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Does Water Pollution Influence Willingness to Accept the Installation of a Mine Near a City? Case Study of an Open-Pit Lithium Mine

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Abstract: Currently, the use of lithium as a resource in the manufacturing of technological components such as mobile phones, computers or even in the automotive sector, is in high demand. In this sense, the prospects for lithium open-pit mines in order to obtain this highly valued resource have improved remarkably. However, the installation of this type of mine causes certain negative environmental consequences such as air pollution, water pollution, and even a reduction in the biodiversity of the environment, which generates welfare losses due to the cost involved. The objective of this work is to analyse the preferences of the citizens of Cáceres (Spain) regarding the possible opening of an open-pit lithium mine in the surroundings of the city. For this, a choice experiment was carried out to identify the willingness to accept certain levels of contamination and/or reduction of biodiversity and to quantify its monetary quantification. Likewise, a mixed-effects model was applied in order to analyse the heterogeneity in preferences and the willingness to accept the installation. The results showed that water pollution is one of the most relevant attributes in the preferences, revealing a very high willingness to accept (€12–38/year) for water pollution compared to other attributes.

Keywords: lithium mine; contamination; experiment of choice; preferences; willingness to accept

1. Introduction

Currently, lithium as a natural resource is one of the minerals in most demand worldwide. The applications of the mineral to the electrical industry are remarkable [1]. From its use in batteries in the automotive sector to its application in the computer industry sector, or for use in the pharmaceutical industry, it extends to many components. Therefore, lithium is considered of notable importance among minerals used for the construction of electric batteries [2]. Furthermore, lithium has been incorporated as a critical raw material by the European Union [3]. In this sense, the European Union promotes the creation of investment projects in items such as lithium for use in the electronic field and its development [4].

Another reason for this high demand is the current transition in which advanced economies are immersed worldwide towards production systems that generate low levels of carbon, which leads to an increase in demand for other minerals as an alternative to traditional production systems. In particular, the Kyoto Protocol (1997) [5] establishes the objective of reducing CO₂ emissions between 2008 and 2012 for participating countries using different market mechanisms such as international emissions

trading, more specifically 5% on average in relation to 1990 levels. Thus, the Kyoto pact laid the foundations for subsequent agreements, such as the United Nations Conference on climate change in 2015, under the Paris agreement [6]. The countries attending this conference marked the reduction of the global temperature in the long term as an important objective, as well as the reduction of CO₂ emissions to achieve sustainable development.

Therefore, in recent decades the countries of the so-called “lithium triangle” (Argentina, Bolivia and Chile), which have the highest concentration of lithium in the world, began to exploit these reserves for the production of batteries. In the case of Spain, the San José Valdeflórez project stands out [7] for the development of an industrial plant in Cáceres (Extremadura) aimed at the extraction and processing of lithium, which could become the second largest deposit in Europe. The main objective of this project is to obtain lithium hydroxide for the production of rechargeable lithium-ion batteries used in electric vehicles. However, the companies that are part of this project foresee an economic revitalization in the area, among other aspects through the direct and indirect creation of jobs. In addition, an increase in tax resources could be expected as a consequence of the activity itself.

All these economic benefits are estimated during the project, in addition to the possible environmental impacts that it would entail and how they could be mitigated, for which proposals have been prepared for the recovery of the area and rehabilitation after extraction. However, this initiative is not without its detractors, due to the environmental cost it would entail for the residents of that town. Specifically, the San José Valdeflórez project would be located just 2 km from the urban centre of the city, close to an ornithological reserve and also to a place that has been considered a Special Protection Area for birds since 1989. Although it is true that there was previously a tin extraction mine, upon its closure, this space was considered a natural space and extension of the Llanos de Cáceres and Sierra de Fuentes Area of Regional Interest. Currently, this place, called “Las Minas de Valdeflores”, contains numerous varieties of both flora and fauna, as well as various places to promote and develop ecological tourism, such as botanical or ornithological activities.

Figure 1 shows the location of the project.

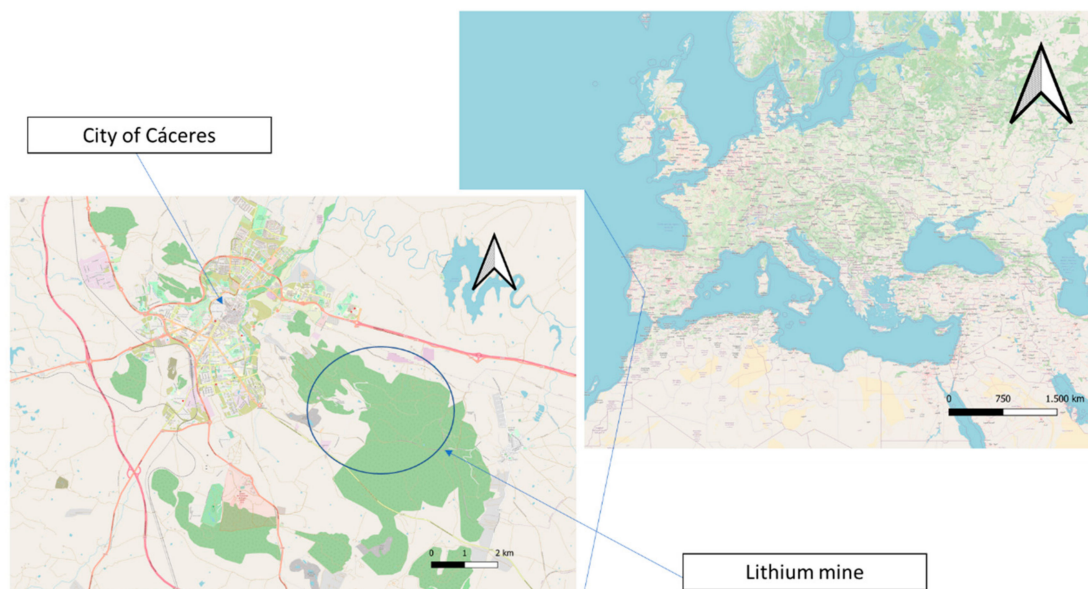


Figure 1. Map of the location of the lithium mine.

There is extensive literature on the well-known syndrome “Not In My Backyard” [8–15]. This phenomenon is defined as the denial of the installation of productions close to the place of residence due to the possible adverse effects that they may cause to citizens. These effects are considered in the economic literature as negative externalities and, in many cases, they address the development

of nuclear power plants in the vicinity of urban centres or at a specific distance. Various studies have addressed this issue focusing on mining projects, highlighting social non-acceptance in the European Union [16], the installation of a gold mine in Turkey [17], mining and quarrying (popularly referred to as ‘digging the backyard’) in the UK [18] or in the case of the Czech Republic [19].

This type of project can generate certain health risks [11,20,21] in addition to other conflicts in terms of environmental justice and its valuation [22,23]. In this sense, there is high demand for reports on corporate social responsibility for companies in the mining and energy sector [24] and a more equitable use of mining resources [25]. The externalities that these facilities can generate are numerous; however, in the case of an open-pit lithium mine there are several fundamental aspects that mark a clear negative impact on the citizens who live in its vicinity and who, therefore, must be evaluated in terms of considerations of human health, as happens in various parts of the world [11,20,26].

With regard to potential damage, an open-pit lithium mine project can have various effects, similar to those caused by a gold mine [20,21]. In the first place, it requires the use of a scarce resource such as water for the dissolution of the mineral. This triggers chemical reactions that end up generating sludge and contaminated water that can have a great environmental impact if not managed properly. Second, another process involved in obtaining lithium [27] is the calcination of the mineral ores, which generates significant emissions of combustible gases and consequently immediate air pollution. Finally, the installation and opening of the mine supposes the elimination of the existing biodiversity in the area, even more so when the installation is located close to areas with significant environmental contributions due to their biodiversity.

Against this background in operating large enterprises, and as a mechanism to mitigate the adverse effects caused by such actions, the sustainable development goals (SDGs) set different objectives to try to reduce the impacts that the world faces from different perceptions: environmental, political and economic [28]. In particular, the installation of an open-pit mine, as mentioned above, can influence the following sustainable development goals: SDG 6: clean water and sanitation [29], SDG 11: sustainable cities and communities [30], SDG 13: climate action [31], and SDG 15: lives of terrestrial ecosystems [32]. Therefore, it seems necessary to analyse the impact that the installation of this mine would have on these objectives for the sustainable development of the area.

In this context, the objective of this work is to analyse the preferences and the willingness to accept as a measure of well-being and cost of the installation of the open-pit mine near the city of Cáceres. For this, the choice experiment methodology will be applied, which will allow us to assess the willingness of citizens to accept the different externalities that the mine can generate: water and air pollution and loss of biodiversity. In addition, we propose the estimation of the mixed logit model, since it allows individual parameters to be obtained that will enable the analysis of preferences heterogeneously.

Willingness to accept (WTA) as a measure to value goods without a market is a powerful tool used in the field of environmental economics [33–36]. This willingness to accept or be compensated represents the minimum amount of money that an individual would be willing to receive for giving up the said asset. Therefore, within the objective of this work, this tool allows this to be answered, evaluating the externalities that occur in the installation of mining projects of this type, as in the case of nuclear power plants in China [12].

2. Material and Methods

2.1. Data Collection

The data were collected from a survey of people residing in the city of Cáceres and its surroundings during the years 2018–2020, from which a total of 219 valid surveys were obtained, using simple random sampling. The questionnaire was structured in two parts: in the first part, the respondent is introduced to the assessment exercise that is going to be carried out, where they are informed about the experiment and the purpose of the assessment. A section of “cheap talk” has been included: this is

a brief explanatory introduction to the experiment that they are going to carry out on which one is asked to position oneself as closely as possible to one's real situation, in order to avoid the hypothetical bias of the experiment [37,38]. A description of the different levels of each attribute is also included, as well as the "choice experiment" methodology used. In the second part, questions related to the most representative socioeconomic variables are addressed.

The main descriptive statistics of the sociodemographic characteristics of the sample are included in Table 1. The average profile of respondents in the sample surveyed was: 37 years old, with a percentage of women of 48.88%, and 57.99% of the respondents having higher education. Regarding income, around 40% of those surveyed state that they have an income of more than €800 and less than €2500 per month. We include information from city of Cáceres (province or regional data when the information is not available). It must be considered that the sample is not only from Cáceres, but also from nearby urban centres that could be affected by the installation of an open lithium mine.

Table 1. Variables and sample sized used: descriptive statistics.

Variable	Sample	City of Cáceres (2019)
Age (years)	37.30	45.66
Gender (% woman)	48.88%	50.43% ¹
Household size	3.5	2.44 ²
Household income	<€800	10.50%
	>€801 and <€1400	25.11%
	>€1401 and <€2500	38.81%
	>€2500	51.59%
Educational level (%)	Primary education	13.34%
	Secondary education	25.57%
	Higher education	57.99%
		26.8% ²

¹ Data from Province ² Data from Region (Extremadura).

2.2. Choice Experiment

From the first applications of the choice experiment models in the field of transport and marketing [39], multiple applications have been developed, both for environmental assessment [40–42], and in the field of health economics [43,44] or the agrifood sector [45,46]. In this paper, this alternative is proposed to obtain an assessment of citizens' preferences regarding the installation of an open lithium mine in the surroundings of their city, since the relevance of the cost in environmental terms could imply a loss of well-being for the residents. After that, we can follow the step of applying the choice experiment: (1) selection of attribute and levels; (2) experimental design and choice set; (3) data collection; (4) estimation method [47].

To do this, the following attributes were incorporated into the choice experiment: water pollution, air pollution, reduction of biodiversity and the annual price that they are willing to accept. The selection of the attributes and their levels has been based on the effects that the installation of this type of facility entails for the citizens closest to the mine. All the attributes, as well as the different levels, are listed in Table 2.

From the proposed experiment, the total set of comparisons given the selected attributes amounts to 108 ($3 \times 3 \times 3 \times 4$), which entails a practically impossible number of comparisons for an individual to respond to ($108 \times 107 = 11,556$). To carry out the design, the Stata "Dcreate" module was used, which allows a fractional design to be generated to reduce the number of comparisons with an efficiency level [48]. Specifically, the module uses the modified Fedorov algorithm to create an efficient design [43]. This type of design practice is frequently used in the choice experiment [39]. Finally, eight choice sets were generated that were incorporated into the survey. Each choice set consists of two alternatives and the choice of none of the above. Table 3 shows an example of the choice set.

Table 2. Attributes and levels of the choice set.

Attribute	Levels	Variable
Water contamination (increase)	Current situation	Water
	10%	Water-
	20%	Water-
Air pollution (increase)	Current situation	Air
	10%	Air-
	20%	Air-
Biodiversity (reduction)	Current situation	Bio
	10%	Bio-
	20%	Bio-
Price	€10/year	Price
	€20/year	
	€30/year	
	€40/year	

Table 3. Comparison example used in the choice experiment.

Comparison 1			
Attributes	Situation 1	Situation 2	Situation 3
Water pollution (increase)	20%	10%	Maintain current levels (Status Quo)
Air pollution (increase)	10%	10%	
Biodiversity (reduction)	20%	Current situation	
Price	€30/year	€30/year	
Select option			

2.3. Econometric Model

The model used to analyse citizens’ preferences regarding the acceptance of the installation of an open-pit mine on the outskirts of the city was the random parameter logit model (RPL), as it allows the heterogeneity of the responses in the valuation to be studied.

These models, which are a variant of the random utility models [49], assume that the utility function of each individual is the sum of two terms, a deterministic part that can be described as a function of the factors that influence the utility of individuals and another random, unobserved part that is considered stochastic. Therefore, following [50], we can assume a sample of i individuals with the option of choosing between A alternatives on t occasions, from which the utility of an individual i derived from the choice of an alternative on occasion t is the following:

$$U_{iat} = \beta'_i x_{iat} + \varepsilon_{iat} \tag{1}$$

where β'_i is the vector of specific coefficients of each individual, x_{ait} is the vector of the observable attributes of the individual n and the alternative j on the occasion of election t , $y \varepsilon_{njt}$ is the random term we assume to be an independently and identically distributed extreme value. Therefore, the probability of answering n choosing the alternative i in the election t is given by the following expression:

$$P_{iat}(\beta) = \frac{\exp(\beta'_i x_{iat})}{\sum_{a=1}^A \exp(\beta'_i x_{iat})} \tag{2}$$

Expression 2 shows the conditional logit formula [49]. In this work the approach of the simulation method will be used [51], in which the log likelihood is given by Equation (3):

$$L_i = \prod_{t=1}^T \sum_{a=1}^A d_{iat} \hat{P}_{iat} \tag{3}$$

where d_{iat} is the indicator that takes the value 1 for the alternative chosen at time t and 0 at another time. The overall log-simulated likelihood is $\sum_{i=1}^N \ln(L_i) * \hat{P}_{iat}$, which represents the simulated probabilities:

$$\hat{P}_{iat} = \frac{1}{M} \sum_{m=1}^M P_{iat}(\beta^m) \quad (4)$$

where β^m are the random parameters derived from $\int(\beta)$ and M is the number of random draws. Finally, the estimation is the following:

$$U_{njt} = \beta_0 ASC_1 + \beta_1 ASC_2 + \beta_2 Water_{njt}^- + \beta_3 Water_{njt}^{--} + \beta_4 Aire_{njt}^- + \beta_5 Air_{njt}^{--} \\ + \beta_6 Bio_{njt}^- + \beta_7 Bio_{njt}^{--} + \beta_8 Price_{njt} + \varepsilon_{njt} \quad (5)$$

where β_0 and β_1 are associated with the current situation (alternative specific constant for each choice, ASC), and β_k is the marginal utility associated with each attribute, which shows how the utility level changes if the provision of each attribute increases. Specifically, β_2 and β_3 refer to water, β_4 and β_5 to air, whereas β_6 and β_7 are related to biodiversity, and β_2 and β_8 refer to price.

2.4. Willingness to Accept

In turn, when we introduce the price coefficient in the choice experiment, the marginal ratio of substitution between a coefficient and the price is the WTA for the specific attribute. It is thus calculated as follows:

$$WTA_x = -\left(\frac{\beta_k}{\beta_{Price}}\right) \quad (6)$$

Therefore, the WTA_k represents how much consumers would be willing to accept in monetary terms for each level increase of the attribute k that the product provides.

3. Results

3.1. Preferences

Next, the results are shown after applying the mixed-effects model discussed in the methodology section. Table 4 shows the coefficients, expressed in mean value, of the estimation of the mixed logit model together with their significance and the standard deviation for the three environmental attributes (water pollution, air pollution, reduction of biodiversity), the ASC (alternative specific constants) and the price attribute, as well as the standard deviations in order to offer a vision of the heterogeneity of consumer preferences.

A negative (positive) sign in the coefficient of an attribute means that attribute provides a negative (positive) utility to the consumer. The results show that all the coefficients of the attributes are statistically significant and negative, with the exception of the price attribute and ASC. This shows that consumers state that the polluting effects (air, water and biodiversity) of the installation of a mine generate a negative utility for them; that is, they are detrimental to the well-being of citizens. Price has a positive sign, since it shows a greater preference over receiving a greater amount of money annually. In addition, the coefficients of ASC1 and ASC2 are significant and positive, which indicates that consumers state that a change with respect to the current situation in any of the two comparisons offered generates a positive utility.

Regarding the value of the coefficients, consumers show a higher valuation in average terms for the attribute "water", since the coefficient corresponding to a 20% increase in water pollution (−2.4762) compared to the current level of pollution is the highest of the set of attributes presented. This result shows that water pollution is more important in the utility of respondents' preferences than air pollution or biodiversity, although the second attribute with the highest coefficient in absolute terms is that related to the 20% reduction of biodiversity. On the other hand, if we focus on a 10% increase in

pollution, the most valued attribute is “air” (−1.5233), while the 10% reduction in biodiversity is the attribute least valued (−0.4756) by respondents.

Therefore, the results show that the greatest effect on the utility of respondents is produced by water pollution, especially at high levels; air pollution remains at medium levels and biodiversity is not very important when it is a small loss, but becomes so when the loss is at 20%.

The analysis of the standard deviations of the coefficients (lower part of Table 3) reflects some heterogeneity in the results. The highest values are obtained in water pollution, followed by air pollution and, finally, by the loss of biodiversity. This implies that there is a greater presence of heterogeneity in preferences regarding water pollution, showing a greater breadth of the results obtained, which highlights the relevance of analysing the heterogeneity of preferences.

Table 4. Results of the mixed logit.

Mixed Logit		
	Coef.	SE
Mean		
ASC1	1.9773 ***	0.2601
ASC2	2.3356 ***	0.2682
Water-	−1.0520 ***	0.3037
Water-	−2.4762 ***	0.6243
Air-	−1.5233 ***	0.2886
Air-	−1.4713 ***	0.2706
Bio-	−0.4756 ***	0.1944
Bio-	−2.1084 ***	0.2392
Price	0.0974 ***	0.0093
SD		
Water-	3.2254 ***	0.3625
Water-	5.9336 ***	0.5745
Air-	3.0692 ***	0.3006
Air-	1.6910 ***	0.2449
Bio-	0.7875 ***	0.3136
Bio-	1.9520 ***	0.2537
N	219	
Log-Likelihood	−1,419,8826	
LR chi2	194.49	
Prob > chi2	0.0000	
AIC	2869.765	
BIC	2954.525	

Note: Statistically significant at a level of *** 0.01.

3.2. Willingness to Accept

The results obtained from the estimation of the WTA for each attribute and their intervals are shown in Table 5.

The results of WTA show that the highest value corresponds to water contamination at 20% with respect to the current situation, which is valued as €25.41/year indicating that consumers are able to pay €25.41 per year in order to avoid a 20% water contamination increase, where the variation range is (12.15–38.68). Therefore, while the minimum value of the interval is at similar average levels to the rest of the attributes, the maximum value is the highest of all, which places this attribute as a relevant cost to take into account in the assessment made by citizens. The WTA for 10% contamination levels of water is in penultimate position (15.63), after the WTA of biodiversity loss of 10% (4.88). On the other hand, when considering the heterogeneity of preferences in terms of possibilities of an increase in environmental pollution of 10%, a minimum value of 4.21 and a maximum value of €17.37/year are obtained for water.

Table 5. Estimation of willingness to accept (WTA).

Mixed Logit		
Variable	WTA (Mean)	Interval for WTA *
Water-	10.79	(4.21–17.37)
Water-	25.41	(12.15–38.68)
Air-	15.63	(9.31–21.96)
Air-	15.10	(9.46–20.74)
Bio-	4.88	(0.73–9.03)
Bio-	21.64	(16.28–27.00)

* Estimated by delta method to construct the confidence intervals.

Secondly, and as a sample of the assessment of those surveyed for a reduction in biodiversity of 20%, they are willing to pay €21.64/year to avoid a loss of biodiversity in the area of 20%, although the interval is not as wide or as high as that of water pollution (16.28–27.00). On the other hand, the WTA for 10% biodiversity loss is the lowest of all the coefficients, as is its interval (0.73–9.03). Air pollution is located in an intermediate situation of both attributes, which present values of around €15/year for both increases in levels of 10% and 20% with respect to the current situation, with an oscillation between €9.3 and €21, approximately. This result shows that air pollution at different levels has a better acceptance in average terms than water pollution and loss of biodiversity at 20%.

Finally, various scenarios can be reached, conformable to the WTA previously calculated in Table 6.

Table 6. Willingness to accept of different scenarios.

Scenario	WTA (Mean)
Water-, Air -, Bio -	€31.30
Water-, Air -, Bio -	€30.77
Water-, Air -, Bio -	€48.06
Water-, Air -, Bio -	€45.92
Water-, Air -, Bio -	€45.39
Water-, Air -, Bio -	€62.68
Water-, Air -, Bio -	€47.53
Water-, Air -, Bio -	€62.15

As can be seen, going from the current situation to one in which it increases by 10% in all attributes would mean an average of €31.30, being €14.25 the minimum value and €48.36 the maximum one which increases when any of the attributes becomes 20%. The worst situation in terms of costs is situated in the scenario in which pollution increases equally by 20% with respect to the starting levels, reaching €62.68 on average and a maximum value of €87.64. However, the results seem to show that in the case of air, once a certain level (10%) is polluted, an increase of another 10% in pollution is less valued compared to the other situations.

4. Discussion

Carrying out business projects often leads to the generation of costs associated with the environment, which, in turn, are often difficult to quantify. The valuation of the externalities caused by business activities allows us to approach a quantification of the welfare loss/gain that consumers experience as a consequence of this external effect. The results of the analysis carried out highlight that environmental pollution, whether by air, water or as a reduction in biodiversity, leads to a loss of wellbeing for the respondents, which is a matter of certain relevance for the public and private management of these business projects. The significance of the ASC coefficients seems to indicate that, with respect to the current situation, the installation of the mine itself would entail a positive utility for citizens. This can be explained by the increased value that the project will generate in the area,

from both the mere economic point of view of said area, through the revitalization of the area and the direct and indirect creation of jobs, but it will also mean a higher income for the public coffers.

The results obtained seem to indicate that there is a certain presence of the “Not in My Backyard” theory, since the preferences revealed by people are negative for all the attributes and levels analysed, except for the price, indicating a rejection of the project in the surroundings of the urban nucleus. This is in line with other works that address nuclear power plant facilities [8,11,12,52], construction of waste incineration power plants [10,13] or in cases similar to the one studied for mine projections [16–18,23].

It also shows that there is an assessment of the possible environmental damage that this type of project generates for the health of citizens, as has been observed in other geographical areas such as in the Amazon in relation to human health risks from arsenic in gold mining [20] or in Ghana, also for a gold mine [21], or for nuclear power plants [11]. This fact entails an awareness and concern of citizens for these aspects and that demand the attention of management by public policies to take these opinions and preferences into account. However, these limitations do not necessarily have to imply that these industrial projects be discarded, since they are positioned as an option for a low-carbon economy [1], but there should be a comprehensive analysis of the social impact, environmental and health terms for the population, and corrective actions should be proposed when necessary and provided that the overall assessment of the project is positive.

The high assessment that respondents attribute to water pollution is in line with other studies that analyse public preferences for water ecosystem services [53] or the higher willingness to pay for water purification in India [54] and in Nigeria [55] or for the valuation of water in Ireland for rivers, sea or lakes [56]. However, the values of willingness to pay to improve water quality through improvement programmes [57] are below those achieved in other works, for example the case of Finland [58], or of ecological compensation for water quality in China [33]. This assessment by citizens seems to assume that citizens can learn about the operation of the mine and the inherent risks that the exploitation of natural resources pose to water quality through the use of water to obtain lithium.

On the other hand, there is a willingness to pay for air quality at higher levels than in other studies that analyse it in the Regional Municipality of Hamilton-Wentworth [59], or the social acceptance of air quality in China [16]. In addition, the values in global terms are higher than the results obtained in other studies that analyse the price of clean air and take the damage to health into account [54]. Likewise, when compared with opencast coal mining situations, similar results are also obtained for air quality [19,21,60].

The reduction of biodiversity has been shown to be a significant attribute for its conservation, in line with the works that address biodiversity as a value in itself [40,53] or studies that incorporate the effects of the implantation of a mine or some types or facility in the vicinity on the biodiversity of the ecosystem [13,16,22]. This situation highlights the relevance of biodiversity for people and their well-being, which is in line with the SDGs [27].

Finally, Table 6 allows the different scenarios about the effect of the project on the individual’s welfare to be considered. As we can see, the lowest value is around €30, and the highest (or worst) is more than €60. This can be considered to evaluate the impact of the loss welfare and decide what policy is more effective to avoid the lowest or highest value on an individual’s welfare. Also, the heterogeneity allows the maximum value to be shown in the worst situation, that is, when both the water and air present higher values of contamination; nevertheless, it is close to the maximum values in which all attributes are in a worse situation.

5. Conclusions

The aim of this work was to carry out an environmental assessment of the potential impact of the installation of an open-pit lithium mine around a city, in this case Cáceres (Spain). The main motivation for this type of industrial project was based on the need to find new viable alternatives to achieve a gradual transition towards a low CO₂ emissions economy, which implies the incorporation of practices that reduce these emissions. Given this need, the development and generation of electric batteries are

presented as a feasible alternative in the market, despite the fact that the manufacture of these from lithium and its extraction may lead to negative externalities being generated in the production process that must be considered.

The externalities analysed in this work were of three types: contamination of water, air and the possible loss of biodiversity that could occur as a result of carrying out the project. It is true that these negative external effects will be present regardless of the location of the project in question, although the valuations and environmental consequences may vary when their location is in the vicinity of a city or residential nucleus as opposed to carrying it out in an environment further from the urban nucleus. The 'Not in My Backyard' theory shows how people are reluctant to accept or show some degree of rejection towards facilities around their place of residence. In fact, our results confirm this theory by obtaining a negative assessment of the externalities based on the preferences of the people living in the vicinity of the facility.

More specifically, water pollution was the most valued by the respondents, and as a sample of this, the respondents stated that they are very willing to accept pollution levels higher than the current ones; that is, they require a higher monetary amount for accepting a 20% increase in water pollution levels compared to the current situation. Likewise, the loss of biodiversity by 20% was also a highly valued externality. Finally, air pollution was in an intermediate position. These evaluations highlight the need to take into account these environmental costs in the projects to be carried out and the rejection shown for lithium mine facilities in the vicinity of populated centres. The measurement of heterogeneity allowed a broader view to be obtained of individuals' preferences and willingness to accept, although, to the best of our knowledge, there are no results that indicate that these externalities are not valued.

An important element that results from this study is the public attitude towards a high valuation of externalities, which in some cases could be an impediment to the development of this type of project. The preferences of the people who live in the surroundings of the facilities and, therefore, who are affected by these adverse effects, are a relevant weight in political decision-making, since the implementation of the mine would mean a loss of wellbeing for them.

For all these reasons, and despite the limitations that it could entail, monetary compensation is proposed as an alternative to the scenario of increased pollution. Thus, for example, despite the fact that individuals would be willing to accept a certain amount of pollution/reduction of biodiversity at certain levels, if they produce damage it could become permanent. In turn, monetary compensation does not have to be designed to offset the loss of welfare given and, therefore, lose its objective. Finally, environmental damage would not be compensated in any way and this would entail numerous repercussions for sustainable economic development in the long term.

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