Master's Thesis of City Planning

# The Relationship Between Resident Compensation and the Disamenity of the Seoul Metropolitan Area Landfill

## 수도권매립지 유발 비효용에 주민지원금이 미치는 효과

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# The Relationship Between Resident Compensation and the Disamenity of the Seoul Metropolitan Area Landfill

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# Abstract

Landfills, although essential, face constant opposition and NIMBY fears from local residents. The Seoul Metropolitan Area Landfill is no exception from this phenomenon despite its necessity, as a large proportion of South Korea's waste is being managed in its facilities. With the deadline of the landfill's usage looming, the authorities must find an alternative site willing to accept the siting of a new landfill or convince residents living near the current landfill to accept an extension of the landfill. Since both solutions require increasing the willingness-to-accept (WTA) the landfill by residents, the framework adapted by this study uses the real transaction data of apartments within a 5km radius of the Sudokwon landfill. The hedonic price method is used to determine the correlation between the distance to the landfill and property prices, and whether compensation programmes carried out by the developers have any effect. Results show that the landfill does actually depress property prices, at 1.06 million KRW per 100m of proximity to the landfill. However, examining the interaction with compensation shows that the amount of compensation has a negative correlation with the relationship the landfill has with property price. This may be due to the effectiveness of the compensation programme offsetting the environmental disamenity caused by the landfill. Nonetheless, policymakers must be wary of the fact that the distance to the landfill is a minor determinant of price compared to other characteristics, presumably due to the advanced technology of the landfill decreasing the amount of disamenity caused in the first place. This implicates that although compensation programmes are crucial, addressing the social stigma surrounding the landfill is also important and caution must be taken when setting compensation programmes to ensure that protesters do not begin protesting for the sake of opposition or for compensation.

Keywords : Sudokwon landfill, hedonic price approach, compensation, environmental valuation, LULU, NIMBY
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# Chapter 1. Introduction

## 1.1. Research Background and Purpose

Landfills, in every step of its controversial existence – from construction to operation – face strong opposition from local communities, its presence considered a locally unwanted land use (LULU). Nonetheless, its necessity is undisputable, as landfills remain one of the main methods of municipal waste management. Although many accept the theoretical necessity of its existence, it remains a point of conflict for local authorities and residents, causing the so-called NIMBY or "not in my backyard" phenomenon. The phenomenon occurs because landfills show features of both a public good and a private bad (Feinerman et al., 2004). Conflict is heightened in cases where waste is accepted from areas outside of the municipal area the landfill is located in. In 2020, 195.460 million tonnes of waste were produced in South Korea in 2020, of which 70.55 million tonnes were from the Seoul Metropolitan Area (KEC, 2020). When this statistic is put in context, more than 30% of the waste produced in South Korea is from the Seoul Metropolitan Area. Although this percentage is small relative to the proportion of South Korea's population living in the area, the benefits of having the proper infrastructure to manage waste in the Seoul Metropolitan

Area is clear, as to ensure no public crisis arises from 30% of South Korea's waste being left unmanaged. Nonetheless, the benefits are non-rivalrous and non-excludable in that it is shared across society whilst the costs are concentrated in areas near the site. This especially the case for the Sudokwon Landfill, as it accepts waste from areas within the Seoul Metropolitan area but outside of its own municipal zone of Incheon. Those who oppose landfills near their homes worry of the negative external effects, such as the depression of property prices, which may be perceived as being much greater than the benefits gained from the facility. All the while, authorities appeal to public interest and attempt to achieve social agreement.

South Korea is no exception to the NIMBY phenomenon, highlighted by the ongoing conflict regarding the Seoul Metropolitan Area Landfill (hereinafter referred to as Sudokwon Landfill). The agreement to extend the operation of the Sudokwon Landfill in 2015 was especially controversial, with local residents strongly opposing the decision of the local government. Many criticised the lack of local residents' involvement in the negotiation. Nonetheless, although the previously agreed upon end date was 2025, a proviso clause in the contract has provided a loophole for the end date to be extended. The government of Incheon has been stronghandedly demanding to end Seoul and Gyeonggi's use of the landfill by 2025, publicising

their demands for a new landfill solely for Incheon's waste (인천광역시공론화위원회, 2020). The Sudokwon Landfill Site Management Corporation (hereinafter referred to as SLC) and the South Korean Ministry of Environment, however, has shown signs of its desire to continue after 2025, causing a significant backlash among residents yet again. Furthermore, even if Incheon was to create a landfill of their own, it is possible that residents that live near the new landfill may oppose having a landfill near their homes, even if it accepts waste from their municipal area.

This study aims to empirically analyse whether the existence of landfills actually lowers local property prices at a statistically significant level. In other words, the value of the disamenity caused by the Sudokwon landfill will be quantified. Additionally, the effect of compensation provided by the SLC to local residents on the disamenity will be examined.

Therefore, the results of this study will provide empirical data on the environmental externalities caused by landfills and whether compensation can alleviate the disamenity caused, allowing decision-makers such as the Ministry of Environment to take reasonable action regarding not only the Sudokwon Landfill site, but other future landfill sites and NIMBY facilities. In an age where local acceptance is crucial to the construction of public LULU facilities, environmental

policies such as compensation programmes may be necessary to relieve the public anxiety surrounding such facilities. This study may provide the information needed to legitimise such action.

## 1.2. Research Question

The research questions posed in this study are as follows:

1) Do landfills depress nearby property prices?
2) Do resident compensation programmes affect the disamenity caused by landfills?

In order to answer these questions, a specific form of environmental valuation, the hedonic price method will be used to analyse the real transaction data of apartments within the area of direct influence of the landfill. The timeframe of the data used will be 2010-2019, which is the timeframe which the Sudokwon Landfill Corporation provides a detailed breakdown of the financial support given to different municipal regions in the sphere of influence.

Chapter 2 will discuss the background of this study, in particular the concept of locally unwanted land uses and the surrounding conflicts and the methods of environmental valuation. Chapter 3 will consist of a critical examination of past literature that uses the hedonic price method to value the disamenity caused by landfills. In Chapter 4, the Sudokwon landfill will be discussed in detail, along with the ongoing compensation programmes. Chapter 5

will include empirical analysis, specifically regression analysis to determine the WTP of living further away from the Sudokwon landfill, and the effect of compensation on that WTP.

# Chapter 2. Study Background

## 2.1. Locally Unwanted Land Uses (LULUs) and Not In My Backyard (NIMBY) Fears

The acronym LULU (locally unwanted land use) was created by Popper (1985), with regard to the large development projects the U.S. was going through in the 1980s. As the phrase suggests, it refers to land uses that is needed in society but often faces objection by people who lives near them. Some common examples of LULUs would be airports, highways, hazardous waste facilities, power plants and landfills. Although they are essential infrastructure needed in society, local opposition is often fierce and cause problems in the process of development and operation.

The reason behind such severe opposition is related to the negative externalities caused by LULUs. Considered to be odiferous, polluting, and noisy, LULUs face negative stigma in the local community, who perceive these costs they bear to be larger than the benefits they individually receive, although the facility itself provides benefits to society as a whole to other areas as well. The fact that the costs are only concentrated in the areas nearby the facilities worsens the offense taken by the local residents.

Landfills, the subject of this study, in particular, is one of the most opposed LULUs, despite technological advancements allowing

them to be cleaner, safer and quieter (Greenberg et al., 2012; Peng, 2017). Opposition faced by landfills are usually termed the NIMBY phenomena, and is also a common occurrence in development plans for public facilities such as nuclear waste facilities (Gerrard, 1993), prisons (Thomas, 1992), or even renewable energy facilities (Wolsink, 2006). Various hypotheses regarding the reasons behind local communities opposing LULU developments have been given, with most of them relating to perceived risk or externalities. These projects are controversial due to the risk of externalities it brings to the local area, ranging from environmental and health risks to a fall in property prices(Hunter & Leyden, 1995).

Park et al. (2007) states that there are four different facets to conflicts surrounding landfills: administrative, environmental, social and economic. Administrative reasons include the lack of trust in government rooted in information asymmetry and insufficient efforts in fixing this asymmetry. The lack of clear information and opportunity to participate in decision-making processes heightens the fears and uncertainty of residents regarding the impact of the landfill. Environmental reasons refer to odour, dust, and noise from the operation of the landfill. Social reasons usually rise when waste from another municipal region is managed in the landfill, as the benefits of the landfill are shared whilst the costs are only borne by

households near the landfill. Economic reasons refer to compensation required by residents to make up for the costs, incurred by a decrease in property value. Nonetheless, the public sector must be wary when administering compensation, as by responding differently depending on the intensity of the opposition may lead to residents strongly opposing from the very beginning for the sake of opposition and economic compensation.

Groothuis and Miller (1994) attributes two dimensions to NIMBY fears towards hazardous waste facilities: tolerance and avoidance. Tolerance entails the rational acceptance of economic arguments regarding LULU developments, whilst avoidance involves personal fear of possible consequences. The predominance of either one of the beliefs can be separated by demographics, with people with higher income and education being more likely to tolerate (Groothuis & Miller, 1994). Advancements in technology have greatly lowered the dangerous and hazardous nature of landfills, with the introduction of sanitary landfills (Madon et al., 2019). Nonetheless, opposition against landfills persists among communities. Dear (1992) blames the rise of NIMBY on self-interested, turf-protectionist behaviour, which could be detrimental for a community, as necessary services will not be provided.

In order to solve the opposition within communities and

reduce unnecessary conflict arising NIMBY concerns, not only technology but perception of the actual impacts of the facilities must be improved – methods may include compensation programmes, consensus building or risk communication (Schively, 2007). Such solutions, however, require the measurement or quantification of the externality caused by the facilities. Furthermore, the results of civil conversations arising from NIMBY syndrome may bring about positive changes to policy and allow the democratisation of the policy process (Koh & Jung, 1998).

## 2.3. Environmental Valuation

Disamenity arising from landfills is an example of a non-market negative externality. Such non-market goods require a method of valuation. There are three approaches often used to estimate the monetary value of environmental impacts on people: direct, indirect and benefits transfer (Perman et al., 2012). While the first two are otherwise known as stated preferences and revealed preference, some common methods of each approach are listed in Table 1.

Table 1: Types of methods for environmental valuation

| Approach | Method | Explanation |
|---|---|---|
| Direct (Stated preference) | Contingent valuation | Survey used to ask people to directly state their WTP or WTA |
| | Choice modelling | Survey used to ask people their alternatives |
| Indirect (Revealed preference) | Hedonic price approach | Housing prices examined to reveal individuals' value of an environmental attribute |
| | Averting behaviour | Value of an environmental good = amount of money spent to offset impact |
| | Cost of illness | Changes in private and public expenditures on medical goods and services |
| | Travel cost | Cost spent on trip to a certain site used as proxy |
| Benefits transfer | Mean transfer value | Mean value of WTP derived |

(Eshet et al., 2005; Perman et al., 2012)

Revealed preference methods, which is the method this study will be using, aims to indirectly discover the monetary value of an environmental good or effect on individuals. Rosen (1974) laid out the theoretical foundation to find the implicit prices of attributes using the hedonic price model, which will be described in detail in the next section. Since goods are tied to its characteristics, market prices reflect these characteristics. Using Rosen's method, first-step regression analysis of price on characteristics is used to estimate

implicit prices of attributes.

## 2.4. Hedonic Price Method

The hedonic price method determines the effect of different housing characteristics on property value. This study specifically assumes that environmental quality, affected by the existence of a landfill nearby is one of the attributes that affects property price. The difference in price paid for a property will reflect the differences in environmental quality in the respective properties.

This section will explain the hedonic price method for differentiated goods, as described in a seminal paper by Rosen (1974). It should be noted that some assumptions Rosen employs for this model states that the household is a price taker that only purchases one property.

Haab and McConnell (2002) and Lancaster et al. (2017) provide a good guide of how to use the model. Households gain utility from consumption (C) and housing services (H) following the utility function:

$$U = U(C, H),$$

in which $H$ is a vector of $n$ different housing characteristics $H = H\,(q_1, \cdots, q_n)$. Distance from the landfill would be included in $H$, along with other aspects that determine property price. Households,

when selecting a certain property live in, are selecting a certain set of attributes that property possesses.

It is also assumed that each household is also endowed with income *Y*. Households maximise utility subject to the following budget constraint:

$$Y = C + P(H_i),$$

in which $P(H_i)$ is a hedonic price function of the n housing characteristics $(i = 1, \cdots, n)$. $C$ denotes composite good with price normalised to one. Unlike the composite good C, housing is a differentiated good, where different housing properties cause different price. When maximising their utility subject to the budget constraint, households determine the optimal quantities of both the composite good and each of the $n$ housing characteristics.

The Lagrangian Function can thus be set up as:

$$L = U(H_i, C) + \lambda(Y - C - P(H_i))$$

When maximised with respect to C, $H_i$ and $\lambda$, the first order conditions are as follows:

$$\left(\frac{\delta L}{\delta H_i}\right) = U_{H_i} - \lambda P_{H_i} = 0$$

$$\left(\frac{\delta L}{\delta C}\right) = U_C - \lambda = 0$$

$$\left(\frac{\delta L}{\delta \lambda}\right) = Y - C - P_{H_i} = 0 \quad \text{for } i = (1, \dots, n)$$

The partial derivative of the hedonic price function with respect to property attribute $H_i$ is:

$$P_{H_i} = \left(\frac{U_{H_i}}{U_C}\right) \text{for } i = (1, \dots, n)$$

Therefore, the marginal rate of substitution between the characteristic and the composite good is the implicit price of the characteristic.

The hedonic price function takes the form:

$$PRICE = \beta_0 + \beta_1 DISTANCE + B_3 X + \mu,$$

where X is other characteristics.

The hedonic price method takes various functional form when being used in quantitative analysis. The three main forms that will be discussed in this paper are Linear, Semi-log and Double-Log (Lee, 2008).

The linear functional form of the hedonic price method is straightforward as the name suggests. It assumes a linear form of the function and takes the form aforementioned when deriving the hedonic price function. The strength of this model is that it is straightforward and easy to interpret, with the coefficient $\beta_1$ acting as the willingness-to-pay for distance away from the landfill. However, the downfall of this model is also its simplicity, as if the

relationship one is trying to approximate is not linear, the effectiveness of this model greatly decreases and requires transformations. Furthermore, it may be problematic to interpret the increase of price change to be the same magnitude as the increase in a characteristics due to the difference in units (Lee, 2008).

The Semi-Log form is when natural is applied to the dependent variable. The general functional form is as follows:

$$\ln Y_i = \alpha + \beta_1 X_{1i} + \beta_2 X_{2i} + \epsilon_i$$

The strengths of this model is that the coefficient shows the approximate percentage change of price in relation to the change in a characteristics (Malpezzi, 2008; Triplett, 2016). However, this form faces problems with realistic interpretation.

The Double-Log, or log-log form involves applying the natural log to both the independent and dependent variables. The functional form is as follows:

$$\ln Y_i = \alpha + \beta_1 \ln X_{1i} + \beta_2 \ln X_{2i} + \epsilon_i$$

DiPasquale and Wheaton (1996) state that the double-log form is more realistic than the linear form, as it reflects the law of marginal utility between real estate characteristics and its prices. The coefficient in the double-log form represents the elasticity of the price to the corresponding characteristic variable. Nonetheless, problems with the log-log form arises when dealing with dummy

variables, as log0 is undefined. There are various discussions upon how to deal with this problem, either through changing the dummy variable to 1 and 2, or not transforming the dummy variable at all. The latter solution will be taken by this study.

To derive the willingness-to-pay for the semi-log and log-log model, the marginal price must be calculated first (Kang, 2020; Kennedy, 1992; Monty & Skidmore, 2003). The formulae for each functional form can be seen in Table 2. The notation $\bar{p}$ refers to average price and $\overline{LF}$ is the average of the variable of interest, distance from the landfill.

Table 2: Formulae to calculate Marginal Value

| | Marginal Value |
|---|---|
| Semi-log | $\bar{p} * \widehat{\beta_1}$ |
| Double-log | $\beta_1 * \frac{\bar{p}}{\overline{LF}}$ |

Once the marginal value is calculated, WTP can be calculated by multiplying the change in distance from the landfill ( $\Delta LF$ ). Furthermore, for dummy variables in a logarithmic regression, the coefficient must be transformed before being multiplied to the average price①.

① The coefficient β is transformed by the equation $(e^{\beta} - 1)$ to provide a percentage estimate of the effect.

# Chapter 3. Literature Review

## 3.1. Valuing Disamenities of Landfills

There has been a number of research carried out worldwide in measuring the value of environmental disamenities, including but not limited to the case of landfills.

Hite et al. (2001) uses the hedonic price model to quantify the impacts of a change in environmental quality on property value. The change in environmental quality is due to landfills in the US, namely Franklin County, Ohio. Log transformations of price and dependent variables are used to estimate the hedonic function, rather than the Box-Cox model. The Box-Cox model was not suitable, as when one standard deviation from the mean was subtracted from the standard errors or price and lot size, the resulting values were negative. Analysis shows that the four landfills cause a significant welfare loss in the area, as property prices increase once the distance to the landfill is larger than 3.25 miles.

Ready (2010) examined the residential sales of Berks County, Pennsylvania, which is near to three landfills of different sizes. Using meta-analysis, results showed that the magnitude of the depression

of property values commensurate with the capacity of the landfill. A significant number of low volume landfills did not affect property values at all, unlike high volume landfills. The Sudokwon landfill, in this context, where high volume is defined as 500 tonnes per day or more, fulfils the criteria.

In the case of South Korea, Jeon (2011) estimated the effect of expansion of an incineration plant in Seoul on local property values. Price data were grouped into event-driven time periods and statistically tested with the Chow-test before analysing whether the event of expansion caused a change in the effect. Results showed that the size of the effect was in fact not fixed, but changed with time, in accordance with political and economic issues. This is relevant to the current study in that the decision to extend can be seen as a political issue.

Kim (1996) uses the hedonic price method to quantify the externality of the Sudokwon landfill. Local residents' willingness to pay to live farther away from the landfill and willingness to accept for living near the landfill was derived by examining local property prices. Other than the distance to the landfill, independent variables used were distance to the downtown area, area of the property, and length of residence. The double log and semi log form was used in

deriving the hedonic formula. Since the study was carried out before the Ministry of Land, Infrastructure and Transport provided local property price data, data from real estate companies and surveys were used. Results showed that property prices were lower nearer the landfill, but exact marginal prices were not calculated.

Kim and Jung (2012) analyses the impact of the Ulsan city landfill by using samples of property prices within 2 km of the landfill. The independent variables used were lot shape, land categories and use. The results revealed that a 1% increase in distance from the landfill lead to a price increase of 0.063%.

Kang (2015) estimated the WTP for the reduction of disamenity from the Sudokwon Landfill using the Hedonic Pricing Model. Although this is similar to the current study, it uses cross-sectional data to estimate the effect of the odour from the landfill. The Box-Cox transformation method was used in estimating the hedonic model. Independent variables used other than distance to the landfill were divided into three categories, property characteristics, area characteristics, and environmental characteristics. The results showed that as the distance to the landfill increases by 100 metres, apartment prices increase by 4.016 million Korean won. Thus, an apartment that is 100 metres farther from the landfill would be 4.016

million KRW more expensive than an apartment that isn't. Kang (2021) also evaluated the compensation programme ongoing in the surrounding areas, using the choice experiment method to conclude that the compensation is insufficient.

## 3.2. Compensation Programmes for Residents

As a means to resolve opposition from local residents, financial compensation programmes are often used to offset the harm caused by landfills (Klein & Fischhendler, 2015). Compensation is not only used in the development stages of a landfill, but also during its operation and often when extension decisions are made. Park et al. (2007) found that those who live nearer the Sudokwon landfill believe economic compensation to be one of the most important factors in accepting the existence of a landfill. In comparison, those who live further away, who prioritised transparency in the process of siting the landfill and disclosure of information.

Ferreira and Gallagher (2010) used the contingent valuation method to examine residents' attitude towards compensation in Ireland and found that many strongly rejected compensation in the first stage due to NIMBY concerns. Rejection rates were greater in communities ex-ante landfill siting, but ex-post landfill communities

also showed a significantly high rejection rate as well. However, many respondents went on to accept at least one compensation package in later stages. Furthermore, residents also preferred individual compensation over community compensation, which was contrary to previous studies.

Frey et al. (1996) found that there exists a “bribe effect” regarding opposition against essential infrastructure. This means that economic compensation is regarded as bribes and that moral principles take a much more crucial role in siting of unwanted land uses. To account for the moral cost that is often overlooked by economists, compensation must not be in the form of direct payment to households but rather given to the community as a whole to weaken the bribe effect.

In the case of the Sudokwon Landfill, Kang (2021) uses the choice experiment method to determine whether the compensation is being provided proportionately to the environmental damage caused by the Sudokwon landfill. Results showed that the size of the compensation is not large enough to internalise the damage caused by the landfill. However, it is unclear that in deriving the WTP of residents that whether residents are already receiving money was incorporated into the analysis.

Hong et al. (2012) also analyses survey data of residents that live within and beyond the Environmental-Adverse-Effect Zone of the Sudokwon landfill site to determine whether compensation increases the acceptance of the landfill. Results showed that residents reacted positively to potential financial compensation, especially those who lived within close proximity of the Sudokwon landfill.

As seen through the review of previous literature in this section, summarised in the table below, there already exists various previous literature that analyses the effectiveness of compensation on the acceptance of landfills, including the Sudokwon landfill. However, most previous studies using the hedonic price model does not incorporate compensation programmes, and studies that examine compensation programmes independently are carried out using survey data. There is a lack of examination using the hedonic price model together with the composition of compensation according to region. This not only applies within the context of the Sudokwon landfill, but also for other parts of the world. Thus, this study will contribute to the existing literature by using the hedonic price method to see whether residents' WTP changes with the existence of compensation programmes.

Table 3: Summary of Previous Literature

| Author | Subject | Methodology | Results |
|---|---|---|---|
| Hite et al. (2001) | Landfills in Franklin County, Ohio (USA) | Hedonic price model | Property prices increase once the distance is larger than 3.25 miles |
| Ready (2010) | Landfills in Berks County, Pennsylvania (USA) | Hedonic price model | High volume landfills negatively affect property prices |
| Jeon (2011) | Incineration plant in Seoul (S. Korea) | Hedonic price model | Negatively affects property prices |
| Kim (1996) | Sudokwon Landfill (S. Korea) | Hedonic price model | Property prices lower nearer the landfill |
| Kim and Jeong (2012) | Ulsan City Landfill (S. Korea) | Hedonic price model | 1% increase in distance = price increase of 0.063% |
| Kang (2015) | Sudokwon Landfill | Hedonic price model | Distance increase by 100m = price increase by 4.015 million KRW |
| Park et al. (2007) | Compensation programme for Sudokwon landfill | Survey data | Those who live nearer the landfill prioritise compensation |
| Ferreira and Gallagher (2010) | Compensation programmes for landfills (Ireland) | Contingent valuation method | Residents prefer individual compensation over community compensation |
| Kang (2021) | Compensation programme for Sudokwon landfill | Survey data | Compensation not large enough to internalise the damage |
| Hong et al. (2012) | Compensation programme for Sudokwon landfill | Survey data | residents react positively to potential financial compensation |

# Chapter 4. The Sudokwon Landfill

## 4.1. Characteristics of the Study Site

The subject of this study is the Sudokwon Landfill, located in Seogu, Incheon of South Korea. It is the largest landfill site in South Korea, and one of the largest single landfill in the world (Santa Maria, 2019). The total area of the site amounts to 16 million $m^2$. The site is divided into four sections, with the third site being divided into 3 further subsections. The landfill began accepting waste from 56 surrounding provinces in 1992. As seen in Table 3, the first landfill site was full by 2000, and the site was transformed into a park with a golf course. The second landfill site was full by 2018.


Figure 1: Sudokwon Landfill Site

Table 4: Size of the Sudokwon Landfill site

| Description | Status | Site Size (10,000$m^2$) | Landfill Size (10,000$m^2$) | Landfill Capacity (10,000 tonnes) | Operation Duration |
|---|---|---|---|---|---|
| 1st Site | Ended | 409 | 251 | 6,425 | 1992–2000 |
| 2nd Site | Ended | 378 | 262 | 8,018 | 2000–2018 |
| 3rd Site (Level 1) | Ongoing | 103 | 83 | 1,819 | 2018–Undecided |
| 4th Site and remainder of 3rd Site | Undecided | 593 | | 6,538 | Undecided |
| Others② | | 117 | | | – |
| Total | | 1600 | | 22,800 | |

① Includes R&D complex and cisterns
(Source: Sudokwon Landfill Site Management Corp.)

The Sudokwon landfill was built to replace the Nanjido landfill, which was filled by the end of the 1980s. The Nanjido Landfill was not a sanitary landfill, and received numerous complaints concerning its odour, which its successor aimed to solve by using sanitary landfill technology (Kim et al., 2021). Not only did the Sudokwon landfill succeed in drastically lowering the level of odour, it managed to successfully carry out projects that allowed it to generate energy from waste (Moon Kyung & Yun Hee, 2009). Nonetheless, despite its level of sanitation, the Sudokwon landfill has been a site of

controversy and conflict (Koh & Jung, 1998).

It should be noted that at the time of planning, the second site was projected to be full by 2016. By the 2000s, however, it was clear that the waste reduction policy led by the Ministry of Environment was successful to the extent that the volume of waste being brought into the landfill was significantly reduced, opening grounds for discussions on the extension of use. As a result, on 3rd December 2014, the local governments of Seoul, Incheon, Gyeonggi-do, and the Ministry of Environment formed a four-way negotiation group. At the time of these discussions, the governments of Seoul and Incheon, the largest stakeholders, were in conflict regarding the extension. Due to the absence of an alternative site, the Seoul Metropolitan Government insisted on extending the use of the Sudokwon landfill. On the other hand, the Incheon Metropolitan Government, backed by the antipathy and opposition of its residents, responded with a call for the end of the use of the Sudokwon landfill. The conflict ran deep, causing each government to run advertisement campaigns supporting each respective position (Shin, 2017). It took 7 months after the negotiation group ③ was formed for the group to come to the conclusion of extending the use of the landfill. The conditions of the agreement were that the Sudokwon landfill will only be used until an

③ 28th June, 2015

alternative landfill is created.

## 4.2. Current Status of the Study Site

Although the government bodies were able to come to an agreement in 2015, the sentiments were not shared by the local residents of Incheon. Opposition from residents existed from as early as 2007, when the Ministry of Environment published "The Second Environmental Management Plan for the Sudokwon landfill", stating that the landfill can be extended for use until 2044. Conflict between the stakeholders intensified after the four-way negotiation took place, and residents of Incheon that opposed the extension mobilised themselves into a civic organisation. The civic organisation even filed two administrative litigations against the Incheon Metropolitan Government. ④ The reasoning behind their opposition included their hopes for an increase in property prices being crushed (Kang, 2015).

Since the extension, the local government of Incheon and its residents have been strongly voicing their desire for the use of the Sudokwon landfill by non-local provinces – i.e. Gyeonggi-do and Seoul – to end by 2025. However, although the Ministry of Environment and the two provincial governments held two calls for an alternative landfill site, no applications were received (Ko, 2021).

④ The two litigations were dismissed in February 2016 and February 2017, respectively. Shin, S., & Kim, Y. (2019). Changes in Perceptions of Conflict Actors and Conflicts Aspects: Since the Decision to Extend the Use of the Seoul Metropolitan Landfill Site. *한국정책학회보*, *28*(2), 67-101.

The minimum required area was lowered for the second call, but the lack of candidate cities led to the authorities announcing that they will not be making a third call. Instead, the authorities are looking to lower the volume of waste brought into the site.

Nonetheless, local residents are adamant about the deadline, and conflict persists. In August 2022, a civil organisation filed another lawsuit against the former mayor of Incheon and the former head of the Sudokwon Landfill Termination Organisation on account of embezzling the resident support fund (Hong, 2022). With the deadline to end the usage of the landfill impending at the time of this study, the authorities are at a crossroads to either find an alternative site or increase residents' acceptance of the existing site before 2025 to prevent a waste disposal crisis.

## 4.3. Resident Support Fund

Since the beginning of operation, the SLC has spent 1.2768 trillion won in benefits to Incheon City and its residents (Sudokwon Landfill Corporation, 2021). The subsidies provided by the SLC is divided into three main recipients: the residents, the municipal government, and sports facilities. Currently, the compensation programme ongoing in the area for residents involves a "resident support fund" – 10% of the profit from accepted waste is used to

improve the welfare of the residents that are affected by the environmental damage caused by the landfill (Kang, 2021). The amount was set in accordance with the Waste Treatment Facilities Promotion Act, and joint projects were carried out after deliberation by a council of local residents.

The recipients of the resident support fund are determined by “PROMOTION OF INSTALLATION OF WASTE DISPOSAL FACILITIES AND ASSISTANCE, ETC. TO ADJACENT AREAS ACT” ("폐기물시설촉진법," 2007). The law states that there are two relevant spheres of influence for determining who receives resident support funds. The first is the sphere of direct influence, where people are encouraged to move, as they are likely to fall under direct environmental impacts of the landfill. The second, larger sphere of influences is the sphere of indirect influence. Those who live within the sphere of indirect influence are also likely to fall under environmental impacts, but less so than those within the sphere of direct influence. Those who live within the larger boundary are the ones that qualify for compensation, rather than being encouraged to move. The SLC however, does not make a distinction between the two spheres and provides compensation for those that live in the sphere of indirect influence.

The boundaries of the two spheres changed over time but was

most recently set by Presidential Decree in 2007 – 200m for the sphere of direct influence and 2km for the sphere of indirect influence. The changes in boundaries, however, meant that the municipal areas that received compensation has changed throughout the years as well. As seen in the table below, the most recent major change has been made in 2010, when four municipal areas were dropped from being compensated (SLC, 2018). It is also notable that the areas being compensated has not changed since the end of site 2 and the beginning of site 3.

Table 5: Changes in spheres of Influence 1997~2022

| Years | Spheres of influence |
|---|---|
| '97~'06 | Anpodong, Geoweolri, Gumdan1dong, Gyeongseodong, Yangchonmyeon |
| '07~'09 | Oryudong, Wangildong, Gyeongseodong, Yangchonmyeon, Majeondong, Geumgokdong, Geomamdong, Baekseokdong |
| '10~'22 | Oryudong, Wanggildong, Gyeongseodong, Yangcheoneup[a] |

a. Minor changes were made to "tong" areas due to administrative changes, rather than actual changes in coverage

The resident support fund consists of various community improvements and projects⑤ in municipal areas that fall within the sphere of indirect influence, along with direct cash payment to households. The amount of funds received by each municipal area is determined by the level of environmental impact each area suffers,

⑤ Elderly care facilities, improvement of local schools, construction of parks, etc.

along with the number of residents living. The SLC has set additional requirements to determine which households get cash compensation from the resident support fund (SLC, 2018). The requirements state that the recipient must be registered as a resident within the sphere of indirect influence. Compensation is given to those that can prove that they actually lived within the sphere in the relevant year since the 31st of December of the previous year regardless of whether they own their property. However, direct cash compensation was not executed every single year since the beginning of operation. In fact, it was discontinued during the period of 2007-2014 and restarted before being discontinued in 2019 again. The compensation programme is a form of a Pigouvian tax, where the negative externalities from the landfill is internalised. The problem with such taxes arises, however, when the scale of the damage and the recipients of compensation is miscalculated.

Table 5 shows a summary of the Resident Support Fund in 2006 and 2010. The drop in household reflects the change in municipal areas covered by the fund, therefore increasing the RSF allocated per household as a result.

Table 6: Sudokwon Landfill Resident Support Fund

| | No. of Households | Resident Support Fund (million | RSF per household (10,000 KRW) |
|---|---|---|---|

| | | KRW) | |
|---|---|---|---|
| 2006 | 10,933 | 9,828 | 89 |
| 2010 | 7,224 | 11,697 | 162 |

# Chapter 5. Empirical Analysis

## 5.1. Data Collection

The physical scope of this study is the real estate transaction data of apartments that are considered areas of direct influence, and those in the indirect sphere of influence, and thus are eligible for receiving compensation from the Resident Support Fund. The temporal range of the data collected is 2006 and 2010. The reason for the choice of year is because in 2007 the SLC announced that in 2010 there will be a discontinuation of compensation for 4 municipal areas. 2006 thus denotes the year before the announcement, or the year where there was no speculation at all that there will be changes in compensation. 2010 is the year when the change is implemented. This allows the effects of the policy change to be isolated. Furthermore, the SLC only provides a detailed breakdown of compensation by municipal areas for 2006 and 2010, and not for the years in between.

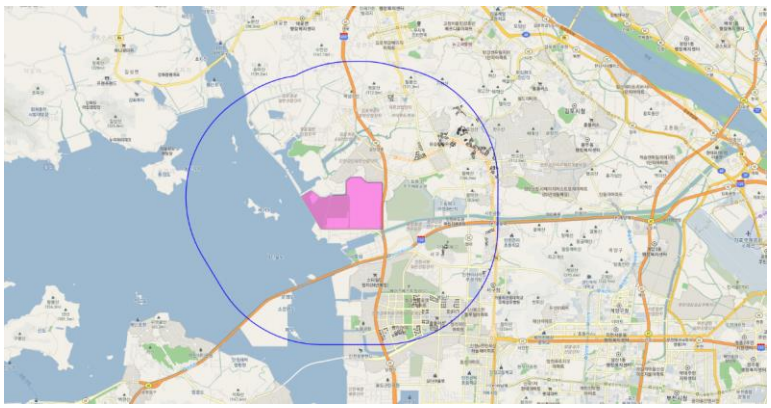

Figure 2: Map of 5km radius of the Sudokwon Landfill

After determining the physical scope of the study, data on the apartments within the 5km radius of the Sudokwon landfill was collected. There was a total of 48 apartment complexes within the sphere of influence. The data was divided into individual and dependent variables. The independent variable, price data was collected through the South Korean Ministry of Land, Infrastructure and Transport. The dependent variables were divided into characteristics that affect the independent variable: apartment, apartment complex and environmental characteristics. The dependent variables of interest to this study consists of two environmental characteristics, landfill and support. All distance data was taken in metres, monetary data in 10,000 won. There are also dummy variables for brand of the construction company and whether the floor of the apartment is “royal”, or higher than the 3$^{rd}$ quartile of the total floors, which is known to be preferred in South Korea (Jung

et al., 2009).

Table 7: Description of Variables

| Variable | | | Explanation | Unit | Source |
|---|---|---|---|---|---|
| Independent | | price | Real transaction price | 10,000 KRW | Ministry of Land, Infrastructure and Transport (MOLIT) |
| Dependent | Apartment | area | Area of apartment | $m^2$ | MOLIT |
| | | royal | Dummy variable indicating whether floor of apartment is royal | non royal: 0<br>royal: 1 | MOLIT |
| | Apartment Complex | years | Number of years since completion of construction | number | MOLIT |
| | | total | Number of total apartments | numbers | NRE, RE114 |
| | Environment | landfill | Distance to landfill | m | QGIS |
| | | support | amount of support given to municipal area | 10,000 KRW | SLC |
| | | school | Distance to nearest elementary school | m | QGIS |
| | | park | Distance to nearest park | m | QGIS |
| | | hospital | Distance to nearest hospital | m | QGIS |

Table 8 shows the descriptive statistics of the variables. The total number of observations for the time period of 2006 and 2010

was 2128. The closest to the Sudokwon landfill an apartment gets was approximately 2.8km, and the furthest 5km.

Table 8: Descriptive Statistics

| Variable | Obs. | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| price | 2128 | 18448.96 | 66110.623 | 3900 | 62000 |
| area | 2128 | 82.24 | 21.06 | 39.65 | 200.18 |
| royal | 2128 | 0.24 | 0.43 | 0 | 1 |
| years | 2128 | 5.07 | 4.41 | 0 | 20 |
| total | 2128 | 520.34 | 334.93 | 79 | 1351 |
| landfill | 2128 | 3866.49 | 699.88 | 2800.74 | 4885.18 |
| support | 2128 | 29009.45 | 29124.57 | 0 | 134200 |
| school | 2128 | 499.72 | 316.82 | 87 | 1500 |
| park | 2128 | 511.87 | 305.51 | 168 | 1700 |
| hospital | 2128 | 1720.15 | 1396.463 | 298 | 4400 |

## 5.2 Analysis Framework

Before beginning any statistical analysis, the correlation between the variables were examined to check for multicollinearity.

Table 9: Matrix of Correlations

| Variables | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
|---|---|---|---|---|---|---|---|---|---|---|
| (1) price | 1.000 | | | | | | | | | |
| (2) landfill | 0.091 | 1.000 | | | | | | | | |
| (3) supportq | 0.024 | -0.387 | 1.000 | | | | | | | |
| (4) area | 0.706 | 0.163 | 0.028 | 1.000 | | | | | | |
| (5) royal | -0.047 | -0.008 | 0.015 | -0.073 | 1.000 | | | | | |
| (6) years | -0.389 | 0.207 | -0.070 | -0.204 | 0.050 | 1.000 | | | | |
| (7) total | 0.193 | 0.201 | -0.047 | 0.264 | -0.033 | 0.186 | 1.000 | | | |
| (8) school | -0.200 | 0.248 | -0.018 | 0.030 | 0.028 | 0.254 | 0.126 | 1.000 | | |
| (9) park | -0.096 | 0.294 | -0.096 | -0.047 | -0.042 | 0.028 | 0.082 | 0.228 | 1.000 | |
| (10) hospital | 0.111 | -0.127 | -0.350 | -0.063 | -0.012 | -0.312 | -0.065 | 0.021 | -0.031 | 1.000 |

The results are shown in Table 9. Results show no variables with significant correlation worthy of concern to another; thus all variables were used in the analysis.

In order to use the hedonic pricing method to conduct its analysis on the disamenity caused by the Sudokwon Landfill, the hedonic price equation must be estimated. There are various functional forms of the hedonic price function, such as linear, log, semi-log, and Box-Cox transformations, as mentioned in Chapter 2 (Halstead et al., 1997; Lee, 2008; Triplett, 2016). This paper uses the semi-log function for the relative simplicity of interpretation.

## 5.3 Results

The first regression analysis was carried out using the semi-log form of the hedonic method to answer the first research question, whether the existence of the Sudokwon landfill lowers nearby property prices.

Table 10: Regression Results

| | (1) |
|---|---|
| | lnprice |
| landfill | 0.0000587*** |
| | (6.78) |
| area | 0.0107*** |
| | (37.29) |
| royal | 0.00512 |
| | (0.40) |
| years | -0.0310*** |
| | (-21.36) |
| total | 0.000113*** |
| | (6.45) |
| school | -0.000250*** |
| | (-13.42) |
| park | 0.00000808 |
| | (0.42) |

| | |
|---|---|
| hospital | 0.0000346*** |
| | (8.28) |
| _cons | 8.800*** |
| | (232.32) |
| *N* | 2128 |

*t* statistics in parenthesis (* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$)

Regression results show that all of the selected independent variables except royal and park have a statistically significant relationship with the price. Distance from the landfill has a positive correlation on price, meaning the price of the apartment increases when it gets farther away from the landfill. This acts as evidence that landfills do cause a negative externality, or disamenity to those who live near it, lowering property price. However, it must be noted that the relative size of the correlation is smaller than other variables that affect price, such as how old the apartment complex is.

The marginal price of the distance to the landfill, and thus the WTP of getting away from the landfill can also be calculated using the formula derived in Chapter 2. The WTP is 1.08 million won per 100m of distance between the apartment and the landfill.

The second regression used the hedonic method to take into consideration the interaction effect between landfill and support. By this, the relationship support has with the coefficient of the distance to the landfill on price can be isolated and examined. The equation below shows the regression equation including the interaction effect.

A new interaction term is created to see the relationship, as given by landfill*support. Thus, the coefficient of interest is $\beta_3$, showing whether the amount of support affects the correlation of the distance and the landfill has on price. If statistically significant, support has an effect on the residents' acceptance of the landfill in that the correlation of the distance to the landfill and price differs depending on the amount of support being provided to the municipal area the apartment is located in.

$$price = \beta_0 + \beta_1 landfill + \beta_2 support + \beta_3 landfill * support + \cdots + \varepsilon$$

Table 11: Regression Results with Interaction

| | (1) |
|---|---|
| | lnprice |
| landfill | 0.000332*** |
| | (31.40) |
| support | 0.0000382*** |
| | (35.30) |
| c.landfill#c | -1.11e-08*** |
| .support | (-34.79) |
| area | 0.0104*** |
| | (45.63) |
| royal | 0.0210* |
| | (2.07) |
| years | -0.0443*** |
| | (-35.77) |
| total | 0.000136*** |
| | (9.75) |
| school | -0.000154*** |
| | (-10.06) |
| park | -0.0000193 |
| | (-1.27) |
| hospital | 0.0000214*** |
| | (5.65) |
| _cons | 7.860*** |
| | (181.45) |
| *N* | 2128 |

*t* statistics in parenthesis ($^{*}$ $p < 0.05$, $^{**}$ $p < 0.01$, $^{***}$ $p < 0.001$)

The results show that again all variables have a statistically significant correlation to price at p<0.01, except royal which is significant at p<0.05, and park which isn't significant. The interaction term between landfill and support is also statistically significant, showing that there is an interaction effect occurring. The coefficient, is negative, showing that the increase in support has a negative correlation on the effect of distance.

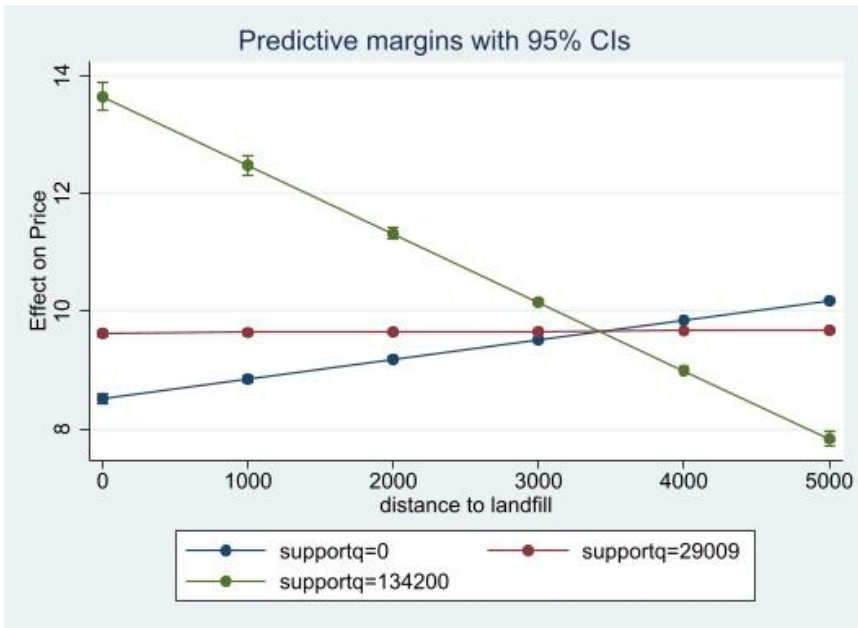


Figure 3: Interaction Plot of Distance to Landfill and Support

Figure 3 shows the interaction plot between the distance to the landfill and support. As seen through the change in slopes, the relationship between price and the distance to landfill progressively decreases as the amount of support increases. In fact, when support is at its maximum value, the price and the distance to landfill have a

negative relationship, meaning prices actually decrease as it gets further away from the landfill.

$$\overline{support} = 29009$$

$$\beta_1 = 0.000332 \quad \beta_3 = -1.11 * 10^8$$

$$\beta_1 + \left(\overline{support} * \beta_3\right) = -0.000289$$

The equations above demonstrate that even when we use the mean value of support, the coefficient for landfill becomes negative. In fact, even at the lowest level of support after zero within the collected data, which is 82 million won, is sufficient enough to change the coefficient negative.

Furthermore, the WTP for living 100m away from the landfill can be calculated again with the new coefficients. When the level of support is zero, the WTP is 612,000 won, which is lower than the results from the previous regression. However, when the amount of support increases from 0 to the next highest level, 82 million won for Geomam and Gyeongseodong in 2006, the WTP becomes negative at 5.43 million won per 100m. This means people are willing to pay 5.43 million won to get 100m closer to the landfill. Since 82 million won is the lowest level of compensation after zero, it can be generalised that the level of support for all areas in the years 2006 and 2010 were large enough to transform the nature of the correlation between property price and the distance to the landfill.

# Chapter 6. Conclusion

## 6.1. Policy Implications

Regression results in Chapter 5 suggest two implications. On one hand, the real transaction prices of the apartments that are within the area of indirect influence of the Sudokwon landfill is regressed against the characteristics of the apartment, the proximity to the landfill has a negative relationship. Specifically, 1.08 million won is decreased when the apartment gets 100m closer to the landfill. In other words, households are willing to pay 1.08 million won to get 100m away from the Sudokwon landfill. This acts as evidence for the disamenity caused by the landfill in surrounding areas.

In comparison to the WTP for living outside of the sphere of indirect influence (2km), the average compensation given to each influenced household, seen in Table 6 of Chapter 4 is extremely low. The WTP for living far enough so that the apartment is not included in the sphere of indirect influence is 21.2 million won. Nonetheless, it must be noted that the average per household doesn't reflect how individual compensation is being distributed. It may be the case that those living nearer the landfill are getting more compensation than those that are in the same municipal area but living farther away,

rather than an average. Although the average compensation per household may not reflect how compensation is spread amongst households, this suggests that a thoughtful reallocation of funds must be carried out to ensure an effective and efficient solution to opposition as it has the potential to lower the effects of the landfill on price.

When the interaction effect between the distance to the landfill amount of support given to the municipal area of the apartment is isolated, results shows that more support lowers the intensity of the correlation between the landfill and prices. This implicates that the resident support fund may be effective in lowering the disamenity caused by the landfill. Given the correct level of compensation, residents' opposition may be resolved, to the point that prices increase when it gets closer to the landfill. Therefore, policymakers must be wary in not setting the compensation level excessively high to the point that it cancels out the negative impact caused by the landfill. When using the data given by the SLC regarding compensation programmes for each municipal area, those that received support was receiving an excess amount. On the other hand, areas where compensation was discontinued, not only does price decrease as distance to landfill decreases, but strong opposition exist against the existence of the landfill. This shows that

although moderation is key, compensation is necessary for lowering the impact of the landfill.

The results of this study provides various implications for policymakers and authorities that look to extend the use of the Sudokwon landfill or find an alternative site. Both actions will most likely face opposition from local residents, and the opposition will be mostly justified, in that the existence of a landfill does depress property prices. However, with appropriate compensation schemes in place, resistance may be diffused as property prices actually increase with the existence of the landfill. Yet the fact that strong opposition still exists in the areas surrounding the Sudokwon landfill suggest that either the level of compensation is inadequate, or there is another problem other than environmental disamenity underlying the conflict.

It must be noted, therefore, that the magnitude of the correlation of the landfill is marginal in comparison to other variables. This may be due to the fact that the Sudokwon landfill is one of the largest, most advanced sanitary waste management facility in the world, and causes less environmental disamenity than past literature or opposition suggests. This may suggest that the opposition from locals may not be grounded in environmental disamenity but is instead caused by negative stigma or stereotypes surrounding the

harm caused by the landfill. Therefore, decision-makers must be wary in their selection of compensation, taking into consideration that compensation may act as a form of encouragement to oppose for the sake of opposition, especially since it is extremely difficult to correctly determine the appropriate amount of compensation. Residents may begin to oppose due to the prospect of being compensated, rather than for the actual environmental disamenity caused by the landfill.

## 6.2. Limitations and Future Research

A limitation of this study is one that applies to most hedonic price method studies. It would be near impossible to observe and include every single characteristic of an apartment that affects its price. Some blatant characteristics, such as the direction the apartment faces in terms of the amount of natural light it gets could not be included in the analysis due to the limitation in that data given by the Ministry of Land and Transport. This inevitable flaw of the method may introduce an omitted variable bias to the results.

Moreover, there exists the threat of selection bias, meaning the correlation seen between price and distance to the landfill may not be applicable to the population as a whole, but rather only within the context of those who live in the radius of influence of the

Sudokwon Landfill. There is a possibility of confounding factors other than compensation programmes that the current analysis was unable to isolate or remove, which would further limit to which this study can be used as evidence for the claim that compensation can be used to reduce resident opposition.

Possible improvements that can be made in the future, and thus limitations to the current study would be to include an in-depth breakdown of resident support funds for the years 2007-2009 to the experiment. This would not only allow more observations for a more robust conclusion but also allow the research to examine whether the effect of the change in the resident support fund varies across time, from announcement to actual application. The price data from the MOLIT is also limited in that we are unable to see if the same units were sold at different points of time, due to privacy reasons. These data limitations especially apply to the study at hand, as the data was insufficient for a difference-in-differences method, or other methods to examine the causal effect of the discontinuation of resident support fund as it did not fulfil the assumption of parallel trends. The increase in abundance of data may change this and allow for more comprehensive examination of the problem at hand. The results of this further exploration will allow for stronger evidence to support the conclusion and implications made by this study, that resident

compensation could be used to effectively overcome opposition regarding landfills.

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# 국문초록

쓰레기 매립지는 사회에 필수적인 시설이지만 지역 주민들의 지속적인 반대에 직면해 있다. 이는 대한민국의 폐기물의 상당 부분이 매립되고 있는 수도권매립지에도 해당되는 문제이며, 수도권매립지의 사용 기한이 다가옴에 따라 당국은 새로운 매립지를 수용할 도시를 찾거나 현재 수도권매립지 근처에 살고 있는 지역 주민들이 매립지의 사용 기한 연장을 받아들이도록 설득을 해야 한다. 두 방안 모두 주민 수용성을 높여야 하는 만큼 본 연구는 매립지가 실제로 인근 부동산 가격을 낮추는지, 그리고 수도권매립지공사의 주민 지원금 제도가 어떤 영향을 미치는지 검토한다. 연구 방법은 헤도닉 가격 모형을 사용하며, 수도권 매립지 반경 5km 내에 있는 아파트 매매 실거래가 정보와 아파트의 특성을 분석한다. 결과는 매립지가 실제로 부동산 가격을 낮추는 현상을 보였고, 매립지와 100m 가까워질 때마다 아파트의 매매가가 108만원이 줄어들었다. 이는 매립지로 인한 환경적 비효용을 증명한다. 하지만 보상금을 변수로 추가해 매립지까지의 거리와 상호효과를 검토했을 때 주민지원금이 증가할수록 매립지까지의 거리의 효과가 줄어드는 것을 발견할 수 있었다. 이러한 변화는 매립지의 환경적 비효용을 상쇄시키는 지원금의 효과일 수 있지만, 의사결정자들은 매립지까지의 거리가 아파트의 가격에 영향을 미치는 다른 특성에 비해 효과가 작다는 것을 감안해야 한다. 이는 매립장의 첨단 기술으로 인해 환경적 비효용의 규모가 생각보다 작다는 점 때문일 수 있기 때문에 매립장의 수용성을 늘리기 위해서는 인식 개선 또한 필수적이라 볼 수 있다. 따라서 수용성의 증가에는 지원금의 역할도 중요하지만, 매립지를 반대하는 이들이 보상 또는 지원금을 위한 반대를 하지 않도록 주의가 필요하다.