odours, within the same complex, increases, likely due to a media effect driven by widespread complaints. This advertising effect highlights that the perception

of pollution is also shaped by indirect factors and suggests that, in addition to distance, other variables should be considered, such as wind direction, building characteristics, morphology and local market. Taken together, the available evidence shows that while landfills systematically affect property values, the magnitude and distribution of these effects are influenced by socio-economic, technological and cultural contexts.

### 4.2 Incinerators

Another type of polluting industrial issue discussed in the literature refers to incinerators. Municipal solid waste incinerators are among the most debated types of plants in environmental dissertations, due to concerns related to emissions and potential health risks, as well as their impact on the perceived quality of the urban setting. For this reason the real estate market is often considered a sensitive and reactive indicator of their presence. A relevant case can be observed in China, where the Nengda municipal incineration plant has led to a reduction of up to 25.9% on the housing asking price located within a three-kilometer radius, with the effect gradually decreasing with distance [31]. In the Czech city of Liberec, a statistically significant reduction in properties values in the area surrounding the city of Termizo a.s. plant has been evidenced as follows: the effect decreases with distance but remains detectable over several kilometres [32]. In North American contexts, the literature has explored the dynamics related to both the construction and operational phases of incinerators. Studies on the North Andover plant in Massachusetts have highlighted how the impact is more marked in the initial phases (pre- announcement, construction and commissioning), with an estimated loss of USD 2,283 per mile during construction, which increases to USD 8,100 at the time of opening and stabilizes around USD 6,607 in the operational phase [33, 34]. These outcomes are confirmed by Zeiss [35], which has investigated the effect of the Salem incinerator (Oregon) on real estate market, finding a moderate but stable reduction in property selling values, especially in the period between the announcement and the start of operation. More broadly, a meta-analysis of over 75 peer-reviewed studies on pollution sources and environmental degradation has indicated that incinerators are among the facilities with a significant negative effect on property values, although the strength of the effect depends on the visibility of the plant, the quality of available information and the urban context [36].

Particularly interesting is also the case study conducted in Phuket, Thailand, where the municipal incinerator has been perceived negatively by the resident population, due to emissions and fear of health effects, negatively influencing the perceived value of neighboring properties, as documented in the analysis carried out with a risk perception assessment approach [37]. Finally, the French case study comparing three different plants located in urban areas, suggests that the loss of real estate value can vary between 0.4% and 1.3%, depending on the distance, the presence of visual barriers and the technological efficiency of the site [38]. Incinerators produce effects that, while not always macroscopic, are systematically negative for the housing value, especially where the information environment is uncertain or risk communication is lacking. Unlike other polluting plants, however, their impact also appears to be modulated by factors such as the phase of the plant's life cycle, the presence of mitigation infrastructure and the

perceived fairness in the distribution of energy benefits compared to the environmental costs borne by local communities.

### 4.3 Thermoelectric Power Plants

With reference to thermoelectric power plants, public interest is currently focused on the contrast between energy needs and social acceptance of environmentally intensive infrastructures. One of the most analyzed cases concerns the United States: it has been estimated that the opening of 92 large fossil fuel power plants in the 1990s has led to a reduction in property values of between 3% and 7% within a two-mile radius of the plant. The effect has been particularly relevant near the largest capacity plants and has been accompanied by a lowering of average income, education and home ownership levels in adjacent areas [39]. A similar case has been documented in China where Deng et al. [40] have studied the positive effect on the real estate market resulting from the closure of two coal-fired power plants in a large city: the removal of the plants has caused an immediate increase in housing prices ranging from 12% to 14% within a 5 km radius, along with an increase in transactions of up to 31%, confirming the negative impact that these plants have determined on the market. In South Korea, Kim et al. have shown that proximity to a gas-fired power plant has led to an average price reduction of about 8 million won per kilometer (about USD 7,100 per kilometer), equal to 0.7% of the average value of the apartments analyzed, in a highly densified urban context with increasing housing demand [41].

Significant effects also emerge in the European context: analyzing over 1.5 million real estate transactions in the Netherlands, Eichholtz et al. have found that gas-fired power plants generate a systematic negative effect on residential prices in surrounding areas, with a particularly visible dynamic in urban contexts. The study compares the effect of coal, gas, biomass and wind turbine plants, showing that gas-fired plants lead to reductions similar to those observed for wind farms, while biomass plants show positive effects only when located in areas with low initial values [42].

A research in Manama (Bahrain) estimates that air pollution, largely attributed to thermoelectric production, accounts for about 16.7% of the variation in real estate prices in the metropolitan area, highlighting the link between energy production, air quality and market dynamics [43].

On the contrary the Indian case of Kalisindh Thermal Power Project [44] shows a complex evolution: while the opening of the power plant has brought benefits in terms of employment and infrastructure, it has also fuelled real estate speculation and local variations in land prices, making it difficult to define a clear overall impact on housing values.

In Finland there is an emerging topic: the integration of local heat production within district heating networks, as a more decentralized alternative to large thermoelectric power plants. Although the study does not directly measure real estate value, it suggests that increased thermal efficiency and reduced operating temperatures may also lead to improve in residential quality.

From a political and territorial perspective, the analysis carried out by Cowell [46] has investigated the location of gas-fired power plants in the UK from 1988 to 2019, showing how they have often occupied areas previously dedicated to coal or oil plants,

thus avoiding the most bitter conflicts but still contributing to the reproduction of a high-carbon energy system. Finally, a regional experimental study conducted in China [47] has confirmed that the negative perception associated with gas-fired power plants has a persistent effect on housing prices, regardless of the size of the plant and its efficiency, proving that perceived unattractiveness plays a decisive role in real estate dynamics.

### 4.4 Petrochemical Plants

An increasingly discussed aspect in the relevant literature, especially in urban or semi-urban contexts where such infrastructures coexist with residential settlements, concerns the impact of petrochemical plants and the oil & gas sector on the real estate market. Studies conducted in densely industrialized areas have shown how proximity to refineries, gas pipelines, liquefaction plants and petrochemical hubs significantly influences housing values, although this effect can take different directions, depending on the socioeconomic context, environmental conditions and the population's perception of risk.

A strongly noted case is in the United States, where two petrochemical refineries have been associated with a significant reduction of nearby real estate, particularly as a function of the distance from the plant and the presence of significant events (such as accidents or environmental disputes). In this context, several studies report a more pronounced negative capitalization effect in lots adjacent to refineries, which is only partly reduced by the presence of buffer zones [48]. Proximity to refineries is associated with a statistically significant increase in a dangerous cancer risk, particularly for lymphoma and bladder cancer, with the most severe and critical effects observed within 10 miles of the plants: this criticity emerges from the analysis of data from 6.3 million Texas residents [49]. The implications for the study of the real estate market are indirect but relevant, since perceived health risks can significantly influence housing demand.

An emblematic paradoxical effect is being observed on Bonny Island in Nigeria. In fact, the presence of oil and liquefied natural gas facilities (such as those operated by Shell and Exxon Mobil) has led to rising property values, due to increased employment, improved infrastructure and strong housing demand from incoming workers. However, concerns have been highlighted about a speculative dynamic, aggravated by a lack of regulation and potential long-term environmental damage, including oil spills and air pollution [50]. Similarly, in East Malaysia, the project to establish a petrochemical hub has generated initial uncertainty on the local real estate market, with depressive effects in the pre-announcement phase, which were later partially recovered thanks to the construction of new infrastructures. Also in this case, the perceptual factor and institutional communication played a decisive role [51].

An additional element that affects real estate values trends is the history of industrial accidents which can shape the reputation of a territory and affect market perceptions.

For instance, a study by the University of Texas [52] on Teesside in the UK has highlighted how neighbourhoods closer to large industrial complexes show higher mortality rates from lung cancer and respiratory diseases, especially among women, thus fuelling a negative territorial image that is reflected in property values.

In a more strictly economic context, the operational flexibility of refineries - that is, their ability to adapt production according to crude oil and derivatives prices – not only affects the resilience of the industrial asset, but also shapes the expectations of real estate

investors in surrounding areas [53]. In a doctoral thesis at Birkbeck College [54], this issue is examined from a financial point of view, with valuation models developed for the Vadinar refinery in India, demonstrating that environmental risks and the volatility of refined product prices significantly affect the site's assessment as a "neighborhood" for potential real estate investors. Using a multivariate analysis, Martin and Reed [55] show that the negative externalities associated with refineries are perceived more strongly in low-income areas, where residents have limited resources to mitigate or avoid exposure, which reinforces spatial and social disparities in property values.

Taken together, the available evidence suggests that petrochemical and oil & gas plants have a differentiated impact on the real estate market. In some contexts, the effect is negative, especially where environmental risk is strongly perceived and not compensated by visible economic benefits, while in other cases the impact can be neutral or even positive, particularly when these infrastructures support local development and employment, provided that environmental management is effective and communication between companies, institutions and local communities is transparent [56, 57].

### 4.5 Brownfields

Brownfield sites, as they are commonly known, are regarded as a major challenge in urban regeneration. At the same time, they can also present an opportunity to restore and revitalize severely degraded areas without contributing to uncontrolled urban sprawl.

If managed appropriately, the regeneration of brownfield sites can support local economic growth, improve environmental conditions and contribute to social cohesion, transforming underused areas into productive urban spaces.

Several studies show that the remediation and redevelopment of these areas can have positive effects on the real estate market, particularly when supported by targeted planning interventions. For example, in Cuyahoga County, Ohio, a relevant research has found that housing prices increase significantly after brownfield rehabilitation, with particularly marked effects in low- and moderate-income neighborhoods. In these contexts, the conversion of contaminated sites into residential, commercial or recreational areas has led to an increase in the perceived value of the district, also thanks to the improvement of environmental quality and the reduction of the negative connotation associated with pollution [58]. Similarly, a nationwide analysis in the United States have estimated that property values near sites redeveloped under the federal Environmental Protection Agency program increased on average between 5% and 11.5%, reaching up to 15% in the most successful cases [59].

In England, a significant effect on the most deprived neighborhoods, both by increasing housing values and by reducing urban marginalization, has been associated to the residential redevelopment of brownfield sites. Specifically, between 2001 and 2008, the most disadvantaged districts experienced a 25% increase in regenerated surface area, accompanied by parallel improvements in socio-economic indicators [60]. Building on these findings, analysis of English cities have also showed that the probability of redeveloping a brownfield site responds elastically to housing prices: a 21% increase in prices can incentivise the regeneration of most brownfields, suggesting that residential policies can play a propulsive role in fostering sustainable urban densification [61]. Similarly, from a United States perspective, the Northeast-Midwest Institute summarizes the environmental, economic and fiscal benefits of brownfield regeneration, including higher

property values, new local tax revenues and infrastructure cost savings compared to greenfield development [62].

Similarly, in New Jersey, studies indicate that amended brownfields can meet part of the demand for affordable housing, particularly for more vulnerable and weak social groups. About 14% of respondents are willing to live on a previously contaminated site, provided that the site has been properly reclaimed, with stronger preferences observed among younger individuals and lower-income households [63].

Another relevant aspect concerns the relationship between risk perception and property value variations: although the negative effects of environmental stigma tend to decrease after restoration, property values are also influenced by factors such as trust in the decontamination process, information transparency and the future use planned for the site [64].

In this regard, evidence from Canadian and U.S. cases suggests that effective brownfield regeneration, particularly when supported by effective planning strategies and community involvement, can result in property value increases of up to 30% [65].

### 4.6 River and Marine Pollution

In the literature considered in this study, river and marine pollution is examined as an environmental issue that significantly influences property values, particularly in coastal areas and along urban waterways. Degradation of water quality, in fact, affects both the direct use of aquatic ecosystems and the perceived aesthetic and health quality of the surrounding residential environment, and directly influences housing prices. A study conducted in Narragansett Bay (Rhode Island, United States) shows that high chlorophyll concentrations - an indicator of eutrophication - negatively influence housing prices up to one kilometer from the coast. Real estate values appear more sensitive to acute pollution events, such as algal blooms or fish kills, than to annual average levels. The spatial and temporal impact is significant, with estimated losses ranging from USD 18 million to USD 136 million for the entire coastal strip in scenarios of declining environmental quality [66].

Similar results are reported in the study by Bin and Czajkowski [67] in which technical and perceptual indicators of water quality in Florida (United States) have been compared.

The study finds that objective measures, such as nutrient concentration or dissolved oxygen levels, provide more robust and reliable predictions of real estate marketeffects than subjective indices based on site appeal. Similarly, in Chesapeake Bay within the same national context, Leggett and Bockstael show the important role of watershed environmental quality in determining waterfront property values, with reductions in water clarity causing depreciation of up to 7% [68].

Also in river area, the link between water quality and real estate market is clear: the study carried out by Poor et al. [69] on rivers and lakes in Wisconsin (United States) has quantified an increase in value of up to 16% for each improvement in ecological status (from “polluted” to “acceptable”), showing the responsiveness of the remediation interventions.

Another important pollution effect is caused by agricultural wastewater, which produces a localised decline in property prices near river confluences, for example the

Danube and Rhine basins (European rivers), particularly where environmental degradation is greatly evident: turbid water or damaged riparian vegetation. For this reason homes lose visual or recreational access to watercourses [70].

Conversely, the rediscovery and renaturalisation of riverbeds referring to buried watercourses in Los Angeles led to property value increases of over 10% for nearby homes; this is an example of how environmental restoration can mitigate and avoid long-term declines associated with pollution [71]. More recently, a study of coastal areas in China, based on a spatial approach and machine learning techniques, found that the presence of marine litter and microbiological contaminants reduces property values, with effects varying according to tourist seasons and visual exposure [72].

Overall, these findings highlight a broader issue addressed in the theoretical literature: the economic quantification of damage caused by marine contamination is still underestimated, due to difficulties in distinguishing between direct uses of the ecosystem (such as bathing and fishing) and its intrinsic or existence value. Nevertheless, initial attempts at monetary valuation indicate substantial and persistent effects on private property values, particularly in densely populated areas and regions subject to heavy tourist pressure [73].

### 4.7 Other Polluting Sources

Recent studies have considered additional types of sites together with the primary sources of environmental pollution. Although these belong to categories that have been considered less systematically, they may still have a significant impact on property values in nearby areas. This applies, for example, to disused military areas, which are often affected by contamination from heavy metals, fuels or munitions, making their reuse particularly challenging [74]. Consistent with these findings, a study conducted in Germany shows that regeneration initiatives involving former North Atlantic Treaty Organization (NATO) installations—although often complex—can contribute to a gradual recovery in real estate prices in medium-sized cities such as Augsburg and Mannheim, particularly when remediation processes are carried out effectively and communicated transparently to the public [75].

Another category concerns disused mining areas and quarries, where landscape degradation is frequently accompanied by environmental risks related to soil and groundwater contamination, further influencing the dynamics of surrounding property markets [76]. In this context, Weber and Christophersen show that the presence of abandoned mines can reduce the value of nearby assets by up to 20%, with negative effects that persist even after mining activities have ended [77]. Similar findings emerge from studies conducted in Peru, which show that mining operations can generate long- lasting adverse impacts on residential selling prices. These effects tend to decrease only when environmental remediation measures and social compensation programs are effectively implemented [78].

Finally, intensive agricultural sites—particularly those associated with industrial livestock farming, such as Concentrated Animal Feeding Operations (CAFOs)—can also generate negative externalities, including odours, liquid waste and nitrate pollution. Empirical studies conducted in a North American context [79, 80] have documented a significant decrease in property values in rural areas of Iowa located near CAFO facilities. This suggests that even forms of pollution not directly linked to industrial production,

but rather to land use practices and natural resource management, can substantially affect local residential real estate markets, especially in contexts where regulatory frameworks and information transparency are limited.

## 5 Conclusions

This paper not only analyses the basic aspects linked to the relationships between different typologies of polluting sites and residential property values, but also identifies the main mechanisms through which environmental contamination influences housing market dynamics. The review is organised according to the main categories of contamination sources with the aim of understanding how different environmental hazards affect local residential systems.

The analysis of the selected studies highlights that the impact on property values is consistently negative in most cases, although its magnitude and persistence vary significantly across site typologies. In particular, landfills emerge as one of the most penalizing factors, with property value reductions often ranging between 5% and over 30%, and with effects that may persist even after site closure. Incinerators show generally moderate but systematic negative impacts, often concentrated in the pre-operational and construction phases. Thermoelectric power plants are associated with price decreases typically between 3% and 7% in surrounding areas, although these effects may be partially reversible following plant decommissioning.

By contrast, petrochemical plants and oil-related infrastructures present more heterogeneous outcomes: while negative impacts prevail in contexts characterized by high environmental risk perception, neutral or even positive effects may occur where economic benefits and employment opportunities offset environmental externalities.

A different pattern is observed for brownfield sites, where remediation and redevelopment processes are generally associated with increases in property values, commonly ranging between 5% and 15%, and reaching higher levels in the most successful regeneration cases. Similarly, environmental quality improvements in river and coastal areas produce measurable positive effects on housing prices, while pollution events generate significant economic losses.

Overall, the findings confirm that the effect of polluting sites on residential real estate values is not determined solely by physical contamination, but rather by a combination of factors including risk perception, information availability, socio-economic conditions and the lifecycle stage of the site.

Relevant international academic contributions have been examined focusing on the current body of knowledge on the effects of environmental risks on property prices, highlighting heterogeneous impacts: both common patterns and differences across contexts have been considered. This topic is part of a broader and increasingly relevant public debate. The future research may benefit from more systematic comparative analyses of different types relating to contaminated sites, in order to better understand the conditions under which their impacts on property values become more or less pronounced [81].

Another area for future research concerns the integration of real estate valuation techniques with advanced spatial and temporal analytical tools, which can help capture both the localized distribution of impacts and their evolution over time. More attention

could also be given to the role of remediation policies, urban regeneration processes, and institutional and official communication strategies, as these factors influence market expectations and the perception of environmental risk. From this point of view, the intersection of economic evaluation, spatial planning and environmental governance represents a promising direction for supporting more informed and sustainable decisions in urban transformations [82].

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## References

1. Meadows, D.H., Meadows, D.L., Randers, J., Behrens, W.W.: The Limits to Growth: A Report for the Club of Rome's Project on the Predicament of Mankind. Universe Books (1972)
2. United Nations: Report of the United Nations Conference on the Human Environment. UN Publications (1972)
3. World Commission on Environment and Development: Our Common Future. Oxford University Press (1987)
4. European Commission: Environment 2010: Our Future, Our Choice – The Sixth Environmental Action Programme. Publications Office of the European Union (2001)
5. World Health Organization: Global Air Quality Guidelines. WHO (2021)
6. European Environment Agency: Air Quality in Europe – 2022 Report. Publications Office of the European Union (2022)
7. The lancet public health: air pollution and health. Lancet Publ. Health **2**(1), e4–e5 (2017)
8. European Union: Direttiva UE sulla qualità dell'aria. https://www.epicentro.iss.it/ambiente/direttiva-ue-qualita-aria-2024. Accessed 29 Mar 2026
9. Ministero della Salute – Istituto Superiore di Sanità: Progetto SENTIERI. Epidemiologia & Prevenzione, Suppl. 3 (2010)
10. ISPRA: Annuario dei dati ambientali. Istituto Superiore per la Protezione e la Ricerca Ambientale, Roma (latest edn.)
11. Consulcesi: Inquinamento atmosferico e salute: dati aggiornati per l'Italia. https://www.consulcesi.it. Accessed 29 Mar 2026
12. Bartke, S., Schwarze, R.: Urban land and soil in European environmental policy. Land Use Policy **48**, 176–183 (2015)
13. Zuin, V., Bedogni, T., Cecchetti, G.: Environmental justice and risk perception: a European overview. Sustainability **3**(2), 234–249 (2011)
14. Boyle, M.A., Kiel, K.A.: A survey of house price hedonic studies of the impact of environmental externalities. J. Real Estate Lit. **9**(2), 117–144 (2001)
15. Gayer, T., Viscusi, W.K.: Housing price responses to newspaper publicity of hazard risks and the EPA's Toxic Release Inventory. J. Environ. Econ. Manag. **43**(3), 272–292 (2002)
16. Ready, R.C., Abdalla, C.W.: The amenity and disamenity impacts of agriculture. Am. J. Agr. Econ. **87**(2), 314–326 (2005)
17. Rosen, S.: Hedonic prices and implicit markets: product differentiation in pure competition. J. Polit. Econ. **82**(1), 34–55 (1974)
18. Bastian, C.T., Keske, C.M., Hoag, D.L.: Spatial effects in hedonic property valuation models incorporating environmental disamenities. Ecol. Econ. **132**, 268–276 (2017)

19. European Union: Directive 2004/35/EC on environmental liability. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32004L0035. Accessed 29 Mar 2026
20. Barbieri, M., Sappa, G., Vitale, S., Parisse, B., Battistel, M.: Soil control of trace metals concentrations in landfills. J. Geochem. Explor. **143**, 146–154 (2014)
21. Hite, D., Chern, W., Hitzhusen, F., Randall, A.: Property-value impacts of an environmental disamenity: the case of landfills. J. Real Estate Financ. Econ. **22**(2), 185–202 (2001)
22. du Preez, M., Lottering, T.: Determining the negative effect on house values of proximity to a landfill site by means of an application of the hedonic pricing method. South Afr. J. Econ. Manag. Sci. **12**(2), 256–262 (2009)
23. du Preez, M., Balcilar, M., Razak, A., Koch, S.F., Gupta, R.: House values and proximity to a landfill in South Africa. J. Real Estate Lit. **24**(1), 133–149 (2016)
24. Gradinaru, G.I., Ioan, I.: Estimating the impact of landfill proximity on the value of real estate goods. Amfiteatru Economic **14**(31), 38–45 (2012)
25. Arimah, B.C., Adinnu, F.I.: Market segmentation and the impact of landfills on residential property values: empirical evidence from an African city. Netherlands J. Housing Built Environ. **10**(2), 157–171 (1995)
26. Nelson, A.C., et al.: Price effects of landfills on house values (1992)
27. Reichert, A.K., Small, M., Mohanty, S.: The impact of landfills on residential property values (1992)
28. Ready, R.: Do landfills always depress nearby property values? (2010)
29. Smolen, G.E., Moore, T., Conway, D.: Economic effects of hazardous waste landfills (1992)
30. Li, R.Y.M., Li, H.C.Y.: Have housing prices gone with the smelly wind? Sustainability **10**, 341 (2018)
31. Zhao, Q., Simons, R.A., Li-jun, F., Fen, Z.: The effect of the Nengda incineration plant on residential property values. J. Real Estate Lit. **24**(1), 85–102 (2016)
32. Humpolová, Š.: Evaluation of the Impact of Incinerator Proximity on Property Values. Masaryk University (2018)
33. Kiel, K.A., McClain, K.T.: House prices during siting decision stages. J. Environ. Econ. Manag. **28**(2), 241–255 (1995)
34. Kiel, K.A., McClain, K.T.: The effect of an incinerator siting on housing appreciation rates. J. Urban Econ. **37**(3), 311–323 (1995)
35. Zeiss, C.: Property value impacts of an incinerator facility. J. Urban Plan. Dev. **116**(2), 52–67 (1990)
36. Simons, R.A., Saginor, J.D.: A meta-analysis of environmental contamination impacts. J. Real Estate Res. **28**(1), 71–104 (2006)
37. Adisak, et al.: Valuing risk perception and disamenity of incinerator: a case study (n.d.)
38. Rivas-Casado, M., Serafini, J.: Assessing the impact of incineration plants on housing markets in the UK (2016)
39. Davis, L.W.: The effect of power plants on housing values. Rev. Econ. Stat. **93**(4), 1391–1402 (2011)
40. Deng, G., Hernandez, M.A., Xu, S.: Environmental quality and housing markets in China. Environ. Resour. Econ. **77**, 751–780 (2020)
41. Kim, J.-H., Kim, Y.-K., Yoo, S.-H.: Power plant proximity and housing values. Energies **16**, 1983 (2023)
42. Eichholtz, P., Kok, N., Langen, M., van Vulpen, D.: Clean electricity and house prices. J. Real Estate Financ. Econ. **66**, 743–777 (2023)
43. Buhammoud, S.R., El-Kholei, A.O., Al Ubaydli, O.: Air pollution and real estate prices. Arab Gulf J. Sci. Res. **38**(3), 172–188 (2021)
44. Karra, R., Mishra, P.N., Jain, P.: Economic impact of a thermal power project. Ind. J. Soc. Polit. Sci. **4**(3), 75–86 (2017)

45. Penttinen, P., et al.: District heat production and real estate investments. J. Sustain. Dev. Energy **9**(2), 1080343 (2021)
46. Cowell, R.: The role of place in energy transitions. Geoforum **112**, 73–84 (2020)
47. Garriga, C., et al.: Migration and housing markets in China. Am. Econ. J. Macroecon. **15**(2), 413–440 (2023)
48. Flower, P.C., Ragas, W.R.: The effects of refineries on property values. J. Real Estate Res. **9**(3), 319–338 (1994)
49. Williams, S.B., et al.: Proximity to oil refineries and cancer risk. J. Natl. Cancer Inst. **112**(10), 978–986 (2020)
50. Jumbo, A., Ihuah, P.W.: Oil and gas industry and residential property values. Int. J. Innov. Environ. Stud. Res. **12**(1), 19–28 (2024)
51. Cheng, E.K., Chin, Y.S.: Petrochemical hubs and housing prices. INSPEN (2010)
52. Bhopal, R.S., et al.: Living near petrochemical industries and health. Occup. Environ. Med. **55**(12), 812–822 (1998)
53. Dong, H., Liao, W., Gu, Q.: Flexibility of oil refineries under price uncertainty. Energy Econ. **42**, 271–280 (2014)
54. O'Driscoll, P.J.: Financial valuation of an oil refinery. PhD Thesis, University of London (2016)
55. Martin, D., Reed, R.: Environmental risks and real estate value. Working Paper (2005)
56. INSPEN: Petrochemical hub and property value. Research Monograph (2010)
57. Institute for Corporate Real Estate: Corporate real estate and sustainability reporting (2011)
58. Woo, A., Lee, S.: Brownfield redevelopment and housing prices. Environ Plan A **48**(6), 1107–1132 (2016)
59. Haninger, K., Ma, L., Timmins, C.: The value of brownfield remediation. J. Assoc. Environ. Resour. Econ. **4**(1), 197–241 (2017)
60. Schulze Bäing, A., Wong, C.: Brownfield residential development. Urban Stud. **49**(14), 2989–3008 (2012)
61. Carozzi, F.: Estimating the house price elasticity of brownfield redevelopment (n.d.)
62. Paull, E.: Impacts of brownfields redevelopment. Northeast Midwest 9 (2008)
63. Greenberg, M., et al.: Brownfield redevelopment as a smart growth option. Environmentalist **21**(2), 129–143 (2001)
64. Gallagher, D.R., Jackson, S.E.: Community involvement at brownfields sites. J. Environ. Plan. Manage. **51**(5), 615–630 (2008)
65. De Sousa, C.: Brownfield vs greenfield development. J. Environ. Planning Manage. **43**(6), 831–853 (2000)
66. Liu, T., Opaluch, J.J., Uchida, E.: Water quality and housing prices. Water Resour. Res. **53**(8), 6454–6471 (2017)
67. Bin, O., Czajkowski, J.: Water quality and coastal housing values. Ecol. Econ. **85**, 213–221 (2013)
68. Leggett, C.G., Bockstael, N.E.: Water quality and residential land prices. J. Environ. Econ. Manag. **39**(2), 121–144 (2000)
69. Poor, P.J., Pessagno, K.L., Paul, R.W.: Hedonic value of water quality. Ecol. Econ. **60**(4), 797–806 (2001)
70. Klemick, H., et al.: Water quality and real estate in Europe. Sci. Rep. **13**, 39022 (2023)
71. Saphores, J.D.M., Li, W.: Value of urban stream restoration. Urban Stud. **49**(14), 3277–3295 (2012)
72. Liu, Y., et al.: Marine pollution and housing prices. Sustainability **15**(1), 500 (2023)
73. Boyle, K.J., Parmeter, C.F., Pope, J.C.: Assessing damages to contaminated property. Risk Anal. **26**(3), 635–650 (2006)
74. McGrath, D.T.: Industrial land redevelopment and contamination risk. J. Urban Econ. **47**(3), 414–442 (2000)

75. Wenger, A., Möckli, D.: NATO and European identity. In: Routledge Handbook of Transatlantic Security, pp. 103–122. Routledge (2010)
76. Stolz, R., Rink, D., Külke, M.: Re-use of former military areas. Urban Res. Pract. **12**(2), 153–171 (2019)
77. Weber, B., Christophersen, A.: Mining brownfields and policy approaches. Environ. Pract. **4**(4), 209–218 (2002)
78. Aragon, F.M., Rud, J.P.: Pollution and economic growth. Econ. J. **126**(597), 939–963 (2016)
79. Herriges, J.A., Secchi, S., Babcock, B.A.: Livestock facilities and property values. Land Econ. **81**(4), 530–545 (2005)
80. Kim, J., Goldsmith, P.D.: Swine CAFOs and property values. Environ. Resource Econ. **42**(4), 509–534 (2009)
81. Gerelli, E.: Mobilità urbana, congestione e inquinamento. Economia Italiana 1 (2002)
82. Bettoni, M.: Prevenzione degli effetti sanitari dell'inquinamento atmosferico. Annali Istituto Superiore di Sanità **36**(3), 263–266 (2000)