EVALUATION OF GEOSITES AS AN ALTERNATIVE FOR GEOTOURISTIC DEVELOPMENT IN GUAYAQUIL, ECUADOR

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ABSTRACT

The geodiversity consists of a wide variety of geological elements that can be considered as a heritage, due to the unique characteristics of a specific place. The analysis focuses on Guayaquil, a cosmopolitan city, considered the pearl of the Pacific and the main port of Ecuador, its birth and location are marked by features of geodiversity that, in one way or another, have marked the development of the city in interaction with the social, economic and cultural activities of its inhabitants. Its heritage values highlight some elements of geodiversity, becoming an icon of the Ecuadorian coast. The aim of this research is to evaluate 12 geosites belonging to the city using the Brilha and Medina assessment methodology for the enhancement of their resources contributing to education and tourism. The methodological process includes: (i) geological and geographical framework of Guayaquil; (ii) cataloging 12 sites with geological and mining interest within the study area; (iii) assessment of geosites using the designated methodologies; and (iv) analysis of strengths, opportunities, weaknesses and threats (SWOT) and generation of a matrix of threats, opportunities, weaknesses and strengths (TOWS) through a cross of SWOT variables for the establishment of strategies of development in geosites in the geoturistic field. The manifestations of geodiversity obtained show the existence of an important geological and mining heritage with geoturistic incidents within the territory of the city, establishing that the 12 points of interest considered serve as basic tools for the consideration of natural resources, which complement the great biodiversity of the ecosystems linked to the mangrove that make it a candidate to preserve the biosphere, adding the unique characteristics of the environmental and tourist geological sector with a view to dissemination and promotion as an alternative in conservation that serve to enhance opportunities for society.

Keywords: Guayaquil, geodiversity, geological and mining heritage, geosites, geotourism.

1 INTRODUCTION

Geotourism aims to support the conservation and protection of geodiversity [1] and, at the same time, emphasize a tourist resource to symbolic sites in urban areas such as mines and quarries for exploitation, outcrops and surface features [2].

The term geodiversity was first implemented in the late 1990s and focused mainly on the protection or geoconservation of representative spaces in a given sector [3], [4]. Its definition is raised by many authors, such as the set of sites with very different features, including geological and geomorphological, landscape and other systems created by human activity and natural processes [5].

Focusing on the etymology of the word geodiversity, Carcavilla et al. [6] consider her as "... an intrinsic property of the territory and a characteristic attribute of it. As property of the territory that it is, it has a certain relationship with other aspects, such as geography, landscape, climatic characteristics, and even cultural and economic aspects…" which allows to assess a region, and thus be able to compare with other areas similar to this, for its

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respective analysis and conservation. On the other hand, when referring to the concept of geoconservation, Ramos and Fernández [1] describe it as a "set of strategies and actions aimed at the conservation of geodiversity and the singular elements that represent it in each region", which are implemented in the evaluation of geological heritage and geodiversity, to adequately manage a given land [7].

Geological heritage is considered as a site or set of geological elements that have a high value of scientific, cultural and/or educational interest [8]–[10]. Some authors such as Durán Valsero et al. [11] and Brilha [12], highlight the great value that comes with the protection, valuation and conservation of a heritage, especially the important intervention of institutions and all the people involved with the place (inhabitants and scientific researchers), Urquí [13] emphasizes that "the geological heritage gathers those places that show in a relevant way the functioning of the geological processes that act today or what they did in the past", thus increasing the degree of importance not only regional but also national and international, as this is important information that benefits the comprehension of the Earth's evolution.

Another term related to geological heritage and of great importance is the mining heritage, which emphasizes all human activity carried out in the subsoil or on the surface, and which are highly related to mining [8]. To take advantage of exploited areas according to Nita and Myga-Piątek [14], is of great importance for the increase of tourism in post-mining areas, thus stimulating the economy and social growth of those sites where the mining industry predominated and all buildings built around it as cities [15] and other places that today represent great thrust as tourist attractions.

The growing need to reduce the negative effects and take advantage of this activity as an economic resource through geotourism, leads to the evaluation and valuation of heritage interest present on the site, as well as the projection of potential geosites that support an adequate management of strategies for their respective geoconservation [16], [17]. Those sites with a high degree of geological interest are referred to as geosites, thus promoting tourism development and providing multiple purposes such as research, conservation and sustainable development [18]–[20].

According to Rodríguez Font [21], the geosites play a fundamental role, then, "the valuation of the geosites corresponds to a phase of great relevance in the diagnosis of the geological heritage of an area, through which it is possible to recognize the relative importance of the inventoried sites. With the assessment, the selection of sites with better characteristics is facilitated", in this way it is possible to propose strategies in protected areas.

At present, many of the countries seek to implement existing criteria and methodologies to achieve the assessment of their geodiversity, including becoming included in various projects such as the Global Geoparks Network endorsed and permanently monitored by UNESCO [22]. These geoparks are geographical areas that highlight the important aspects of an internationally recognized site, to preserve and plan strategies that contribute to the sustainable economic development of the privileged city [23].

Around the world, there are 147 geoparks, among which Hong Kong (China) stands out as a unique geopark due to its diverse ecological resources, sedimentary rock formations, hexagonal columns of acidic volcanic rocks very close to the city [24]. Also, several land and water routes have been generated and improved for safe access to its geosites, to take advantage of geotourism as a Geopark.

Ecuador is a country with abundant geodiversity in its different regions and important geological outcrops of various kinds. It has a geopark located in the province of Imbabura and, therefore, included in the Global Geoparks Network by UNESCO [25].

Some cities in Ecuador are representative internationally, Guayaquil is the main seaport of the country and is considered a tourist and commercial city, where geological singularities

stand out that highlight the importance of geodiversity and represent an opportunity for geotourism. Even with the right guidance, it can be considered a Geopark prospect.

Is it possible that including elements of geodiversity such as geosites, Guayaquil manages to strengthen its tourism offer by complementing traditional values, new schemes within the framework of a geopark project? So, the aim of this work is to evaluate 12 geosites belonging to the city using the Brilha assessment methodology for the enhancement of their resources contributing to education and tourism.

2 STUDY AREA

The city of Guayaquil is recognized as the first port in the country and has one of the best port facilities on the South American west coast. It is bordered by the majestic Guayas River and invaded by arms of the sea (salty estuary), which makes the city a unique and unforgettable geoturistic attraction. Also, it consists of a river port (to the east) and seaport (to the south), which causes an increase in export and import activities of products to be marketed [26].

It has places suitable for various recreational, cultural, landscape and great diversity of flora and fauna, as well as geological structures that do without the rest and manage to highlight the great geodiversity that it has in its surroundings [29]. In addition to its great tourist attractions and the geographical location it possesses (Fig. 1), its progress and structural evolution, geographical settlements and other events, today they are reflected in many of its geosites and the heart of its inhabitants [29].

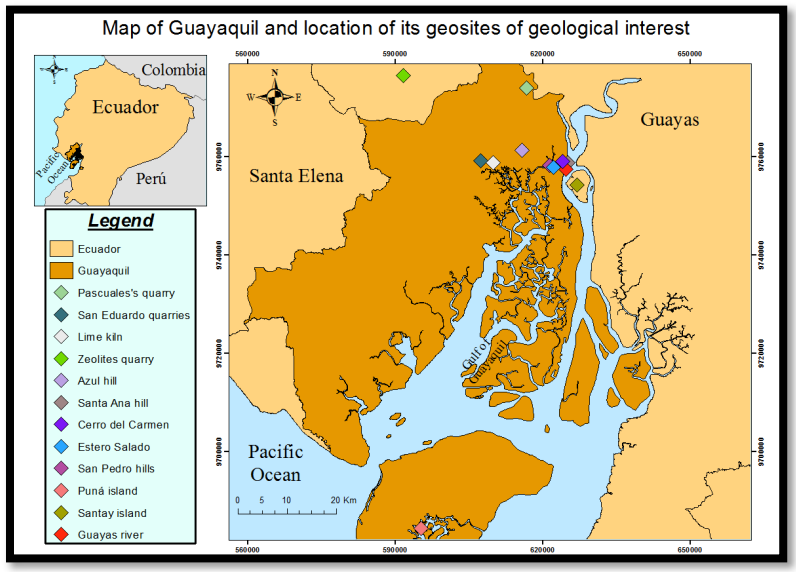


Figure 1: Map of the city of Guayaquil and the location of its sites of geological interest. *(Source: Modification of SIN [30].)*

3 METHODOLOGY

For the development of the research work, the four-phase approach has been considered, in which it is considered from the geographical/geological framework and the cataloging of 12

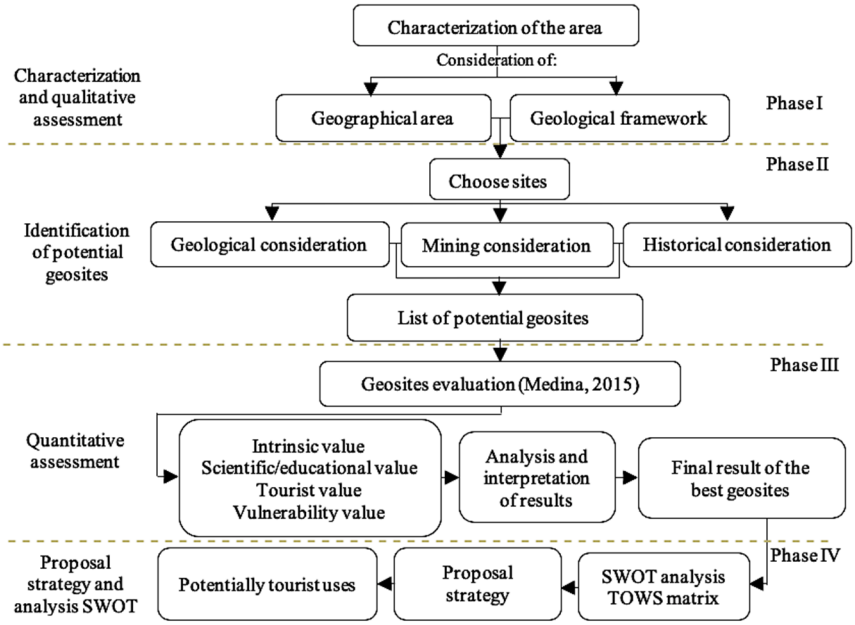


Figure 2: General methodology.

geosites to the evaluation and proposal of SWOT strategies and analysis (Fig. 2), with the purpose to conserve and promote geotouristic development in Guayaquil.

3.1 Characterization of the studied area

The geographical area of Guayaquil is located on the Ecuadorian coast west of the Andes mountain range likewise, the existence of different geomorphological features or macro domains such as the Chongón-Colonche mountain range, the delta-estuarine complex of the Guayas river and the alluvial plain of the Daule and Babahoyo rivers [29]. Which are presented in different parts of the city and selected sites.

3.2 Cataloging of 12 geosites

For the selection or cataloging of the 12 potential geosites, the interaction they have with geodiversity is considered and together with their high geological and mining interest. And, later, using their approval percentage [31] it will be possible to verify how suitable these sites are identified for their corresponding evaluation.

3.3 Geosites assessment

To carry out a quantitative assessment of sites with geological interest is implemented the Brilha and Medina methodology, whose methodological bases are by Brilha (2005) and Pereira (2010) [32]. For this, the four values are taken into account: (A) intrinsic value, (B) scientific/educational value, (C) tourist value and (D) value in vulnerability. Which have a subclassification value of 1 (lowest value), 2 and 3 (highest value), which serves to quantify and obtain the values by approval percentage (AP).

3.4 SWOT analysis and TOWS matrix

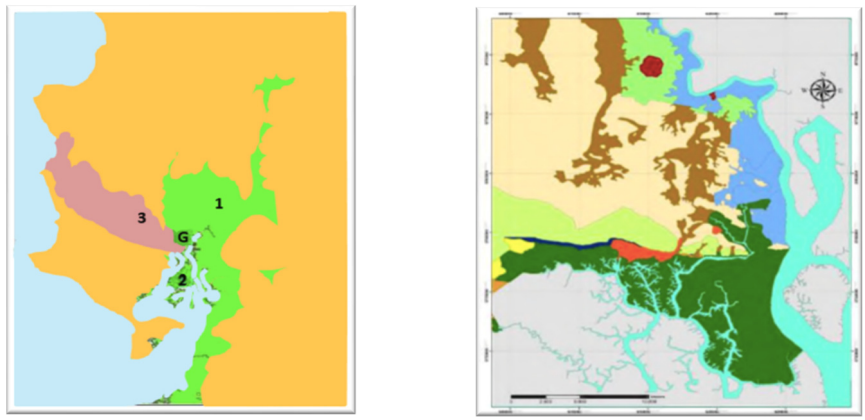
The SWOT analysis consists of identifying the strengths, opportunities, weaknesses and threats of the cataloged and evaluated sites. On the other hand, through the TOWS matrix, strategies can be created following the combination of internal and external characteristics (strengths and weaknesses; opportunities and threats, respectively) [13].

According to Urquí [13], when using the SWOT analysis and the TOWS matrix, a series of strategies can be established that guarantee the use and implementation of effective actions, which should be used in the evaluated geosites.

4 RESULTS

4.1 Geographical and geological framework of the Guayaquil city

Geographically Guayaquil is a city located west of the Guayas River (Fig. 1) and consists of three geomorphological macro-domains [29] which are, the estuarine-deltaic plain of the Guayas river that invades it from the south and south-west, the mountain range Chongón Colonche marks its limitations to the southwest and northwest of its geographical area and in the opposite direction as the alluvial plain of the Daule and Babahoyo rivers (Fig. 3(a)).



(a) (b)

Figure 3: Map of the city of Guayaquil. (a) Geomorphological [34]; and (b) Geological [33]. (a) 1 = Alluvial plain of the Daule and Babahoyo rivers; 2 = Estuarine-deltaic plain of the Guayas river; 3 = Mountain range Chongón-Colonche; and G = Guayaquil. (b) = Alluvial deposit; = Estuarine deposit; = Alluvial-Lacustrine deposit; = Colluvial deposit; = Ancón group; = Azúcar group; = San Eduardo Formation; = Guayaquil Formation; = Cayo Formation; = Piñón Formation; and = Undifferentiated granitic rocks.

Within the study area or area considered, there is the presence of Mesozoic and Cenozoic rocks, quaternary sedimentary deposits and volcanic sites. The same ones that, depending on the geology present in each sector (Fig. 3(b)) can settle in different formations [29], [33]: the Piñon Formation (Jurassic–Cretaceous), Cayo Formation (Upper Cretaceous), San Eduardo Formation (Upper Eocene) and the Guayaquil Formation (Upper Miocene).

Table 1 shows the geological characteristics of each of the sites of geological interest, which have been visited and evaluated according to the methodology applied (Fig. 4).

Table 1: Geological framework of the 12 geosites.

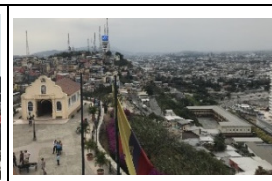
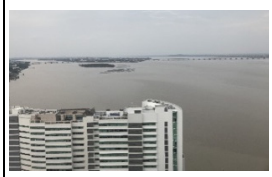
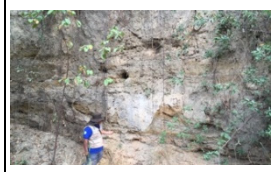
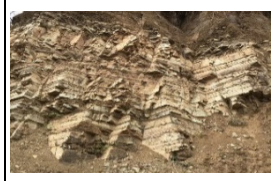
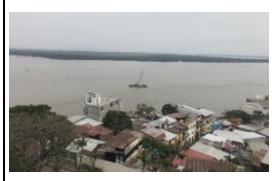
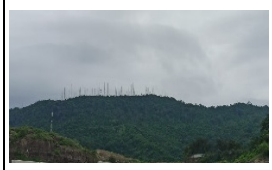
		**Santa Ana hill** It is located on the edge of the Guayas river and has a viewpoint with spectacular views of the city, is constituted by silicified shales with a high degree of fracture and sandstone intercalations, belonging to the Guayaquil Formation [29].
		**Guayas river** It has an amplitude average of 2 km and is formed by the hydrographic basins of the Daule and Babahoyo rivers, the sedimentation occurred in the transgression and regression of seawater in recent years has generated two islets [29].
		**Puná island** It has a natural and cultural appeal due to the indigenous population that inhabits it, its geomorphology is smooth (0–300 msnm) and is consists of shales and sandstones, as well as deposits of the upper Pliocene–Quaternary and Quaternary marine terraces.
		**San Eduardo quarries** Formed by alluvial soils and limestone rock (San Eduardo Formation) of good mechanical resistance and low porosity [29]. Much of this territory belongs to the Holcim company (which generates and distributes cement throughout the country).
		**Zeolites quarries** It is a quarry for the exploitation of natural zeolites in volcano-sedimentary rocks with alluvial and colluvial clay soils and it constitutes the deposition of marine sediments belonging to the Cayo Formation and with more than 1,700 m thick [35], [36].
		**San Pedro hills** It is one of the hills belonging to the Chongon-Colonche mountain range, its homoclinal structure of average general heading N110º [29] and very old rocks (silicified shales). It is close to the salty estuary and its mangroves.
		**Santay island** It is located between the cities of Guayaquil and Durán and offers a tourist tour highlighting its culture and biodiversity. It is an islet 4 km wide and is formed by the accumulation of sediments by the transgression and regression of the sea in the Guayas river [29].

Table 1: Continued.

		**Lime kilns** Years ago, it has been the means to camp and be in harmony with nature. These old nights kilns are located in the Cerro Blanco Protected Forest and are specifically constructed of carbonate rocks that belong to the same zone.
		**Cerro del Carmen** It has highly fractured rocks that generate sliding of blocks (of varied size), causing the search for solutions to slope stabilization [29]. It has a viewpoint and a natural beauty that enhances its tourist activity. There are slumps (gravity folds in the left figure).
		**Estero Salado** It has a unique natural ecosystem with the presence of brackish water channels and mangrove forests, seated in deltaic type soils [29]. It is an estuary under the influence of transgression and regression of the sea.
		**Pascuales's quarry** It is in the Piñon Formation, it is made up of basaltic and diabasic rocks, which are used as construction aggregates, ballast material and sub-base of fillings and embankments [29], [35], [36]. There is the presence of mining activity (by more than one company) and the formation of a small lagoon.
		**Azul hill** Its high relief and bluish color represent the great diversity of flora and fauna that it has. It consists of agglomerates, sandstones, limolites and shales (at its base). Following this, there is the Guayaquil Formation characterized by chert in centimeter layers [29], [35], [36], in addition to the presence of zeolites.

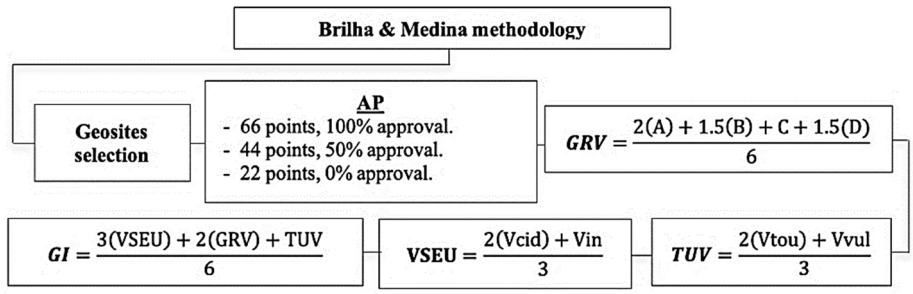


Figure 4: Methodology applied for the evaluation of geosites. AP = approval percentage; GRV = geosite relevance value; Vtou = tourist value; Vvul = vulnerability value; TUV = tourist use value; Vcid = scientific/educational value; Vin = intrinsic value; VSEU = value of scientific/educational use; GI = geoconservation index.

4.2 Quantitative assessment of catalogued geosites

After the assessment made by experts in the field, favorable results were obtained for the analysis of the results obtained which can be seen in Table 2.

Table 2: Quantitative assessment of the selected geosites.

No.	Geological places of interest (LIGs, acronym in Spanish)	AP (%)	GRV	VSEU	TUV	GI (%)
1	Santa Ana hill	84.85	13.42	2.44	2.59	84.85
2	Guayas river	83.33	12.83	2.75	2.44	83.33
3	Azul hill	80.30	12.75	2.61	2.26	82.36
4	Puná island	77.27	12.50	2.61	2.04	80.69
5	Estero Salado	74.24	11.42	2.36	2.22	74.44
6	Santay island	69.70	11.08	2.33	1.90	69.70
7	Lime kilns	65.15	10.08	1.69	2.16	65.15
8	Cerro del Carmen	60.61	9.67	1.89	1.74	61.94
9	Pascuales's quarry	56.06	9.00	2.03	1.42	59.03
10	Zeolites quarry	53.03	8.50	1.81	1.42	55.14
11	San Pedro hills	51.52	8.25	1.81	1.35	53.89
12	San Eduardo quarries	50.00	8.33	1.89	1.13	54.31

Note: AP = approval percentage; GRV = geosite relevance value; TUV = tourist use value; VSEU = value of scientific/educational use; GI = geoconservation index.

4.3 Matrix of analysis of strengths, opportunities, weaknesses and threats (SWOT)

Based on the results obtained, the implementation of a SWOT analysis (Table 3) and TOWS matrix (Table 4) is implemented. Thus, obtain a correct approach to strategies based on the internal (SW) and external (OT) characteristics of Table 3 and mentioned in Table 4.

5 ANALYSIS OF RESULTS

The strategic location of Guayaquil, by the Gulf of Guayaquil, sedimentation towards the sea of the great Guayas basin, and the effects of cyclical regressions and transgressions, make it a unique ecosystem, with a great geological and mining diversity as formations, deposits and types of rocks visible in different places, as well as its three geomorphological macro-domains (Fig. 3(a)), which make this city a suitable place for knowledge and study through visits to its sites geological interest. In this way, we are facing a unique laboratory on the Pacific coast, capable of providing us with knowledge and opportunities for innovation.

The methodology proposed by Medina, which includes aspects of Brilha (2005) and Pereira (2010) [32] for the development of an inventory and quantification of geological and mining heritage (Fig. 4), gave very encouraging results in the classification and evaluation of the selected sites. The countries involved in the conservation of their heritage, especially geological, those with geoparks such as China (Hong Kong), who managed to protect their geological heritage and be recognized worldwide through a legal framework endorsed by UNESCO, similarly, An official geoconservation and recognition of the city of Guayaquil can be sought given the presence of sites with great geological and mining interest, and for its wonderful environment presented in this work along with a diversity of references [26]–[29], [33], [34].

Table 3: SWOT analysis of the defined area.

Strengths	Opportunities
• Great variety of geodiversity. • Geodiversity has a historical, cultural and landscape contribution. • Natural diversity diverse in a marine estuary environment. • They have great research and tourism interest at national, international level.	• Official recognition of geological and mining places of interest by the public and private entities. • Strengthen characteristic values such as geological and mining, historical, tourism, educational/scientific. • Contribution of new concepts in the natural landscape of great benefit to the coastal city.
Weaknesses	Threats
• Lack of distribution of information relevant to the degree of value present in each geosite. • Lack of land use by administrators despite its high tourist value around the city. • Some roads in poor condition and without registration or information of safe routes for access.	• The alteration, social and industrial insecurity, destruction or contamination of the surroundings in many of these sites, due to population settlement. • The low interest of care against the high index of visitors can generate a more rapid deterioration in natural or non-renewable places. • Absence of studies relevant to each place and its value of interest.

Table 4: TOWS matrix, approach to strategies based on the data in Table 3.

Strategies: Strengths + Opportunities	Strategies: Weaknesses + Opportunities
• Cultural scientific recognition of the features of geodiversity and its incorporation and empowerment for geoturistic development.	• Develop a territorial planning methodology that incorporates geodiversity with heritage, protection, development and sustainable use criteria for an intelligent city.
Strategies: Strengths + Threats	Strategies: Weaknesses + Threats
• Develop multidisciplinary projects that enhance a geodiversity for sustainable development. • Deploy various activities to increase geotourism and thereby improve the interest adopted with your community.	• An integral strategy of communication, promotion and development of places of geodiversity integrated to the development of an intelligent city. • Promote studies relevant to each place, to implement more optimal care and conservation for each geosite.

On the other hand, the percentage obtained from the geoconservation index (GI) is very favorable and is consistent with the results of the AP, thus having a way to validate the geosites in more detail and guarantee their enhancement as heritage and as a geosite icon for geotourism in the city.

For the use of each sector, you can use the strategies listed below:

- Disseminate the benefits and contribution of each geosite to create preservation and protection plans in certain environments prone to deterioration, in such a way that the negative effect of the city on the surroundings of each geosite is reduced.
- Incorporate into the land management the places of geological interest (geodiversity), routes and access roads to each determined area for proper management and accessibility to each point of interest. Likewise, promote a study that adapts to each site to reduce the present insecurity and implement optimal care and conservation for each geosite.

6 CONCLUSIONS

Given the results obtained from the 12 sites of geological interest selected, these can be considered as geosites and iconic places for the development of Guayaquil, being Santa Ana hill, Guayas river, Azul hill, Puná island, Salado estuary, Santay island, Lime kiln and Cerro del Carmen, who have an approval percentage (AP) greater than 60% which shows the degree of geological interest present in each one. So, only four sites such as the Pascuales quarry, zeolite quarry, San Eduardo quarries, and San Pedro hills have an AP close to 50%, exceeding expected expectations after the evaluation by experts in the area.

According to the geoconservation index (GI) (Table 2), sites with a value greater than 80% are essential for its use, care and dissemination as a tourist attraction, and sites with an appropriate percentage of 60–80% can be added for tourist use and its respective conservation and use analysis. To preserve and promote each of these places, its greatest strengths such as the richness and natural beauty that each one has to be emphasized, but one of its greatest threats is the insecurity, destruction and pollution caused by the population due to the low knowledge that stands out in each geosite. That is why, it is of great importance to create geoconservation plans and improve access routes and information channels, to take advantage of the heritage and landscape value that each geosite offers.

Given the study and the results obtained, the 12 geosites present an assessment that allows us to incorporate geotouristic development in Guayaquil.

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REFERENCES

[1] Ramos, A.G. & Fernández, G., Geoconservación, geoturismo y espeleoturismo: Análisis de dos sistemas cavernarios en argentina. Pesquisas em Turismo e Paisagens Cársticas, 2016. (In Spanish.)

[2] Manosso, F.C., Potencial del geoturismo y la geodiversidad en la Serra do Cadeano, Paraná, Brasil. *Estudios y perspectivas en turismo*, **21**(2), pp. 322–338, 2012. (In Spanish.)

[3] Sharples, C.A., Methodology for the identification of significant landforms and geological sites for geoconservation purposes. Forestry Commission: Tasmania, Australia, 30 pp., 1993.

[4] Serrano Cañadas, E. & Ruiz Flaño, P., Geodiversidad: concepto, evaluación y aplicación territorial. El caso de Tiermes Caracena (Soria). *Boletín de la A.G.E. N.o*, **45**, pp. 79–98, 2007. (In Spanish.)

[5] Kozlowskyi, S., Geodiversity: The concept and scope of geodiversity. *Przeglad Geologiczny*, **52**, pp. 833–837, 2004.
[6] Carcavilla, L., Durán, J.J. & López-Martínez, J., Geodiversidad: Concepto y relación con el patrimonio geológico. *Geo-Temas*, **10**, pp. 1299–1303, 2008. (In Spanish.)
[7] Urquí, L.C. & de la Cova, R.R.L., La geoconservación en Castilla-La Mancha. Estado actual y perspectivas de futuro. *Cuaternario y geomorfología: Revista de la Sociedad Española de Geomorfología y Asociación Española para el Estudio del Cuaternario*, **23**(3), pp. 11–26, 2009. (In Spanish.)
[8] Carrión, P., Herrera, G., Briones, J. & Sánchez, C., La Geodiversidad, una componente de desarrollo sostenible. *Journal of Science and Research: Revista Ciencia e Investigación.* **3**, pp. 36–42, 2018.
[9] Carrión Mero, P., Herrera Franco, G., Briones, J., Caldevilla, P., Domínguez-Cuesta, M.J. & Berrezueta, E., Geotourism and local development based on geological and mining sites utilization, Zaruma-Portovelo, Ecuador. *Geosciences*, **8**, p. 205, 2018.
[10] Lazzari, M., Geosites, cultural tourism and sustainability in the Gargano National Park (southern Italy): The case study of the La Salata (Vieste) geoarchaeological site. *Rend. Online Soc. Geol. Ital.*, **28**, pp. 97–101, 2013.
[11] Durán Valsero, J.J., Brusi i Belmonte, D., Pallí i Buxó, L., López Martínez, J., Palacio, J. & Vallejo, M., Geología ecológica, geodiversidad, geoconservación y Patrimonio Geológico de la Declaración de Girona. *IV Reunión Nacional de la Comisión de Patrimonio Geológico: Miraflores de la Sierra*, Madrid, June–July 1998, *Comunicaciones*, **1**, p. 69–72, 1998. (In Spanish.)
[12] Brilha, J.B., *Património geológico e geoconservação: a conservação da natureza na sua vertente geológica*, Palimage, 2015. (In Portuguese.)
[13] Urquí, L.C., *Proyecto geosites: Aportación española al patrimonio geológico mundial*, IGME, 2010. (In Spanish.)
[14] Nita, J. & Myga-Piątek, U., Geotourist potential of post-mining regions in Poland. *Bulletin of Geography. Physical Geography Series*, **7**(1), pp. 139–156, 2014.
[15] Duraj, M., Niemiec, D., Sombathy, E., Marschalko, M., Yilmaz, I., Matuszková, B. & Yang, S., Ore mining of kutnohorsko and its economic importance for construction and development. Paper presented at the *IOP Conference Series: Materials Science and Engineering*, **603**(5), 2019. www.scopus.com.
DOI: 10.1088/1757-899X/603/5/052085.
[16] Coratza, P., Vandelli, V., Fiorentini, L., Paliaga, G. & Faccini, F., Bridging terrestrial and marine geoheritage: Assessing geosites in Portofino Natural Park (Italy). *Water (Switzerland)*, **11**(10), 2019. DOI: 10.3390/w11102112.
[17] Castro, C., Marquardt, C. & Zúñiga, Á., Peligros naturales en geositios de interés patrimonial en la costa sur de Atacama. *Revista de Geografía Norte Grande*, **45**, pp. 21–39, 2010. (In Spanish.)
[18] Carcavilla, L., Belmonte, Á., Durán, J.J. & Hilario, A., Geoturismo: Concepto y perspectivas en España. *Enseñanza de las Ciencias de la Tierra*, **19**(1), p. 81. (In Spanish.)
[19] Suzuki, D.A. & Takagi, H., Evaluation of geosite for sustainable planning and management in geotourism. *Geoheritage 2018*, **10**, pp. 123–135, 2011.
[20] Sánchez-Martín, J., Rengifo-Gallego, J. & Martín-Delgado, L., Characterization of the tourist demand of the Villuercas–Ibores–Jara geopark: A destination with the capacity to attract tourists and visitors. *Geosciences (Switzerland)*, **9**(8), 2019.
DOI: 10.3390/geosciences9080335.

[21] Rodríguez Font, C.I., *Patrimonio geológico en la ciudad de Santiago: Caracterización y valoración de geositios en torno a un núcleo urbano*, 2013. (In Spanish.)
[22] United Nations Educational, Scientific and Cultural Organization (UNESCO), Earth Sciences, Global Geoparks. www.unesco.org/new/en/natural-sciences/environment/earth-sciences/unesco-global-geoparks/. Accessed on: 15 Jan. 2020.
[23] United Nations Educational, Scientific and Cultural Organization (UNESCO), International Programme of UNESCO Global Geoparks. www.unesco.org/new/en/office-in-montevideo/natural-sciences/international-programme-for-geosciences-and-geoparks/unesco-global-geoparks/. Accessed on: 15 Jan. 2020.
[24] United Nations Educational, Scientific and Cultural Organization (UNESCO), Earth Sciences, Hong Kong UNESCO Global Geopark (China). www.unesco.org/new/en/natural-sciences/environment/earth-sciences/unesco-global-geoparks/list-of-unesco-global-geoparks/china/hong-kong/. Accessed on: 15 Jan. 2020.
[25] United Nations Educational, Scientific and Cultural Organization (UNESCO), Imbabura UNESCO Global Geopark Ecuador. https://es.unesco.org/galleries/imbabura-unesco-global-geopark-ecuador. Accessed on: 15 Jan. 2020.
[26] Inocar, *Información General de la República del Ecuador, Situación geográfica de Guayaquil, Ecuador*, 2012. (In Spanish.)
[27] Ecuador Travel, Guayaquil. https://ecuador.travel/es/destinos/costa-del-pacifico/guayaquil/. Accessed on: 15 Jan. 2020.
[28] Aguirre, J. & Estrada, S. (eds), Un Guayaquil de leyendas y anécdotas. *ESTILO,* **328**, pp. 26–29, 2018. (In Spanish.)
[29] Reinoso, J., Michalón, R., Avilés, J. & Calle, J., Recopilación de información base para el mapa geoambiental del área urbana del gran Guayaquil y mapas en formato sig. www.dspace.espol.edu.ec/xmlui/handle/123456789/8134, 2005. (In Spanish.)
[30] Secretaria Nacional de Planificación y Desarrollo y el Sistema Nacional de Información (SIN), Mapa de ubicación de la ciudad de Guayaquil, 2013. (In Spanish.)
[31] Medina, W., Universidad do Minho, Escola de Ciencias. Propuesta Metodológica para el Inventarío del Patrimonio Geológico de Argentina, 2012. (In Spanish.)
[32] Medina, W., Importancia de la Geodiversidad. Método para el inventario y valoración del Patrimonio geológico. *Serie correlación geológica*, **31**(1), pp. 57–72, 2015. (In Spanish.)
[33] Vera Grunauer. X., Actualización del estudio de microzonificación sísmica de la ciudad de Guayaquil, Auspiciado por: Secretaria de Gestión de Riesgos, 2013. (In Spanish.)
[34] Benítez, S., Vera Grunauer, X. & Álvarez, V., Estudio Geológico de la ciudad de Guayaquil. Informe final de Investigación y Estudio del comportamiento dinámico del subsuelo y Microzonificación sísmica de la ciudad de Guayaquil. IIFIUC, Universidad Católica de Santiago de Guayaquil: M.I. Municipio de la ciudad de Guayaquil, 2005. (In Spanish.)
[35] Machiels, L., Morante, F., Snellings, R., Calvo, B., Canoira, L., Paredes, C. & Elsen, J., Zeolite mineralogy of the Cayo formation in Guayaquil, Ecuador. *Applied Clay Science*, **42**(1–2), pp. 180–188, 2008.
[36] Machiels, L., Garces, D., Snellings, R., Vilema, W., Morante, F., Paredes, C. & Elsen, J., Zeolite occurrence and genesis in the Late-Cretaceous Cayo arc of Coastal Ecuador: Evidence for zeolite formation in cooling marine pyroclastic flow deposits. *Applied Clay Science*, **87**, pp. 108–119, 2014.