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Neutrosophic Assessment of Corporate Responsibility in Ecuador's Environmental Context

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Abstract. Currently, the environmental situation in Ecuador faces significant challenges due to the interaction of companies with the surroundings. The need to mitigate environmental damage in a context of indeterminacy and complexity becomes a priority. Under a neutrosophic approach, this study aimed to evaluate the responsibility of companies in cases of environmental damage in Ecuador. The results obtained from the neutrosophic Entropy method reveal a balance between certainty and indeterminacy in the assessment of criteria such as the severity of environmental damage and regulatory compliance. Collaboration and effective regulation emerge as essential, as well as the importance of ongoing assessment. Additionally, the neutrosophic Aras method addresses and highlights the indeterminacy of the issue and emphasizes the need for fair and consistent environmental management to promote corporate responsibility in protecting Ecuador's environment.

Keywords: environmental damages, regulatory compliance, community impact, corporate responsibility.

1 Introduction

In recent decades, the debate regarding corporate responsibility in the event of environmental damage has gained significant prominence in both society and the academic sphere [1]. The escalating concern for environmental conservation has prompted scrutiny of the role of businesses and their responsibility in safeguarding natural resources. Of particular note is that in Ecuador, instances of environmental damage caused by companies have been documented across various sectors and geographic regions. These include:

- The oil sector in the Amazon: Ecuador has experienced significant environmental damage in the Amazon region due to oil extraction. Oil spills and resulting pollution have affected indigenous communities and the region's biodiversity [2].
- Mining in Zamora-Chinchipe: Mining, particularly gold mining, has been a source of concern in the province of Zamora-Chinchipe. Although environmental damage has been reported, its exact magnitude and extent may be uncertain due to a lack of complete data and variability in the application of environmental regulations (indeterminacy).
- Agriculture and pesticide use: The use of pesticides and fertilizers in agriculture has resulted in soil and water contamination in various regions of Ecuador [3]. These cases have been documented and steps have been taken to address the problem.
- Pollution in the Guayas River Basin: The Guayas River basin, which includes the city of Guayaquil, has experienced high levels of pollution, primarily due to industrial activity and urban growth. This contamination is a well-established concern within the analysis.
- Mineral extraction in El Cobre: The mineral extraction project in El Cobre, in the province of Azuay, has generated controversy. Some claim it has caused significant environmental damage, while others argue that steps have been taken to minimize its impact. The situation is the subject of debate that presents levels of indetermination existing in the variability of the criteria (indeterminacy).
- Industrial fishing in Galapagos: Industrial fishing around the Galapagos Islands has raised concerns about sustainability and potential damage to the marine ecosystem [4] [5]. The exact assessment of these damages may be uncertain in the results presented to the study (indeterminacy).
- Deforestation in the coastal region: Deforestation in the coastal region of Ecuador has been a well-documented problem, with the conversion of forests to agricultural and urban land [6]. The evidence supports the existence of environmental damage.

These examples illustrate the impact of environmental damage in different regions of Ecuador. The information reveals levels of indeterminacy regarding the quantification of damages, the obtained information, and contradictions in possible impacts. Therefore, it should be analyzed through the application of neutrosophy to assess certainty or indeterminacy in data related to environmental damages caused by Ecuadorian companies. The variety of neutrosophic degrees reflects the complexity and diversity of the situation in the country in recent years.

Another point to analyze is focused on the regulations governing responsibility for environmental damage in Ecuador. In general, these regulations establish the obligation of companies to repair environmental damages. Additionally, they set forth the sanctions and measures that can be applied in case of non-compliance with these obligations. The following regulations are outlined:

- The Constitution of the Republic of Ecuador of 2008 recognizes the rights of nature and establishes the obligation of the State and individuals to protect the environment and restore affected ecosystems.
- The Environmental Management Law establishes standards for environmental management in the country and defines environmental damage as any significant loss, decrease, detriment, or impairment of pre-existing conditions in the environment or one of its components.
- The Mining Law establishes the obligations and responsibilities of mining companies concerning the environment.
- The Prevention and Environmental Control Law sets standards for the prevention and control of environmental pollution [7].
- The Water Law establishes standards for the management and use of water in the country.
- The Forest Law establishes standards for the conservation and sustainable use of forests.

In Ecuador, various legal actions can be taken to establish responsibility for environmental damage. Some of these actions include:

- Civil actions: Civil actions aim to repair environmental damage caused by the company. These actions can be filed by any person or entity that has suffered environmental damage and may include claims for compensation for the damages incurred.
- Criminal actions: Criminal actions seek to sanction the company for the environmental crime committed. These actions can be brought by the Ministry of the Environment or by any person who is aware of the commission of the crime.
- Administrative actions: Administrative actions seek to sanction the company for the violation of environmental regulations. These actions can be filed by the Ministry of the Environment or by any entity responsible for environmental monitoring and control.
- Protective actions: Protective actions aim to protect the environmental rights of individuals and nature. These actions can be brought by any person or entity that believes their environmental rights are being violated.

In general, these actions seek to establish corporate responsibility for environmental damage and pursue their remediation. Moreover, these actions may include sanctions and measures to prevent the recurrence of such damage in the future. This highlights the need for ongoing assessment and strengthened efforts to ensure increased effectiveness in promoting corporate environmental responsibility in Ecuador [8-19-20]. Therefore, the main objective of this study is to:

- Evaluate corporate responsibility in cases of environmental damage through a neutrosophic analysis approach.

2 Methods

2.1 Neutrosophic analysis

The neutrosophic set is defined by the following elements: true α, indeterminate β, and false γ of x in G, respectively and their images constitute standard or non-standard subsets within the range $\{0,1\}$. For X of the universe of discourse, it is defined from the single-valued neutrosophic set G over X as an object in the representation $G = \{\langle x, \alpha_G(x), \beta_G(x), \gamma_G(x)\rangle : x \epsilon X\}$.

Where $\alpha_G(x), \beta_G(x), \gamma_G(x)$ satisfy the following condition for all $x \in X$. So, to define each Single Valued Neutrosophic Number (SVNN), it is expressed as follows: $G = (o, i, z)$ for the modeling of the study.

Therefore, $o = \vartheta_G(x)$, $i = \beta_G(x)$, and $z = \gamma_G(x)$ correspond to the true, indeterminate, and false membership functions, respectively.

To determine a point within the neutrosophic set Y(G) from a number (G), we proceed to use the formula proposed by Smarandache or the formula proposed by Basset, according to equations (1) and (2).

$$Y(G) = o + z - i \quad (1)$$

$$Y(G) = \frac{o + z - i}{2} \quad (2)$$

For the modeling of the methods and evaluation of the criteria, they are defined according to the scales shown in Table 1.

Table 1: Linguistic terms that represent the weight of the importance of the criteria. Source: own elaboration.

Linguistic scale	**SVNN** $(\boldsymbol{o}, \boldsymbol{i}, \boldsymbol{z})$
Very High (VH)	(0.95,0.15,0.14)
High (H)	(0.7,0.2,0.25)
Medium (M)	(0.50,0.55,0.5)
Low (L)	(0.3,0.8,0.80)
Very Low (VL)	(0.10,0.90,0.95)

For the evaluations concerning the alternatives and criteria, an importance scale is defined for each SVNN according to the scales shown in Table 2.

Table 2: Linguistic terms that represent the neutrosophic weight of the alternatives and criteria obtained. Source: own elaboration.

Linguistic term	SVNN
Extremely good (EG)	(1,0,0)
Very very good (VVG)	(0.95,0.05,0.15)
Very good (VG)	(0.85,0.15,0.25)
Good (G)	(0.75,0.25,0.35)
Moderately good (MDG)	(0.65,0.35,0.45)
Medium (M)	(0.55,0.45,0.55)
Moderately bad (MDB)	(0.45,0.55,0.65)
Bad (B)	(0.35,0.65,0.75)
Very bad (VB)	(0.25,0.75,0.85)
Very very bad (VVB)	(0.15,0.85,0.95)
Extremely bad (EB)	(0,0.95,1)

2.2 Neutrosophic entropy

This method was proposed by Zeleny in 1982. It assumes that the neutrosophic importance of a criterion should be proportional to the amount of information inherently provided by the set of alternatives regarding that criterion [9]. Neutrosophic entropy measures uncertainty and indeterminacy in the information formulated using probability theory. It indicates that a broad distribution represents more indeterminacy than one with pronounced peaks.

The greater the diversity in evaluations (values) of alternatives, the more importance that criterion should have in the final decision, as it has greater discrimination power among alternatives [10]. The method measures the diversity and indeterminacy of a criterion through entropy. The calculated entropy is higher when the evaluations of the considered alternatives are more similar. For the development of the neutrosophic entropy method, it is calculated in the following steps:

Step 1. Construction of the decision matrix (see Figure 1).

Figure 1: Neutrosophic entropy decision matrix. Source: own elaboration.

$$\begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ r_{21} & r_{22} & \cdots & r_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ r_{m1} & r_{m2} & \cdots & r_{mn} \end{bmatrix}$$

Step 2. Calculation of the normalized decision matrix P_{ij}, the objective of normalization is to obtain dimensionless values of different criteria to make comparisons between them. It is calculated using Equation (3).

$$P_{ij} = \frac{x_{ij}}{\sum_{i=1}^{m} x_{ij}} \tag{3}$$

Step 3. Calculation of entropy E_j, using Equation (4)

$$E_j = -k\left(\sum_{i=1}^{m} P_{ij} ln(p_{ij})\right), donde\ t = 1, 2, 3, \ldots, n. \tag{4}$$

Where $k = \frac{1}{\ln m}$ is a constant that guarantees $0 \leq E_j \leq 1$ and m is the number of alternatives.

Step 4. Calculation of criterion diversity D_j, Equation (5) allows this parameter to be calculated.

$$D_j = 1 - E_j \tag{5}$$

Step 5. Calculation of the normalized weight W_j of each criterion, using Equation (6).

$$W_j = \frac{D_j}{\sum_{i=1}^{m} D_j} \tag{6}$$

2.3 Aras neutrosophic

The neutrosophic ARAS method determines the complex relative efficiency of a feasible alternative is directly proportional to the relative effect of the values and weights of the main criteria considered [11]. By relying on the theory of utility and the analysis of the neutrosophic Aras [12], the steps of this method are described below:

Step 1: Formation of the decision matrix L_{ij} (see Figure 2).

Figure 2: Decision matrix L_{ij} of the neutrosophic Aras method. Source: own elaboration.

$$\begin{bmatrix} l_{11} & l_{12} & \cdots & l_{1j} & \cdots & l_{1n} \\ l_{21} & l_{22} & \cdots & l_{2j} & \cdots & l_{2n} \\ \vdots & \vdots & \ddots & \vdots & \ddots & \vdots \\ l_{i1} & l_{i2} & \cdots & l_{ij} & \cdots & l_{in} \\ \vdots & \vdots & \ddots & \vdots & \ddots & \vdots \\ l_{m1} & l_{m2} & \cdots & l_{mj} & \cdots & l_{mn} \end{bmatrix}$$

Step 2: Calculation of the normalized decision matrix $\bar{L}_{ij}$, taking into account the beneficial (B) and non-beneficial (NB) values, it is calculated using Equation (7) and (8):

$$\bar{L}_{ij} = \frac{l_{ij}}{\sum_{i=0}^{m} l_{ij}} \tag{7}$$

$$L_{ij} = \frac{1}{l_{ij}^{*}} \tag{8}$$

Step 3: Calculation of the weighted normalized decision matrix is calculated with Equation (9) and in Figure 3.

$$\hat{L}_{ij} = \bar{L}_{ij} \cdot W_j \tag{9}$$

Figure 3: Normalized decision matrix. Source: own elaboration.

$$\begin{bmatrix} \hat{l}_{11} & \hat{l}_{12} & \cdots & \hat{l}_{1j} & \cdots & \hat{l}_{1n} \\ \hat{l}_{21} & \hat{l}_{22} & \cdots & \hat{l}_{2j} & \cdots & \hat{l}_{2n} \\ \vdots & \vdots & \ddots & \vdots & \ddots & \vdots \\ \hat{l}_{i1} & \hat{l}_{i2} & \cdots & \hat{l}_{ij} & \cdots & \hat{l}_{in} \\ \vdots & \vdots & \ddots & \vdots & \ddots & \vdots \\ \hat{l}_{m1} & \hat{l}_{m2} & \cdots & \hat{l}_{mj} & \cdots & \hat{l}_{mn} \end{bmatrix}$$

Weight values W_j are determined using the Entropy method. Where W_j is the weight of criterion j and $\bar{L}_{ij}$ is the normalized classification of each criterion.

Step 4: Calculation of the optimization function S_i by using Equation (10).

$$S_i = \sum_{j=1}^{n} \hat{L}_{ij} \quad (10)$$

Where S_i is the value of the optimization function of the alternative i. This calculation has a directly proportional relationship with the process of the values $\hat{L}_{ij}$ and weights W_j of the investigated criteria and their relative influence on the final result.

Step 5: Calculation of the degree of utility. This grade is determined by comparing the variant that is being analyzed with the best S_o, according to Equation (11).

$$K_i = \frac{S_i}{S_o} \quad (11)$$

Where S_i and S_o are the values of the optimization function. These values range from 0 to 100%, therefore, the alternative with the highest K_i is the best of the analyzed alternatives [13-17].

3 Results

The preliminary neutrosophic analysis establishes indeterminacies when assessing the effectiveness of corporate environmental responsibility in Ecuador. These government regulations and policies are not applied to their full extent and scope in the country regarding corporate environmental responsibility in cases of environmental damage. The neutrosophic analysis of regulations and the analyzed information defines the inherent indeterminacies in this matter:

- Regulatory Compliance: In terms of the existence of environmental regulations, there is a degree of truth in Ecuador. The country has laws and regulations aimed at protecting the environment and promoting corporate responsibility in this area. This reflects a solid foundation for regulation.
- Implementation of Regulations: The actual effectiveness of the implementation of regulations and government policies is an area of indeterminacy. Although there are regulations on paper, their effective implementation can vary depending on factors such as supervisory capacity, corruption, and industry pressure.
- Imposed Sanctions: Sanctions imposed for environmental damage show a degree of truth in Ecuador. There have been documented cases where companies have faced legal and financial consequences for violating environmental regulations. This reflects a degree of compliance and enforcement.
- Effectiveness in Prevention: The ability of regulations and government policies to prevent environmental damage is an area of indeterminacy. While sanctions have been applied in response to damage, the ability to prevent damage in the first place is variable and, in some cases, questionable.
- Corporate Involvement: The active involvement of companies in promoting environmental responsibility is an uncertain aspect. Some companies may voluntarily engage in responsible practices, while others may resist or minimize their responsibility.

The evaluation of the effectiveness of regulations and government policies regarding environmental responsibility presents levels of existing indeterminacy. This emphasizes the need to promote and enhance actions and best practices to mitigate environmental damage in Ecuador. For this purpose, the following actions and best practices are proposed based on the findings of the preliminary neutrosophic analysis:

I. Strengthening the enforcement of regulations: Existing environmental regulations should be enforced more effectively. This includes stricter supervision, harsher penalties for non-compliance, and a legal framework ensuring that companies comply with regulations.

II. Promoting transparency and citizen participation: Promote transparency in the disclosure of environmental information by companies. This encourages citizen participation in environmental decision-making, improving accountability and responsibility.

III. Incentives for environmental responsibility (Indeterminacy): Fiscal and financial incentives can be established for companies that demonstrate effective commitment to environmental responsibility. The effectiveness of these incentives may vary depending on implementation.

IV. Strengthening education and awareness: Environmental education and public awareness are essential to foster a culture of environmental respect. Awareness campaigns and educational programs can help improve understanding and attitudes toward the environment.

V. Promotion of Corporate Social Responsibility (CSR) (Indeterminacy): Encourage the incorporation of CSR practices into business strategies to mitigate environmental damage in Ecuador.

To select the action or best practice to enhance, criteria for evaluation must be established. In the following neutrosophic method, the entropy values (E_j) for each variable, the diversity of the criterion (D_j), and the normalized weights of each criterion (W_j) are determined at the time of evaluation (see Table 3 to 5).

Development of the Neutrosophic Entropy method

Table 3: Neutrosophic entropy evaluation matrix. Source: own elaboration.

Alternatives	Regulatory compliance	Environmental damage	Moral responsibility	Impact on the community	Economic benefits
	SVNN	SVNN	SVNN	SVNN	SVNN
	C1	**C2**	**C3**	**C4**	**C5**
A1	(0.85,0.15,0.2)	(0.45,0.65,0.6)	(0.55,0.5,0.5)	(0.45,0.65,0.6)	(0.75,0.25,0.3)
A2	(0.25,0.85,0.8)	(0.35,0.75,0.7)	(0.35,0.75,0.7)	(0.35,0.75,0.7)	(0.55,0.5,0.5)
A3	(0.45,0.65,0.6)	(0,0.95,1)	(0.45,0.65,0.6)	(0.25,0.85,0.8)	(0.55,0.5,0.5)
A4	(0.55,0.5,0.5)	(0.25,0.85,0.8)	(0.45,0.65,0.6)	(0.65,0.35,0.4)	(0.25,0.85,0.8)
A5	(0.55,0.5,0.5)	(0.25,0.85,0.8)	(0.45,0.65,0.6)	(0.45,0.65,0.6)	(0.25,0.85,0.8)

Table 4: Normalized decision matrix. Source: own elaboration.

Alternatives	C1	C2	C3	C4	C5
A1	(0.35,0.75,0.7)	(0.35,0.75,0.7)	(0.25,0.85,0.8)	(0.25,0.85,0.8)	(0.35,0.75,0.7)
A2	(0,0.95,1)	(0.25,0.85,0.8)	(0,0.95,1)	(0,0.95,1)	(0.25,0.85,0.8)
A3	(0,0.95,1)	(0,0.95,1)	(0.25,0.85,0.8)	(0,0.95,1)	(0.25,0.85,0.8)
A4	(0.25,0.85,0.8)	(0,0.95,1)	(0,0.95,1)	(0.35,0.75,0.7)	(0,0.95,1)
A5	(0.25,0.85,0.8)	(0,0.95,1)	(0.25,0.85,0.8)	(0.25,0.85,0.8)	(0,0.95,1)

Table 5: Calculation according to the entropy method.

Criteria	E_j	D_j	W_j	Order
Normative compliance	0.942	0.058	(0.3,0.8,0.80)	2
Environmental damage	0.859	0.141	(0.95,0.15,0.14)	1
Economic benefits	0.994	0.006	(0.10,0.90,0.95)	4
Impact on the community	0.964	0.036	(0.10,0.90,0.95)	3
Moral responsibility	0.942	0.058	(0.3,0.8,0.80)	2

Criteria weighting: The neutrosophic multicriteria analysis has provided weights for different evaluation criteria, allowing for a balanced consideration of the importance of each criterion in assessing the environmental responsibility of companies.

Relative importance: Based on the calculated weights, the relative importance of criteria has been determined. This has highlighted the relevance of certain aspects, such as the severity of damage and normative compliance, in comparison to others.

Improvement in evaluation: Criteria weighting enhances the quality of the evaluation by considering variability and indeterminacy in the data. This allows for a more precise and fair assessment of companies' performance in terms of environmental responsibility.

Development of the neutrosophic Aras method

Once the weights are defined, the evaluation of each action and best practice is carried out to mitigate environmental damage in Ecuador. To achieve this, the neutrosophic ARAS method is modeled to determine the best action or practice to enhance the ranking of alternatives for the application under study (see Tables 6 to 8).

Table 6: Decision matrix. Source: own elaboration.

Alternatives	Regulatory compliance	Environmental damage	Moral responsibility	Impact on the community	Economic benefits
	SVNN	SVNN	SVNN	SVNN	SVNN
	C1	**C2**	**C3**	**C4**	**C5**
R1	(0.65,0.35,0.4)	(0.45,0.65,0.6)	(0.35,0.75,0.7)	(0.45,0.65,0.6)	(0.55,0.5,0.5)
R2	(0.45,0.65,0.6)	(0.55,0.5,0.5)	(0.55,0.5,0.5)	(0.55,0.5,0.5)	(0.45,0.65,0.6)
R3	(0.55,0.5,0.5)	(0.75,0.25,0.3)	(0.35,0.75,0.7)	(0.45,0.65,0.6)	(0.35,0.75,0.7)
R4	(0.35,0.75,0.7)	(0.35,0.75,0.7)	(0.45,0.65,0.6)	(0.35,0.75,0.7)	(0.45,0.65,0.6)
R5	(0.45,0.65,0.6)	(0.75,0.25,0.3)	(0,0.95,1)	(0.35,0.75,0.7)	(0.65,0.35,0.4)

Table 7: Normalized decision matrix. Source: own elaboration.

Alternatives	C1	C2	C3	C4	C5
R1	(0.25,0.85,0.8)	(0,0.95,1)	(1,0.05,0)	(0.25,0.85,0.8)	(0.25,0.85,0.8)
R2	(0,0.95,1)	(0.25,0.85,0.8)	(1,0.05,0)	(0.25,0.85,0.8)	(0,0.95,1)
R3	(0.25,0.85,0.8)	(0.25,0.85,0.8)	(1,0.05,0)	(0,0.95,1)	(0,0.95,1)
R4	(0,0.95,1)	(0,0.95,1)	(1,0.05,0)	(0,0.95,1)	(0,0.95,1)
R5	(0,0.95,1)	(0.25,0.85,0.8)	(1,0.05,0)	(0,0.95,1)	(0.25,0.85,0.8)
Classification	**B**	**B**	**NB**	**B**	**B**
w_j	(0.3,0.8,0.80)	(0.95,0.15,0.14)	(0.10,0.90,0.95)	(0.10,0.90,0.95)	(0.3,0.8,0.80)

Table 8: Optimization function S_i based on weight W_j assignment. Source: own elaboration.

Alternatives / Weight	C1	C2	C3	C4	C5	S_i	K_i	
R1	0.0544	0.0672	0.0000	0.0262	0.0428	0.1906	80.61%	
R2	0.0307	0.0953	0.0000	0.0344	0.0369	0.1973	83.43%	$S_0 = 0.2510$
R3	0.0445	0.1266	0.0000	0.0231	0.0266	0.2207	93.35%	
R4	0.0299	0.0563	0.0000	0.0164	0.0325	0.1350	57.12%	
R5	0.0345	0.1266	0.0000	0.0200	0.0553	0.2364	100.00%	

The results of the neutrosophic ARAS method evaluate the promotion of corporate social responsibility and incentives for environmental responsibility as the action and best practice to enhance. To enhance these actions, regulatory bodies should work on policies focused on promoting measures aimed at repairing environmental damage caused in Ecuador. Some of these measures are directed at the:

- Compensation or indemnification: Companies can compensate or indemnify individuals or communities affected by the environmental impacts caused by their activities. This may include payment of a sum of money covering damages and losses, as well as the recovery of degraded ecosystems.
- Environmental restoration: Companies can take measures to restore the environment affected by their activities. This may include reforestation of degraded areas, recovery of contaminated water bodies, and disposal of toxic waste, among other measures.
- • Prevention of future damages: Companies can take measures to prevent future environmental damage. This may include the implementation of cleaner technologies [14], adoption of more sustainable practices [15], and conducting environmental impact assessments, among other measures.

- Compliance with environmental standards: Companies can take measures to comply with the environmental standards established in Ecuador. This may include the implementation of environmental management systems [16-18-21], conducting environmental audits, and training workers on environmental issues, among other measures.

Strengthening measures with an impact focused on environmental protection:

Promoting investment in environmental protection and natural resource management: Companies must invest in environmental protection and natural resource management to reduce their environmental impact and promote more sustainable business practices. To achieve this, fiscal and financial incentives can be established for companies that implement environmental protection and natural resource management measures.

Promoting the hiring of environmental insurance: Although there is currently no specific environmental damage insurance in Ecuador, the hiring of civil liability insurance and bonds can be promoted to cover environmental damages caused by companies.

Enhancing citizen participation: It is significant for civil society to actively participate in decision-making related to the environment and corporate responsibility. For this purpose, mechanisms for citizen participation can be established in the evaluation of projects with a high environmental impact and in reporting violations of environmental regulations.

The results indicate the need for a balanced approach to assess corporate responsibility in cases of environmental damage in Ecuador. The severity of environmental damage and regulatory compliance are areas of certainty, while the impact on the community and the complex interactions between economic benefits and environmental damage present indeterminate challenges. The application of regulations and collaboration among stakeholders is fundamental to addressing these challenges and promoting more effective environmental responsibility.

Conclusion

The assessment of corporate responsibility in cases of environmental damage in Ecuador involves a complex balance between certainty and indeterminacy. The results obtained from the neutrosophic entropy method define the severity of environmental damage and regulatory compliance as the criteria with the highest weight. Meanwhile, other factors, such as the impact on the community and the relationship between economic benefits and environmental damage, constitute areas of indeterminacy in the analyzed study. This underscores the need for a balanced approach that recognizes neutrosophic complexity when selecting actions and practices in favor of environmental protection.

The results of the neutrosophic Aras method highlight the action and best practices for promoting corporate social responsibility and incentives for environmental responsibility. Therefore, effective collaboration among companies, government authorities, civil society, and other stakeholders is crucial. Rigorous enforcement of environmental regulations, continuous monitoring, and the imposition of sanctions are essential to ensure that companies assume their environmental responsibility effectively. Furthermore, promoting a culture of corporate social responsibility is essential to align economic interests with environmental protection.

The assessment of corporate responsibility in cases of environmental damage is not a static process. It must be continuous and adapt as circumstances change and new information is obtained. Constant measurement of environmental impact, regulatory compliance, and community well-being is crucial for evaluating the effectiveness of implemented measures and strategies. Environmental responsibility should be a constant concern in both corporate and government decision-making.

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