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Perception of the Geological-Mining Heritage to Promote Geotourism in Guayaquil, Ecuador

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Abstract: Biodiversity is an essential component of nature, relegating the aspects of geodiversity, which provides geological and landscape variety to a territory. However, the importance of geodiversity and its social, economic, educational, scientific, and technological impact on a region, are not well understood. This article measures the geoheritage values of Guayaquil, a port city in Ecuador, via surveys and analyses of variables, with the aim of proposing guidelines or strategies that promote the knowledge and diffusion of that geoheritage. Our methodology included (i) a review of historical landmarks of Guayaquil and their relationship with geodiversity, (ii) a survey and data tabulation, (iii) an analysis of the local population's perception of the city's geoheritage, and (iv) the development of geodiversity strategies using computer tools. Our results determined that people approach areas of interest because of each site's biodiversity and the available information about the site. Once there, they can obtain knowledge about the city's geology, geodiversity, and urban geotourism. Therefore, geoheritage is an essential consideration in establishing educational plans, initiatives, and promotion strategies. Furthermore, the identification of a city's heritage values following geoeducation, and the recognition by society of the city's geosites and their historical–scientific significance, will provide a basis for using geotourism in a context of sustainability.

Keywords: geodiversity; geoconservation; geoheritage; geosites; SWOT; Ecuador

1. Introduction

The perceptions of a place's heritage play a vital role in assessing the degree of interest in that place, its importance, and/or the reasons for visiting it [1,2]. The establishment of criteria related to the management and conservation of a heritage site or object and the involvement of different stakeholders, such as government authorities, businesses, the local community, and tourists [3–8], are important for the economic, social, and environmental sustainability of a specific place or region [4,9,10].

Among the factors that affect the perception of a place's heritage are the geology and geomorphological processes of the landscape (i.e., the geological heritage). This

geological heritage is focused on the sites or areas with geological characteristics that are of scientific, educational, cultural, or aesthetic value [11–18]. In addition, the criteria for geoeducation and geoconservation are linked to human activities, such as mining (i.e., the mining heritage), inclusive of all of the elements of such activities, such as facilities, machinery, structures, and work tools [19,20].

Figure 1 shows the interconnection of the geological heritage and the mining heritage with geosites, geo-resources, natural disasters, and natural diversity in the context of geotourism. These interconnected factors impact an area's sustainability (economic, environmental, and local); they can be managed via geoconservation and geoeducation.

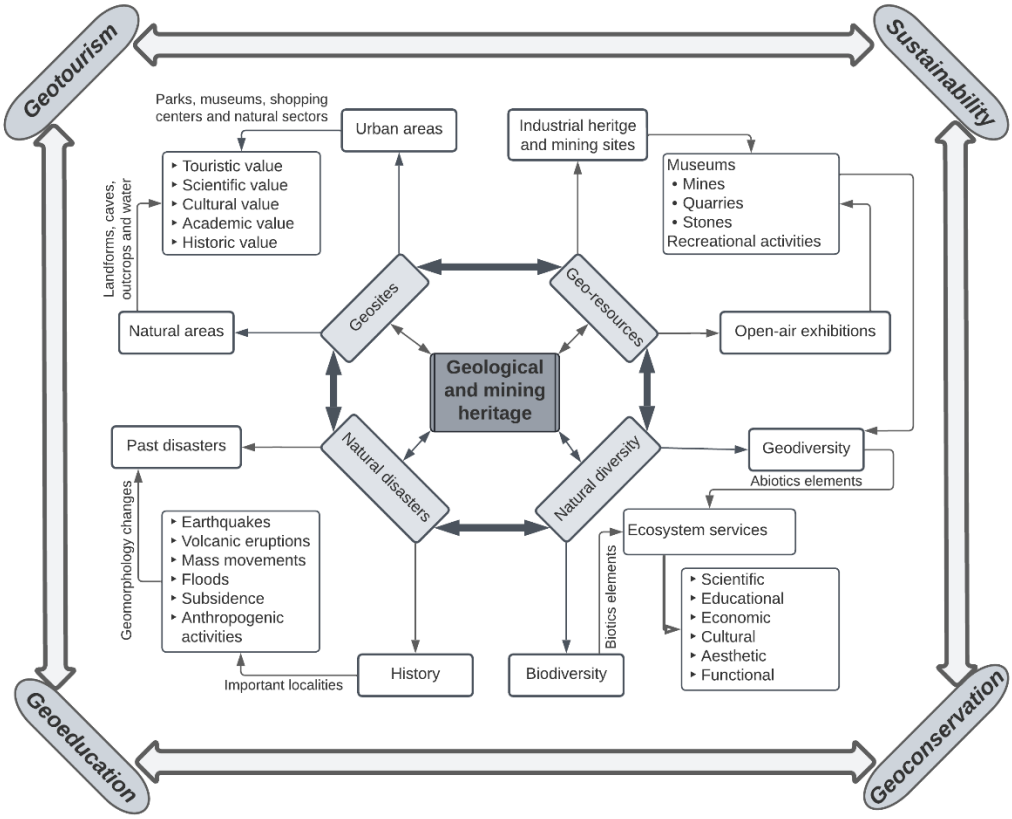

Figure 1. Network of relationships starting with the concepts of geological heritage and mining heritage. Source: adapted from [21–25].

The geological characteristics of a place or region can be analyzed according to geodiversity, which provides an integral framework for managing and evaluating the geological heritage and the mining heritage of the place or region [26–30].

Such an evaluation includes an assessment of the heritage value of sites with geological and mining interest (inside and outside urban areas), which are known as geosites [31–35]. It promotes tourism focused on geology and landscape, also known as geotourism [36]. Unlike conventional tourism, it acquires knowledge and understanding of a site's geology, mining, and geomorphology beyond aesthetic appreciation [37]. This evaluation can be developed from the experts' perspective, who analyze and quantify the intangible value of each sector for its geotourism development [26,38–40]. However, the evaluation of society's expectations allows knowing the perspective of each citizen through surveys and statistical analysis, determining the purpose of their visits and the recommendations to improve each visitor's stay [41,42].

Geoconservation is essential for the preservation and promotion of the development of societies. It is promoted through international programs such as World Heritage Sites (with 1154 heritages) [43] and UNESCO Global Geoparks (with 177 geoparks) [44], which encourage geoconservation and related benefits. Furthermore, geotourism, through geoher-

itage and geoparks, allows adequate sustainability of the local community of a particular sector [45–49], focusing on rural and urban areas, such as the Hong Kong Geopark (China) [50], where ideal geosites for sustainable tourism based on nature exist within the same city [51–53]. Geotourism and geoheritage can also be promoted by geoscience museums, which should use adequate strategies and tools (including multimedia and interactive ones) to maximise their impact on visitors [54,55].

Ecuador is one of the 17 most megadiverse countries on the planet [56], which has three cultural heritage sites, two natural heritage sites, three intangible heritage sites of humanity, and a geopark endorsed and monitored by UNESCO [57–59]. The Imbabura World Geopark in Ecuador [60] is composed of several geosites that highlight the geological and geomorphological structures of the landscape, such as volcanic complexes, lakes, geothermal sites, mountain ranges, and snow-capped mountains, among others [61]. It favours the promotion of geoeducation, history, and conservation of geoheritage, achieved through sustainable geotourism, for communities' sustainable environmental, social, and economic development [62,63]. The country has several places with abundant geobiodiversity, such as the avenue of volcanoes characteristic of the Ecuadorian Andes due to their composition and geological age [64]. In addition, however, there are urban places with natural sectors, such as the city of Guayaquil (Pearl of the Pacific), characterized by its unique geographical location and geological features that marked its origin, evolution, and development.

Guayaquil city represents one of the geotourism attractions of the coastal part of Ecuador, bordered by the Guayas river and enriched by arms of the sea (salty estuary) [65], which gives it a unique dynamic in the environment of the Gulf of Guayaquil. In addition, it has essential tourist attractions such as parks, museums, shopping centres and natural sectors that allow coexistence with the sector's biodiversity, achieved through natural, active (recreational activities) and cultural tourism [66]. Furthermore, these tourist attractions are connected to several public transportation routes, which facilitates their access, but requires proper disclosure through apps, websites, transport mapping and other means of communication [67–69].

In Guayaquil, the evaluation of 12 geosites has made it possible to quantify and analyse the geological, tourism and educational interests, in addition to the geoconservation index of each geosite, incorporating geotourism as a means for the local, social, and economic development of the city [70]. In addition, there are case studies where higher education institutions promote geotourism and sustainability through different geosite evaluation methodologies [56]. Therefore, the inclusion of the heritage perception by the population allows one to know the society's perspective on geosites around the city and enhance its development.

Based on these premises, the following research question is: What would be the elements of geoheritage that promote the economic and social development of the city and are included as criteria to implement its sustainability? To answer this question, the aim of this work is: to measure the perception or recognition of geoheritage values by citizens, through surveys and analysis of variables, for the proposal of strategies that promote the empowerment of geoheritage. In addition, its natural values should be promoted through dissemination, geo-education, and proper geo-conservation.

2. Materials and Methods

For the promotion of geotourism and geoeducation of geosites or sites of geological and mining interest, it is necessary to know the strengths and weaknesses of these places through a quantitative evaluation, which allows for determining the degree of appreciation and importance of each site [71,72]. Then, knowing the heritage value of geosites, it is possible to promote adequate management of programs and planning for developing tourism and geoconservation of these places [73]. Furthermore, this influences the surrounding sectors, increasing the social benefit of the inhabitants and the geosystem of the geosite; that is what this study is focused on.

2.1. Methodological Approach

Guayaquil has geosites that are visited daily by residents of the sector and foreigners, as well as mining sites that highlight the geology of the place and the exploitation of construction material (Figure 2). Therefore, a quantitative evaluation through surveys analyses the experience and satisfaction of its visitors. Furthermore, it highlights the interest and knowledge in developing activities and management for the benefit of the geosites [38]. This type of study allows us to learn the reasons why people go to these geosites and, through an inferential statistical analysis and interconnection of variables, to assess their perception of the geological/mining heritage of Guayaquil city. The significant variables that explain this measurement are considered predictors that determine the relationships with the knowledge of the geological-mining heritage that the respondents have. These predictors form a perception model through a multiple regression analysis that analyses the incidence of heritage knowledge in geotourism, geodiversity, geology, and tourism in Guayaquil [74,75].

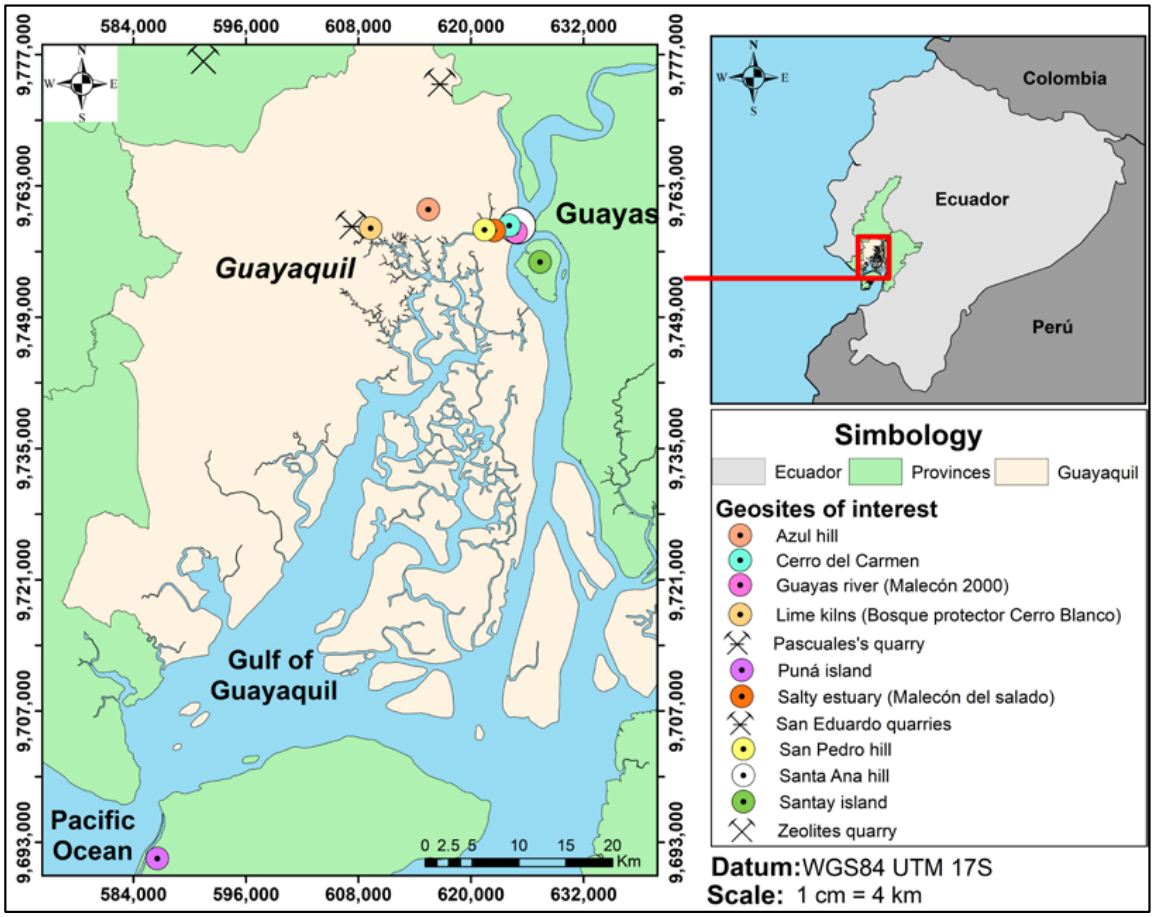

Figure 2. The geographic location of sites of geological and mining interest. Guayaquil, Ecuador. **Source:** Adapted from [76].

The methodological workflow consists of three phases (Figure 3): (i) bibliographic review of the historical milestones of Guayaquil and its relationship with geodiversity, (ii) preparation of a survey and data tabulation, and (iii) analysis of the perception of respondents and the development of key strategies to improve and strengthen the geodiversity of the city.

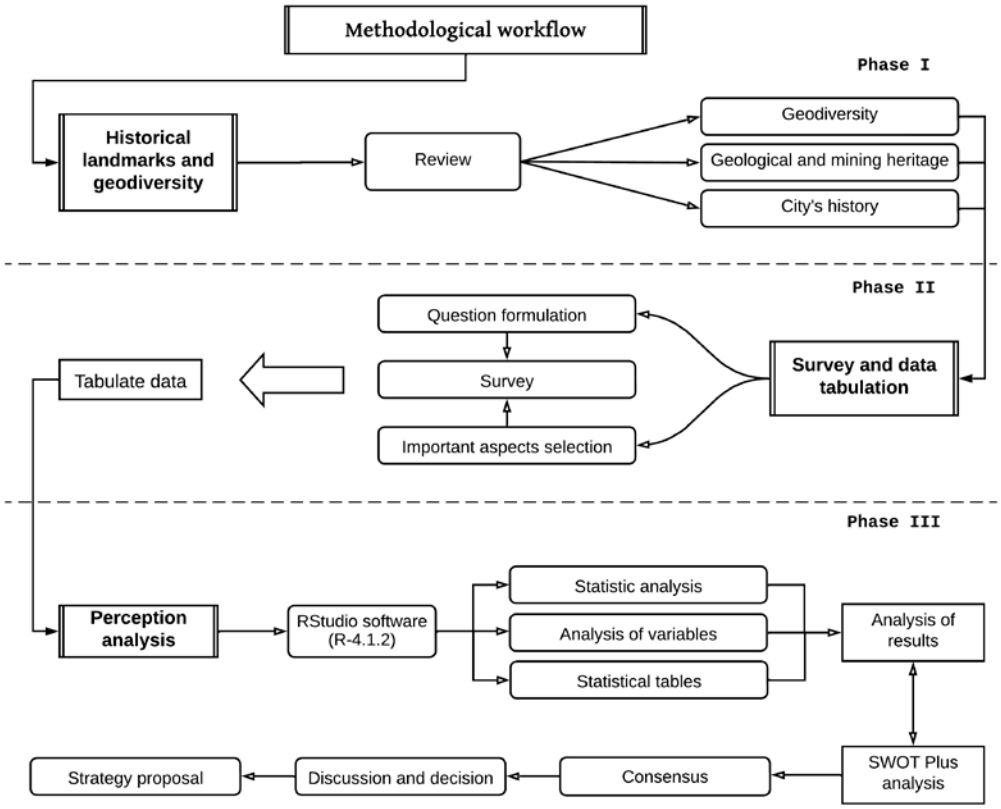

Figure 3. Schematic description of work phases.

2.1.1. Historical Milestones and Geodiversity

Phase I consisted of collecting information through different bibliographic sources, highlighting historical issues of Guayaquil city from its origins. This review allows knowing the milestone events that influenced the development of the current city, in addition to geodiversity and tourism as a source of progress. Furthermore, this phase is fundamental for recognizing places and registering geosites, which are part of the evaluation through surveys directed at society.

2.1.2. Survey and Data Tabulation

Phase II included people with experience and expertise in different areas, aiming to highlight the most important aspects influencing the perception of the city's geological and mining heritage. In addition, the topics discussed allowed for a general survey of the area's inhabitants, and we will analyse its results in Phase III.

The survey carried out for the Guayaquil citizens is based on the survey model implemented by [77], with the purpose of:

1. Sizing the level of knowledge of each interviewee;
2. Identifying the most outstanding tourist areas of Guayaquil;
3. Identifying the level of satisfaction and motivation of the visits;
4. Identifying the interest in promoting geotourism in the evaluated geosites;
5. Identifying the most outstanding issues to improve the degree of citizen satisfaction.

The sample size is obtained using Equation (1) [78,79], considering a probability of success and failure equal to 0.5 ($p = q$), a confidence level of 95% (equivalent to $Z = 2.58$), a sampling error of 5% (e = 0.05) [77], and the population size of $N = 2{,}723{,}665$, according to [80]. Equation (2) is considered from the "n" obtained and the population size to optimise the size of this sample:

$$n = \frac{Z^2 * p * q * N}{(\varepsilon^2(n-1)) + (Z^2 * p * q)} = 665.48 \quad (1)$$

$$n_{optimal} = \frac{n}{1 + \frac{n}{N}} = 665.31 \quad (2)$$

For this work, the analysis determined a minimum of 666 respondents in Guayaquil. Therefore, the questionnaire has three blocks and 34 questions; 31 were designed with closed answers, giving the interviewee a series of alternatives. The remaining three questions allowed the interviewee to formulate their answer. The survey was conducted at the end of September 2021 and can be viewed in the Supplementary Materials Table S1.

2.1.3. Perception Analysis and Strategy Development

Phase III uses the CSV file from phase II, containing the tabulation of the respondents' responses. The data processing and analysis use the statistical program RStudio version R-4.1.2 [81] and the survey questions as categorical variables. The correlation analysis determined the significance of these variables (correlation coefficient R), where the most significant variables explain the perception of the geological and mining heritage [82].

It made it possible to generate a perception model through multiple linear regression, where the dependent variable is the perception of wealth and the independent variables are the set of variables perceived by the inhabitants of the sector (sex, academic training, frequency of use of social networks, international relevance of geosites of Guayaquil, and perception of knowledge in geodiversity, geology, and geotourism). The regression model predicts the perception of the geological and mining heritage through the interaction of each independent variable's estimation coefficients ($\beta_0, \ldots \ldots \beta_n$) [83].

The determination coefficient R^2 explains the proportion of the total variation in the perception of geological-mining heritage in the regression model [84]. The validation of the model focuses on an ANOVA analysis with the significant test statistic (F), which determines if at least one variable explains the perception of the geological and mining heritage [85].

Based on the analysed variables, the matrix identifies the Strengths, Weaknesses, Opportunities, and Threats (SWOT) of the evaluated geosites. Furthermore, in this way, we propose strategies through SWOT analysis to potentially develop geotourism and the local community.

The SWOT matrix is a method with which the appropriate strategies can be established to solve a problem identified in a given topic [86,87]. The generation of a SWOT Plus analysis is an advanced method of the classic SWOT matrix [88,89], focused on the occurrence of existing and potential factors of internal and external origin, as well as their favourable or unfavourable impact on the study of interest [90].

This type of analysis focuses on the significant factors that involve the inhabitants, local authorities, academic institutions, and the intervention of experts [77]. Therefore, through virtual meetings, the internal and external influencing factors are known, mainly based on the respondents' responses on the perception of the geoheritage of Guayaquil city.

3. Results

3.1. History and Geodiversity of Guayaquil

Guayaquil has been the cradle of various settlements of people and their dispossession by locals such as the Huancavilcas. In the pre-Hispanic stage, the ancient cultures that settled in this region lived from maritime trade thanks to various tributaries, such as the Guayas river or the different ramifications of the estuary. Later, with the arrival of the Spaniards in colonial times, this waterway was the largest source of communication and trade [91].

According to legend, the city bears the name of its heroic cacique "Guayas" and his wife "Quil", who encouraged the liberation and fought against their oppressors [92]. Since its foundation, Guayaquil (Pearl of the Pacific), due to its location, became the principal seaport in Ecuador. However, given its geographical position with access to the sea, the city was invaded several times until it achieved its independence, led by the socio-ethnic groups of the time [93]. Its dominant characteristic lies in being an essentially maritime

area, flat and close to sea level, crossed by the most prosperous river network on the South American Pacific coast [94]. It has a particular interest in business and tourism due to its commercial activity, event promotion, product export, tourism, or social recreation areas, and other activities that capture people's interest.

In addition, the city has geosites of environmental and geological relevance, highlighting areas with striking geological structures, such as the presence of slumps in Cerro del Carmen, rocky outcrops with almost perpendicular inclination (dips) (Cerro San Pedro), a continuation of the range Chongón Colonche (Cerro Santa Ana, Cerro Azul), rocky material with industrial interest for construction and road filling (San Eduardo, Pascuales and Zeolite Quarries), in addition to geomorphological processes such as the rapid formation of islets in the Guayas River (Santay Island) [70]. The respondents identified several natural sites that highlight the geo-biodiversity around the city, which benefits the tourist interest of the people and the coexistence with the environment, recreational activities and geo-conservation of the urban natural environment. Among these, we have (Table 1):

Table 1. Historical aspects of Guayaquil and its relationship with geodiversity.

Sites of Interest	Historical Aspect	Relationship with Geodiversity	References
Guayas river (Ma-lecón 2000)	Main waterway or trade channel in which they arrived at the boardwalk of the current city. It began as a place of commerce until it became a tourist centre in 2000, enhancing its heritage, tourist, and commercial value.	Two islets stand out, formed by the sedimentation that occurred in the transgression and regression of seawater. In addition, the naval trips allow us to know the natural and historical environment of the river and the boardwalk.	[95,96]
Santa Ana hill	The leading site where the city started. It was one of the colonial bastions for the city's defence against pirate attacks. In addition, it is one of the scenes of the deed of the independence of Guayaquil.	Rocky massif formed by shale with a high degree of fracture and sandstone intercalations.	[91,97]
Cerro del Carmen	It has a viewpoint and a natural beauty that enhances its tourist activity, declared the nation's cultural heritage in 2003, preserving the history and memory of important people, including war heroes, presidents, and artists who contributed to the city's development.	At the city's beginning, it served as quarries to fill and urbanize the swampy areas of Guayaquil. As a result, it has silicified and fractured shale from the Guayaquil formation, which generate block slides (of various sizes), prompting the search for solutions for slope stabilization.	[91,98,99]
Salty estuary (Malecón del estero Salado)	It has broad ramifications throughout the city. However, several of these areas have grown demographically, and the urban area is more extensive in terms of housing.	It is an estuary influenced by the transgression and regression of the sea that overflows with a tangle of rivers, estuaries and lagoons. It has excellent landscape, aesthetic, and recreational value. It is a unique natural ecosystem, home to diverse flora and fauna, such as mangroves settled on delta-type soils.	[94,100]
Quarries	They are suitable places to promote research and development due to their potential as relevant material in different areas of industry.	The San Eduardo formation's quarries have limestone rock to produce cement for the entire country, in addition to the zeolite quarries located in volcano-sedimentary rocks.	[101]
Lime kilns (Bosque protector Cerro Blanco)	The lime kilns were optimal places for tourist overnight camps and their coexistence with nature. They are in Cerro Blanco, a protected forest since 1989 and the most consolidated in the city.	It is a dry forest with abundant geo-biodiversity and endemic species threatened worldwide, in addition to its geotouristic influence without affecting the intangible natural area of the reserve.	[102,103]
Santay island	It is one of the islets formed in the Guayas River. It has a population that has been arriving from different places but in a controlled manner. In 2010, it was declared a RAMSAR site (type I) on the Ecuadorian coast.	Its diversity of flora and fauna entails a critical tourist and investigative interest. In addition, it is in a brackish environment where various aquatic, terrestrial, bird, and halophilic vegetation (mangrove) species meet.	[104,105]

3.2. Perception of Mining Geological Heritage

3.2.1. Demography

The surveys comprise 62.5% men and 37.5% women in the northern, central, and southern parts of Guayaquil (59.4%, 21.1%, and 28.6%, respectively). In addition, 70% of those surveyed are university students, while 13% and 12% have completed their university and college studies, respectively. Most people are informed or communicate more frequently through social networks. This leads to the continuous use and exploitation of these media to publicize various topics of interest to society, current projects, works, and initiatives and communicate different actions in a particular place.

3.2.2. Distribution of Variables of the Perception Model

The construction of the multiple regression model consisted of the statistical analysis between variables, especially those significantly correlated with the perception of the geological-mining heritage, which is achieved based on the respondents' perception. Variables include gender, academic training, frequency of use of social networks, international relevance of geosites in Guayaquil city, and perception of knowledge in geodiversity, geology, and geotourism.

Variables X_1 to X_7 focus on people's perceptions from different perspectives related to the response variable (Y), as seen in Table 2.

Table 2. Description of variables involved in the perception model.

Variable	Name	Description
Y	Heritage perception	Variable response of perception of geological-mining heritage
X_1	Mode_information (1 *, 2 * and 3 *)	Perception of information through news
X_2	Benefit_tourism (0: No and 1: Yes)	Perception of tourism benefit
X_3	Geodiversity (0: No and 1: Yes)	Perception of knowledge of geodiversity
X_4	Geology (0: No and 1: Yes)	Geology knowledge perception
X_5	Around the city geotourism (0: No and 1: Yes)	Perception of geotourism around Guayaquil city
X_6	Urban geotourism (0: No and 1: Yes)	Perception of knowledge of geotourism in the city
X_7	Biodiversity (0: No and 1: Yes)	Perception of visit motivation due to biodiversity

1 *: Read the headline and news content. 2 *: Read the content and verify information in other media. 3 *: Read only the headline of news, photo, or video.

3.2.3. Perception of the Respondents

The respondents' perceptions can be viewed through the mean of the survey responses ($\overline{X}$) according to the significant variables (Table 2). For example, the information mode variable (X_1) has a scale from 1 to 3 (1: Reads the news headline and content; 2: Reads the content and verifies information in other media; 3: Reads only the news headline, photograph, or video). On the contrary, the other variables have a dichotomous value in the perception that depends on the respondents' knowledge (0: No and 1: Yes). In addition, the values of the standard deviation (SD) demonstrate the degree of concentration and coincidence of the average values of perception of the respondents [106].

Table 3 shows the inhabitants' perception of Guayaquil, using the categorical variables with the highest correlation (R = 0.653).

The order of the variables in Table 3 does not represent the degree of significance of each one. Nevertheless, more than 95% of respondents agree that visiting various sites, such as Santa Ana hill, Guayas River on the Malecón 2000, Salty estuary on the 'Malecón del Estero Salado' (acronym in Spanish), and Santay Island, represent beneficial recreational activities for the inhabitants of the city ($\overline{x_2} = 0.97$).

In the context of geoknowledge, a large part of the respondents know the heritage, mainly in recognition of the geodiversity ($\overline{x_3} = 0.98$) and geology ($\overline{x_4} = 0.98$) of geosites, which encourages learning about tourism linked to the natural and the geological. This action is also known as around the city geotourism ($\overline{x_5} = 0.99$). In addition, following the events caused by the COVID-19 pandemic, people have reflected and agreed that open

spaces are the best place to be with family and in harmony with nature. Furthermore, natural areas can significantly extend territory for tourism and coexistence with the natural ecosystem within a city ($\overline{x_6} = 0.97$).

Table 3. Perception of the respondents based on significant variables.

N°	Explanatory Variables	Mean ($\overline{X}$)	Standard Deviation (SD)
X_1	Mode_information	0.97; 0.99 and 0.93	0.17; 0.12 and 0.26
X_2	Benefit_tourism	0.63 and 0.97	0.49 and 0.16
X_3	Geodiversity	0.76 and 0.98	0.42 and 0.13
X_4	Geology	0.62 and 0.98	0.49 and 0.15
X_5	Around the city geotourism	0.87 and 0.99	0.34 and 0.10
X_6	Urban geotourism	0.72 and 0.97	0.45 and 0.15
X_7	Biodiversity	0.93 and 0.98	0.25 and 0.12

Focusing on the reasons for visits, we have the variable "Biodiversity" ($\overline{x_7} = 0.98$); in addition, the variable "Mode_information" ($\overline{x_1} = 0.99$) highlights the form of communication in which people choose to read the headline and content of news or topics of collective interest.

3.2.4. Geological-Mining Heritage Perception Model

The estimation coefficients β determine the relative importance and sense of the relevance of the explanatory variables or predictors, which contribute to the measurement of the perception of the geological and mining heritage [107]. However, since no predictor explains the perception of wealth, it takes a constant value (intercept). In addition, the significance level (p) establishes the probability that the perceptions of the geosystem are possible and allow measuring the level of perception of the respondents [82,84].

The estimation model focuses on the respondents' perception of the geological-mining heritage and seven significant predictors. According to the β coefficients and the significance level (p) being less than 0.05, these predictors indicate the degree of importance or contribution to the main focus topic. Based on the results, the analysed sites have a tourist interest. The people who come to these places seek to appreciate some of the biodiversity as a priority. In addition, the survey is prepared to find out the interests in geodiversity, and some people are interested in geology and urban geotourism in the city's environment with its landscapes (Table 4).

Table 4. Multiple linear regression results.

Explanatory Variables	β Coefficients	Standard Error β	Significance Level (* p)
Intercept	0.260	0.049	
Benefit_tourism	0.220	0.038	* 0.000
	Knowledge Geo		
Geology	0.198	0.034	* 0.000
Urban geotourism	0.162	0.029	* 0.000
Geodiversity	0.127	0.022	* 0.000
Around the city geotourism	0.040	0.015	0.007
	Reason for visit		
Biodiversity	0.027	0.010	0.014
Mode_information	0.015	0.007	0.021

* $p < 0.05$ significant variables of the perception model, * 0.000 < 0.001.

Table 4 presents the parameters that significantly measure the perception of the geological and mining heritage through the β coefficients in the multiple regression model, where the best way to measure the perception of heritage is through tourism (β = 0.220) in the geosites of the city. This activity allows people to live together in Guayaquil's natural and historical environment.

Interrelated variables, such as "Geology", "Around the city geotourism", and "Geodiversity", are due to the estimators that determine the increase and decrease in heritage perception. The geology (β = 0.198) and geodiversity (β = 0.127) of the geosites influence the perception of tourists, who seek the opportunity for social, cultural, natural, and historical recreation within the city through urban geotourism (β = 0.162). Unlike around the city, geotourism (β = 0.040) deals with large areas and greater biological and geological diversity.

Biodiversity (β = 0.027) is a reason for visiting natural sites inside and outside the city which link humans with the flora and fauna of the various geosystems in a natural environment. Therefore, people tend to obtain information through different media, such as television, social networks, web pages, and magazines (β = 0.015). Therefore, it affects the acceptable estimation of the perception of the geological-mining heritage of the geosites of the city.

3.2.5. Validation of the Perception Model

The coefficient of determination values establishes the goodness of fit of estimation models and the variation in the response variable explained by predictor variables. For example [84,108] determine that R^2 depends mainly on the research area and suggest measurements of 0.67, 0.33, and 0.19 for model validation of substantial, moderate, and weak population perception, respectively. The goodness of fit of this model determined a determination coefficient of 0.426, which indicates that 43% of the variation in the perception of the geological and mining heritage (variable Y, Table 2) can be explored correctly through the seven significant parameters of the multiple regression model (Variables X_1 to X_7, Table 2). Finally, Table 5 shows the results of the ANOVA analysis, considering that the model can be used to explain the relationship between the perception of wealth and the different perception parameters of the respondents.

Table 5. ANOVA analysis of the geological-mining heritage perception model.

Models	Sum of Squares	* DF	* F	Significance Level (* *p*)
Regression	7.613	8		
Residual	10.303	938	43.73	0.0000
Total	17.916	946		
R^2			0.426	

* DF: degrees of freedom; * F: F-statistic; * $p < 0.001$ highly significant.

The F test statistic was 43.73, representing a highly significant value of ($p < 0.001$), which indicates that at least one of the independent variables (X_n) acceptably explains the perception of geological and mining heritage.

3.3. Strengths, Weaknesses, Opportunities, and Threats (SWOT) Analysis Plus

This section aims to determine the strategies that promote the geotourism of the sites within Guayaquil. Therefore, a SWOT Plus matrix identifies the significant factors that surround the topic of geotourism in the city, as shown in Table 6.

Based on the identified strengths (existing, favourable internal/external factors) and recognized opportunities (potential, favourable internal/external factors), the following six strategies can mitigate the present weaknesses (existing, unfavourable internal/external factors) and permissible threats (potential, unfavourable internal/external factors):

- Promote geosites as suitable and heritage sectors with abundant geodiversity, landscape areas, recreational areas, and natural infrastructures optimal for increasing tourism and promoting the local security of the place.
- Inculcate and engage local communities in sustainable management of geosites, preserving natural resources and geo-biodiversity of national and international tourist relevance.
- Propose information and security centres to increase geoeducation, disseminate geosite information and improve the city's local security protocol regulation.

- Creation of projects, programs, or activities that encourage the support of government entities to promote geoconservation and economic growth and increase sales and services in the sector through geotourism.
- Encourage alliances in the geoscience area with academic entities to promote the study of natural resources, evidenced impacts and generation of multidisciplinary projects to obtain international support for the preservation and improvement of the geosystem.
- Develop workshops with communities, government entities, and local authorities of the sector to improve the management of geosites and avoid conflicts of interest, which harm the generation of future projects and adequate planning.

Table 6. Matrix SWOT Plus.

Existing Factors	
Favourable internal factors	Favourable external factors
• Infrastructures of relevance to tourism and nature • Biodiversity (flora and fauna) • Recreational areas • Access routes • Landscapes or sites with a large landscape area • Natural heritage • Job generation	• Various entities protecting areas • Optimal geographical position • Areas recognized as tourism sectors nationally and internationally
Unfavourable internal factors	Unfavourable external factors
• Infrastructures with the presence of deterioration • Low level of security at the local level • Few information posts throughout the geosites • No security strategy for visitors • Few security protocols according to the time • There is no geo-education material	• The average level of education on geodiversity and geotourism • Low level of preservation of natural resources • Poor level of security in the city • Lack of regulation for the security protocol • There is no culture or legislation for geoeducation
Potential factors	
Favourable internal factors	Favourable external factors
• Greater knowledge and dissemination through social networks • Increase in the dissemination of geosites by tourists • Preservation of natural resources • Economic growth at the local level • Increased sales and services • Support from local authorities in these initiatives • Great variety of geodiversity	• Recognition at the national and international levels • Tourism and economic growth at the regional level • Identification of the natural heritage in the region • Possibility of projects for the development of geodiversity
Unfavourable internal factors	Unfavourable external factors
• Lack of support from government entities • Poor management by the authorities • Lack of rules or regulations to safeguard geosites • There is no motivation to generate projects	• Inefficiency in solving problems (basic needs and population growth) • Impacts due to climate change • Conflict of interest between residents, administrators, and private entities • Lack of financing for projects • There are no opportunities for multidisciplinary projects

4. Discussion

This work presents three study approaches that focus on the results obtained, focusing on:

1. Guayaquil's history and geodiversity, which allow knowing the evolution of the city and its link with nature [109–111];
2. The identification of variables, identifying those that best measure the perception of the geological and mining heritage based on public opinion [41,112,113];
3. Analysis of the existing and potential factors through a SWOT Plus matrix is necessary in analysing internal and external factors of a particular case for the proposal of strategies that increase the geoconservation and geotourism of the city [114,115].

These approaches are elaborated on below.

4.1. Geoscientific and Historical Literature of Guayaquil City

The literature review allows us to collect historical information about this city and learn about the various events (geological and demographic), which have given re-knowledge to these places that are commonly visited today. This city played an essential role in intercolonial relations through its triple function as the only port of the Audiencia de Quito, the leading shipyard in the American Pacific, and a great producer and exporter of cocoa and wood [116]. Many places in Guayaquil have an impressive wealth of history, culture, and heritage, attracting tourists from all over. However, their citizens do not have sufficient knowledge of the cultural treasure they possess [117].

One of the most iconic places in the city is the so-called mangroves, characteristic of estuarine areas. However, the wealth it keeps is not fully known or protected by its inhabitants [118]. In addition, due to the expansion of the city, several mangrove ecosystems and estuary branches have been lost, connected to pollution problems, such as the discharge of urban and industrial wastewater into unregulated channels, solid and domestic waste from the population, runoff discharges, and clandestine drainage pipes, among others [119].

4.2. Perception of Geological and Mining Heritage

Tourism, geotourism, geology, geodiversity, biodiversity, and information on sites in Guayaquil are essential and significant parameters to explain the perception of geological and mining heritage. These variables determine people's interest in natural and geodiverse sites to carry out human, tourist, and coexistence activities. For this reason, the geological-mining heritage perception model presents an acceptable goodness of fit (R^2 = 43%) in the relationship between these variables. Similarly to the model of [84], they obtained an R^2 of 43.3% relating variables of participation, promotion, and sense of belonging in the perception of sustainable conservation of cultural heritage in Lenggong Valley (Malaysia). Otherwise, the model of [82] obtained an R^2 of 35% using variables such as tourism attraction, facilities, and environment in the satisfaction perception of Safari tourism. Furthermore, [83], in their model of the visual perception of heritage architecture built in a historical city in India, found an R^2 of 26% to 43%, with the variables in this study being heritage characteristics.

The perception model determines that geotourism in cities is growing because people have better access to and preferences for outdoor places in contact with nature. Geotourism, in general, occurs mainly in rural areas. Because people do not have the time or the mobilization facilities for more extensive transfers, they look for options to carry out the said activity within the city, which is called urban tourism, as analysed in the study by [66].

4.3. Approach of Strategies for the Geoconservation of Heritage

According to the historical study and the analysis of surveys, Guayaquil has a significant patrimonial and geodiverse value in several of its geosites. Therefore, its geoconservation is essential to increase the geo-ecosystem benefit it possesses; analysing the strengths, weaknesses, opportunities, and threats (SWOT) is a way to recognise the strategies to promote the geoconservation and geotourism of the city [120,121], being able to solve the problems present in the place through its potential benefits [122,123].

The analysis of the SWOT Plus matrix makes it possible to propose strategies or proposals that benefit the geological, environmental, and cultural area of the sector, focusing on:

1. Promoting the heritage value of the sector;
2. Encouraging geo-education and the dissemination of information;
3. Increasing geotourism and local security;
4. Encouraging support from authorities and academic institutions;
5. National and international recognition through geotourism and geoconservation of geosites.

Optimal strategies for sustainable development through different approaches, cases, and ways of using the SWOT matrix worldwide are discussed below [124–126].

These strategies focus mainly on the sustainability and geoconservation of natural resources and the existing geo-biodiversity in geosites [127], geotourism being an activity that allows achieving this objective and influencing people, managing to improve their coexistence with nature. Moreover, nature increases the sector's social and economic benefits [128–130]. This has been proposed in places such as the Shandong peninsula (China) [131], the Greek island of Gavdos (Greece) [132], the Kanshi mountain basin (Pakistan's the Salt Range) [133], the Caguanes National Park (Cuba) [127], and the ESPOL university campus (Ecuador) [56], which represent places commonly visited.

5. Conclusions

This work allowed the generation of quantitative results from categorical variables with an evaluation of perception through surveys, achieving acceptable goodness of fit of R^2 = 43% in a sample of 945 respondents in Guayaquil. Based on this study, the significant variables are information mode, tourism benefit, geodiversity, geology, biodiversity, and geotourism around the city and urban form. In addition, the surveys carried out online focused on topics that were easy to understand, had multiple options, and had a lower proportion of free responses, which allowed open access for people without the need for face-to-face counselling due to the bio-safety of COVID-19. The results helped establish that the relevant strategies in a geosystem are geoeducation and heritage disclosure, which generate geoconservation and sustainable development in the city and its inhabitants.

This research identified the variables that best measure the perception of heritage by citizens-highlighting biodiversity, which is a reason for visiting and is present in natural sites, which entails an essential tourist interest to generate a link between the environment and people. However, the respondents have a low degree of geoknowledge (e.g., geology, geotourism, geodiversity), which implies the need to increase information, advertising, and education sites in educational centres so that people know the wide geobiodiversity that exists within the city.

The surveys showed that people look for natural sites to get out of the urban routine, so that they can live together in a healthy, natural environment without danger of contagion. Therefore, the main contribution of this study focuses on recognising geological and mining heritage as an enhancer of natural tourism or geotourism in vast and diverse environments. It is an alternative within cities, allowing sustainable urban development (economic and environmental) within the framework of geobiodiversity through dissemination, geo-education, and adequate geoconservation. In this way, actions could be taken for the correct conservation and management of the city's geological and natural assets, allowing preparation for their enhancement and arousing the interest of people who like sustainable tourism.

Through SWOT analysis, it was possible to provide guidelines to enhance the perception of the heritage in Guayaquil, based on the most representative variables and the existing and potential factors, to minimize the weaknesses and present threats. Among these are:

- Promotion or dissemination of geosites and their heritage value;
- Inculcate sustainable management at the urban, national and international levels;
- Strategic location of geosite information and security centres;
- Encourage the creation of projects or programs that link nature with the city;
- Promote geoscientific alliances to improve the study of natural resources and sustainability;

- Develop workshops as part of a geo-educational program to improve the recognition of natural spaces and reduce conflicts of interest;
- Propose strategies to promote geoeducation in educational centres at all levels for the knowledge of their geoheritage and its conservation.

The limitations of this study are its focus on the digital form through social networks in a planned format and requiring collaboration to carry out the surveys since, due to the confinement stage of COVID-19, the interaction between interviewer and respondent had to be virtual. For future research, the type of surveys (online and face-to-face) could be improved, improving the respondent's understanding, and the characteristics of the study area which generate the reasons for visiting could be verified.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/geosciences12090322/s1, Table S1: Geological and mining heritage perception survey questions.

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