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Geosites and Georesources to Foster Geotourism in Communities: Case Study of the Santa Elena Peninsula Geopark Project in Ecuador

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Abstract: Santa Elena Peninsula is characterized by beautiful geological features, historical geoscientific knowledge, and mineral and tourism resources that could all be combined for the sake of community development. This article provides an overview of the Santa Elena Peninsula Geopark Project through the assessment of six areas that are considered by inhabitants and researchers possible geosites to foster geotourism. The methodology included: (i) a technical description and assessment of the areas of interest evaluating their geological relevance, representativeness, geotouristic prominence, geotouristic scientific interpretation, and conservation criteria; (ii) an assessment through questionnaires carried out on inhabitants; and (iii) a SWOT Plus analysis to propose strategies for promoting geotourism. Results show that the areas of interest are highly valued as geosites, since they integrate geodiversity, biodiversity, and sociocultural aspects. For example, Ancon is a historical icon of early oil exploitation, Baños de San Vicente is a natural spring of thermal water and mud volcano, and Anconcito has bituminous exudations of natural occurrence together with a spectacular landscape produced by erosion. Overall, 90% of these sites were proved to be of high and very high interest in scientific terms. Geotourism is believed to be beneficial for the inhabitants of the Santa Elena Peninsula with respect to education, valorization of resources, and the strengthening of cultural identity of communities.

Keywords: Santa Elena Peninsula; geopark project; geotourism; georesources; SWOT analysis

1. Introduction

In the last few decades, geotourism has shown considerable growth all over the world [1,2]. According to [3,4], geotourism is appreciated and accepted as a useful tool for promoting natural and cultural heritage and for fostering local and regional economic development, especially within rural areas. In the 1990s, the concept of geotourism [5] appeared as "geological" rather than "geographical" tourism. In the first years of the 21st century, the National Geographic Society [6] reported for first time geotourism as geographical tourism. In general, geotourism can be seen as a branch of tourism based on geographical location and geological nature that attributes "sense of place" to the area [7,8]. Geotourism understands, promotes, and appreciates the environment. It recognizes the importance of geological and climatic phenomena also as determinant factors in the biotic environment [9–11]. Nevertheless, if geotourism lacks adequate control and prevision, it can itself pose a threat to nature [10]. In recent years, the concept of geotourism has been completed with economic and environmental aspects. In this way, according to [12], geotourism is "a sustainable tourism with a primary focus on experiencing the Earth's geologic features in a way that fosters environmental and cultural understanding, appreciation and conservation, and is locally beneficial." For [13], the geotourism "allows tourists to know the local geology but also to better understand that the geology is closely related to all the other assets of the territory, such as biodiversity, archaeological and cultural values, gastronomy, etc." Although the appreciation of geology and landscape, travelling to areas of either great natural beauty or unique geographical phenomena is not something new, the geotourism has been able to optimize it.

In geotouristic activities, geodiversity is in the center of attention and represents the basic resource for geotourism. According to [14], geodiversity is "the number and variety of structures (sedimentary, tectonic, geological materials—minerals, rocks, fossils and soils), that constitute the substratum in a region, above which the organic activity is settled, the anthropic included." A more detailed definition is presented by [15]: "geodiversity is the diversity coming from the nature itself (physical-geographical environment) and from the social processes, such as production, settlement and circulation (the human being and its activities)," considering human activities as part of geodiversity." According to [4], it has to be remembered that setting the links between geodiversity, biodiversity, culture, and history can help appreciate the geodiversity as a full-value resource for tourist activities, and thus, as an important resource for local and regional development.

Usually, only a small fraction of the geodiversity has a relevant value to justify the application of geoconservation measures, regardless of whether this fraction is considered geological heritage or not [16]. The geological heritage is defined as a group of geological elements with outstanding scientific, cultural, and educational values [11,15,17]. In general, geological heritage is formed by all those places or points of geological interest, defined as sites or geosites, that stand out from their surroundings due to their scientific and/or educational value [18]. In addition, there is a movable geological heritage (vulnerable parts of earth science exposed to natural degradation or human action, that can—or must—be protected ex situ). Their inclusion into a museum collection often means the only chance for the preservation of these invaluable inanimate natural monuments [19]. Mining heritage is another concept related with geological heritage [11,15,17]. It can be defined as the totality of surface and subsurface mining works, transport facilities, machinery, documents, or objects related to former mining activities with a historical, cultural, or social value [20]. According to [21], geoconservation strategies should be applied to the characterization and management of every feature of geodiversity that shows any kind of value.

According to [22], UNESCO Global Geoparks are "single, unified geographical areas where sites and landscapes of international geological significance are managed with a holistic concept of protection, education and sustainable development." This global initiative created by UNESCO has been developed and promoted worldwide during the last two decades [8]. In particular, Geoparks make the most of geological heritage, together with all other aspects of an area's natural and cultural heritage, to enhance awareness and understanding of key issues facing society, such as using our earth's resources sustainably, mitigating the effects of climate change, and reducing natural disaster-related risks [22–25]. Geoparks give local people new opportunities as new sources of revenue are generated through geotourism, while the geological resources of the area are protected [26].

During the last years, seven UNESCO Global Geoparks have been created in the American continent: Araripe (Brazil), Grutas del Palacio (Uruguay), Comarca Minera (Mexico), Mixteca Alta (Mexico), Colca and Volcanes de Andagua (Peru), Kütralkura (Chile), and Imbabura (Ecuador). The Imbabura Geopark was the first one to be approved in a list of six other geopark candidacy projects in Ecuador, such as Tungurahua volcano, Napo-Sumaco and Santa Elena Peninsula. The activities described in the present paper have been developed under the aegis of the Santa Elena Peninsula Geopark project.

Santa Elena province is in the westernmost part of Ecuador (Figure 1). It has an altitudinal range from 0 to up to 800 m.a.s.l. and an average yearly temperature of 27 °C. Regarding relief, gentle slopes predominate, and it is characterized by dry and arid climatic conditions. The mean annual rainfall is up to 150 mm near the Pacific Ocean and up to 500 mm near the Costanera mountain range. Droughts have occurred regularly throughout the history of the province, affecting the rural economy [27]. Santa Elena province has an area of 3691 km^2. The geographical subdivision of the province is organized at three levels: cantons, parishes, and communes/communities. A total of 44.82% of the territory is rural. Only 34.27% of the Santa Elena population is employed, 73.48% of which are men and 26.52% are women. It was estimated that the basic needs are not satisfied of an average of 52.3% of the population.

The opinion and criteria of the population was gauged at the beginning of the Geopark Project via volunteer activities. Their main interests, which lie in tourism initiatives linked to the marine-coastal sector [28], were given high priority, especially in cases that also included important museums, archaeological values, or ancestral practices [29,30] that are considered economic and effective by the community.

The province has a flat and slightly undulating morphology. More than 60% of the surface is hilly with slopes of rectilinear shape, unevenness between 20 and 70 m and rounded tops. Unstable high cliffs appear where the rocks are broken down into blocks. Cliffs are due to faults parallel to the coast and are made up of marine rocks and marine terraces, some raised a few meters above sea level. The foot of the cliffs is continually undermined by waves, simultaneously producing a retreat of the coast line and a continuous contribution of sediments to the sea. The coast of the territory is of low linearity with sandy beaches and fields of dunes. It has been defined as an allochthonous land of oceanic origin. The stratigraphic record includes 12 formations from the Early Cretaceous to the Pleistocene. The Santa Elena block is located in the basin of the same name, in the geological unit known as the "Levantamiento de Santa Elena" and it comprises a sedimentary sequence from the Cretaceous to the Lower Tertiary (Paleocene–Eocene), developed on oceanic crust. Fissured cherts are the most noteworthy feature of the Santa Elena Formation. Siliceous sandstones of high resistance and hardness are also present, which, if not affected by weathering, can be watertight due to the silicic matrix. Clayey sandstones, in general, are of lower resistance; they are unconsolidated and easily erodible. Clays are of high resistance to the cut in dry state but can be of low resistance when humid, and they may present characteristics of expansion [32].

Santa Elena has been in the center of important archaeological discoveries, imprints of the ancestral civilization of Ecuador. Moreover, the province is known for its oil extraction and mining history. Since the first exploratory wells were drilled in the Santa Elena Peninsula, geologists correlated the rocks of the Ancon oil field with those of Monteverde (north of Ancon) mainly based on paleontological and lithostratigraphic criteria and observed that there was a close correlation between the sedimentary series of these two areas [32]. There are deposits, such as the Ancon oil field, that produce reservoirs of

Tertiary age, while the Cretaceous sequence includes a set of reservoirs with a minor production in Santa Paula, Achallan, Petropolis, Carolina, San Raymundo, and Cautivo.

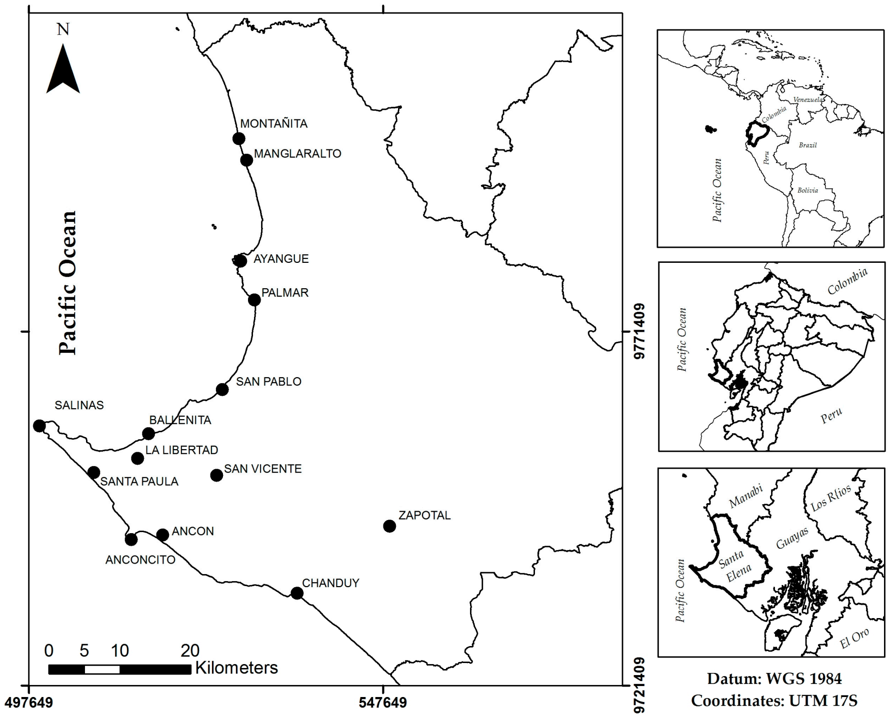

Figure 1. Santa Elena Peninsula location with respect to South America and Ecuador. Modified from [31].

Tourism is a very important activity in the province, where the geographical and climatic conditions and the geodiversity and biodiversity favor the development of sun and beach tourism, adventure tourism, water sports, and ecological and community tourism. The gastronomic diversity and suppliers of services and products related to tourism, such as retail trade, handicrafts, accommodation, and others, aim to meet the needs of tourists and visitors. During the high season of tourism from December to April, there is a floating population of about 100,000 to 500,000 [33].

Since 2016, the Santa Elena Peninsula Geopark Project has been working on strengthening geotourism in order to broaden the touristic offer through the use of geographic resources and the sustainable development of local communities [34]. According to [35], in the Geopark Project area, a total of 45 places have been identified with tectonic, paleontological, mineralogical, geomorphological, petrological, hydrogeological, and/or stratigraphic value. They have been assessed according to the methodology of the Geological Survey of Spain (IGME, by its Spanish acronym) [36]. This methodology is widely used in Spanish-speaking areas, and it is related to other methodologies used for the characterization and assessment of interest of geological and mining sites [15,37,38]. Susceptibility to deterioration, degree of priority protection, and scientific, academic, and tourist interests were among the considered criteria. According to [35], the most outstanding geosites have been identified, such as the coastal aquifer-river system in Manglaralto rural parish, the Chocolatera in Salinas, the Megatherium Paleontological Museum in La Libertad, thermal waters and mud volcano at Baños de San Vicente community, Ecuador's first oil well in Ancon oil field, bituminous exudations in Anconcito community, sedimentary structures in San Rafael community, among others. Moreover, the study enabled the creation of a georoute taking into account the (i) accessibility to the geosites, (ii) the short distance between different geosites, and (iii) the good preservation of the site either by the community or by a governmental entity.

There remains the question whether it is possible to devise strategies to promote geotouristic development by evaluating sites of interest with scientific methodologies and applying a pragmatic approach. To meet this challenge, while at the same time respecting the desire of the community to use and disseminate ancestral practices, coastal georesources are preferred either for their landscape, economic value, or cultural identity, connecting, therefore, geotourism to other types of touristic applications. Thus, it appears that the Geopark Project has to be related to and enriched with sociocultural aspects, relying on the special features of the territory (i.e., water management related to tapes/dikes and the so-called *albarradas* or artificial wetlands, archaeological remains, and oil production) that provide an added value to the already-existing sun and beach tourism.

Therefore, the aim of this paper is to provide an overview of the Santa Elena Peninsula Geopark Project through technical descriptions and assessments of six possible geosites based on a specific methodology of georesources. The possible geosites for this study were selected because they all have a high grade of valuation and are the components of the route proposed by a previous study [35]. Moreover, these places of interest include valuable resources of geological heritage linked to industrial and cultural heritage, they are related to protected natural areas and could be promoters of the local economic and territorial development.

2. Materials and Methods

This research was developed in three phases within the Santa Elena Peninsula Geopark Project framework. The Project counted with the participation of diverse stakeholders such as authorities, experts, researchers, businesses, and the local population. The methodology developed for the technical description and quantitative assessment of areas of geological interest is known as "GREGSIC", standing for Geological relevance, Representativeness, Geotouristically prominent Site, Interpretation, and Conservation. A schematic flowchart of the process is presented in Figure 2.

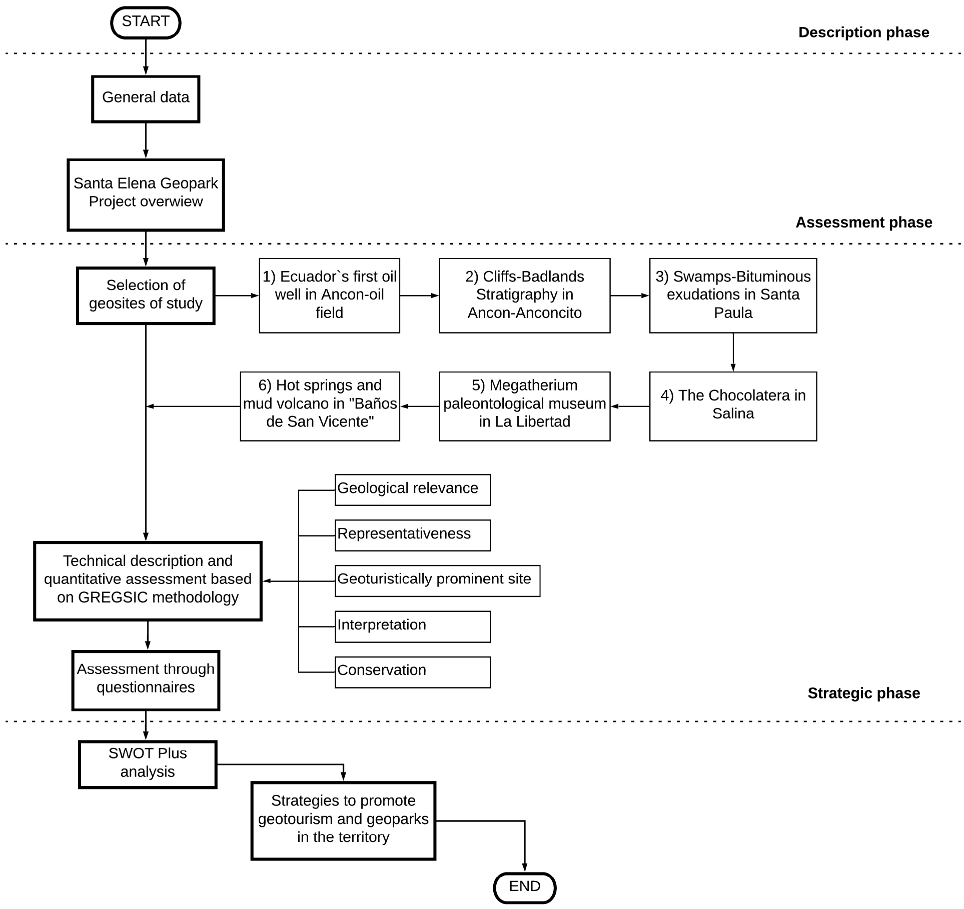

Figure 2. Schematic flowchart of the process followed in this study.

The general methodology included three phases: description phase, assessment phase, and strategic phase.

- In the description phase, an overview of the Santa Elena Peninsula Geopark Project was synthesized with the most outstanding aspects of the project based on general information about geological heritage, geoconservation initiatives, and socioeconomic development projects. The Geopark Project counts on the participation of a large number of national and international experts belonging to the University of Santa Elena (UPSE, by its Spanish acronym), the Centre for Research and Projects Applied to Earth Sciences (CIPAT, by its Spanish acronym) of the ESPOL Polytechnic University (ESPOL, by its Spanish acronym), the Ministry of Tourism of Ecuador (MINTUR, by its Spanish acronym), the Ministry of Environment of Ecuador (MAE, by its Spanish acronym), the IGME, and the UNESCO Chair Programme of the Mining and Industrial Heritage of the Polytechnic University of Madrid (UPM, by its Spanish acronym).
- The assessment phase included the technical description and assessment of the places of interest based on information obtained already by the Santa Elena Peninsula Geopark Project of the UPSE [27,32,39–41]. The MINTUR has a methodology to typify the touristic attractions [42], which was complemented with a methodology developed by the IGME for the evaluation of sites of geological-mining interest, named "IELIG" (acronym in Spanish for "Inventario Español de Lugares de Interés Geológico") [36]. In Spanish-speaking areas, this methodology is widely used, and it is related to other methodologies to characterize and evaluate geological and mining sites according to scientific, academic, and tourist interests, susceptibility to deterioration, and the degree of priority protection, as detailed in previous publications [15,37,38]. Considering mainly these two approaches (i.e., MINTUR and IGME), the "GREGSIC" method was developed using five criteria to categorize the geotouristic value of the areas of interest. The five criteria are geological relevance, representativeness, geotouristical prominency, interpretation, and conservation. In addition to the geological and mining aspects assessed by the IELIG methodology, the MINTUR requires the assessment of various touristic aspects. This part of the work was undertaken by academics and representatives of the MINTUR. The assessment phase also included an assessment through questionnaires completed by inhabitants, businesses, park rangers, and local authorities. On the other hand, the participation of experts and researchers was required for the technical descriptions and quantitative assessment. These experts, the authors of this paper, have specific knowledge and information about the territory and the geosites and are members of the Geopark Project.
- In the strategic phase, a SWOT Plus analysis was performed to identify strategies for fostering geotourism. A classic SWOT matrix [43,44] was adapted from an extended design [45], as a prospective instrument to categorize significant factors by integration of the occurrence of factors in time (existing vs. potential), their origin (internal vs. external), and their impact (favorable vs. unfavorable). This SWOT Plus analysis was proposed by [46], where instead of the four classic analysis groups (strengths, weaknesses, opportunities, and threats), eight categories are considered (strengths, weaknesses, internal opportunities, internal threats, stimulants, counter-stimuli, external opportunities, and external threats). SWOT Plus is a method used in the analysis of strategies for local development of the territory [47–49]. The analysis actively involves representatives of the population, local authorities, companies, park rangers, experts, and researchers; a dozen of meetings were held during the last 18 months with the representatives of the mentioned sectors. As a result, two participatory workshops were organized to extract criteria, opinions, wishes, and visions of those involved, regarding the Santa Elena Geopark Project. The meetings focused on the six geosites considered to be the most representative by the participants and according to the SWOT analysis. This allowed us to describe the necessary strategies for the development of geotourism in the territory. Even the sectional government of the Province of Santa Elena was involved in the last meeting.

2.1. GREGSIC Methodology

The assessment criteria are a combination of the parameters of valuation of places of geological interest developed by the IGME [36] and the parameters of valuation of tourist attractions developed by the MINTUR [42]. The 18 parameters of valuation of the IGME method are focused on the geological heritage taking into account geological aspects such as stratigraphy, sedimentology, paleontology, paleogeography, paleoclimatology, geomorphology, geotechnics, tectonics, history of geology, hydrogeology, petrology-geochemistry, mining-metallogeny, mineralogy-crystallography, and soil sciences. On the other hand, the 10 parameters of valuation used by the MINTUR are focused on promoting tourism in the Ecuadorian territory given that MINTUR is the tourism regulatory authority of the country. The assessment also takes into consideration the conservation of resources of the territory, promotion of cultural identity, community integration, didactic and informative use in earth sciences, strengthening of tourist facilities, job opportunities, and creation of businesses as sources of income for local inhabitants.

The proposed methodology can be applied in different geological and geomorphological settings, can refer to areas of various extensions, and under diverse legal contexts (parks, geoparks, areas with no protection, etc.). Obviously, some indicators have to be adapted for particular conditions. For instance, when evaluating two areas/sites with different geological interests with the same criteria, we obtain more representative data.

The parameters were grouped into five criteria (Table 1) in order to express the degree of geotouristic interest more effectively. Weights were adapted by the authors according to previous research by [35,36] (Table 1), and four possible scores could be selected (Table 2). The degree of geotouristic interest of geosites within the Santa Elena Peninsula Geopark Project was then expressed in four categories, the quartiles of the possible results between 0 and 300, as detailed in Table 3.

Table 1. Criteria of Geological relevance, Representativeness, Geotouristically prominent Site, Interpretation, and Conservation (GREGSIC) analysis and assessment weights. Based on [32].

	Criteria	Weight	Relation between Criteria of IGME and MINTUR
1.	**Geological relevance:** Existence of several types of geological features of international relevance.	25%	IGME • Geological diversity • Rarity
2.	**Representativeness:** A degree of how clearly the given geological feature can be observed and illustrated at the site, and how much of this can help the understanding of the geological topic, process, feature, or geological framework. Visual beauty of the geological features.	25%	IGME • Representativeness • Observation conditions • Spectacularity-beauty • Size
3.	**Geotouristical prominency**: Degree of popularity among tourists as compared to other sites within the territory. Existence of touristic facilities, such as transportation services, access routes, other nearby tourist attractions, and recreational activities.	10%	IGME • Character of locality or reference • Population density • Local socioeconomic environment MINTUR • Hygiene and tourist safety • Dissemination, means of promotion, and marketing of attractiveness • Registration of visitors IGME and MINTUR • Tourist facilities • Possibility of performing recreational activities/leisure • Proximity to other touristic areas

Table 1. *Cont.*

Criteria	Weight	Relation between Criteria of IGME and MINTUR
4. **Interpretation**: Didactic potential considering the difficulty of comprehension of the geological feature by visitors and the possibilities of geoscientific knowledge sharing to all audiences. Existence of scientific data already published.	10%	IGME • Content-informative use • Educational use • Degree of scientific knowledge about the place
5. **Conservation**: Plans related to the present conservation status of the site, sustainability policies, and links with other natural or cultural heritages.	30%	IGME • Geoconservation MINTUR • Policies and regulations • Human resources employed by the administration of the touristic attraction IGME and MINTUR • Association with other heritages: natural or cultural • Conservation

Table 2. Possible scores of geosites.

Possible Scores	Definition
0	Null
1	Medium
2	High
3	Very high

Table 3. Characterization of geosites according to analysis criteria (GREGSIC).

Possible Results	Definition of the Geotouristic Interest Degree
≤75	Low
150–76	Medium
225–151	High
≥226	Very high

2.2. Assessment through Questionnaires

For this study, a questionnaire was designed to be completed by inhabitants of the Santa Elena province with the purpose of determining (i) the level of knowledge regarding terms related to earth sciences, (ii) the most outstanding touristic areas within the Santa Elena province, (iii) the level of satisfaction with tourism activities and motivation to visit the six geosites selected for a georoute within the Santa Elena Peninsula Geopark Project, (iv) the interest to support the geopark project, and (v) the degree of satisfaction in communities, prominent aspects, and issues to improve. The participants were selected randomly from among inhabitants, businesses, park rangers, and local authorities.

The questionnaire was divided into three blocks and was composed of 20 questions; 17 of the questions were designed with closed answers giving the respondent a series of alternatives to choose from and 3 of them allowed the respondent to formulate their own answer (Supplementary Figure S1). The survey was conducted in the first quarter of 2019.

The sample size formula of [50] was used. The study population was the total of inhabitants of the Santa Elena province, about 392,611 people according to projections for 2019 [51]. With a confidence level of 99%, 2.575 was obtained as the Z value ($Z = x - \mu/\sigma$), with 5% sampling error, and unknown variance, as shown in Equations (1)–(4).

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

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

$$n = \frac{(2.575)^{2}\,(0.5)(0.5)(392611)}{\left((0.05)^{2}\,(392611-1)\right) + \left((2.575)^{2}\,(0.5)(0.5)\right)}, \quad (3)$$

$$n_{optimal} \approx 700, \quad (4)$$

where N = population size, ε = sampling error, p = success rate, q = failure rate, $Z_{\forall}$ = value of the normal distribution, and n = sample.

A total of 700 questionnaires were completed in accordance with the determined sample size and following a simple random sampling method. Both face-to-face and internet-based surveys were conducted respecting the respondents' anonymity in all cases. For data processing, the statistical package IBM SPSS Statistics-version 22-2013 was used.

3. Results

3.1. Representative Geosites: Selection and Technical Description

Six areas with evident interest were subjected to the more detailed study. These areas of interest are: (i) Ecuador's first oil well in Ancon oil field, (ii) cliffs–badlands–stratigraphy in Ancon-Anconcito, (iii) swamps–bituminous exudations in Santa Paula, (iv) The Chocolatera cliffs in Salinas, (v) Megatherium Paleontological Museum in La Libertad, and (vi) hot springs and mud volcano in Baños de San Vicente. The areas of interest are shown in Figures 3 and 4.

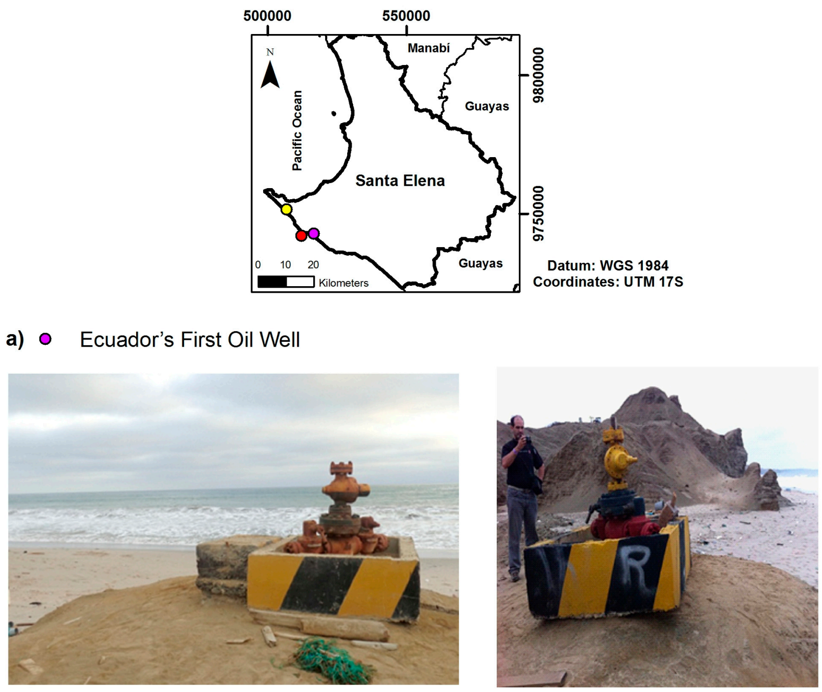

Figure 3. *Cont.*

Figure 3. Situation, panoramic view, and detailed view of (**a**) Ancon oil field, (**b**) cliffs–badlands–stratigraphy, and (**c**) swamps–bituminous exudations.

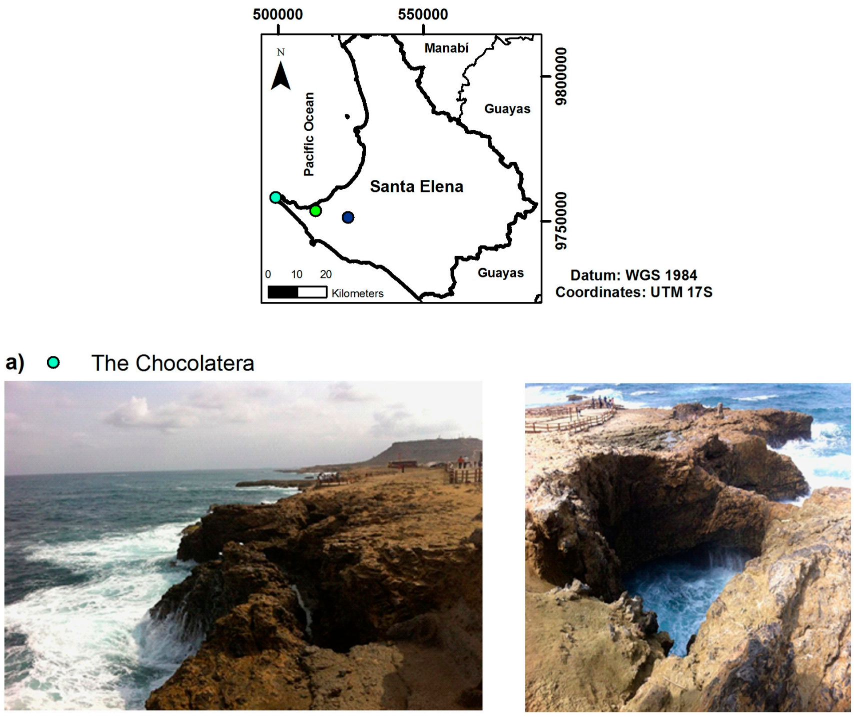

Figure 4. *Cont.*

Figure 4. Situation, panoramic view, and detailed view of (**a**) La Chocolatera cliffs, (**b**) Megatherium Paleontological Museum, and (**c**) San Vicente (hot spring and mud volcano).

The selected areas have significant value regarding (i) the geological disciplines they represent (ii) the interest they generate both in local population and visitors, and (iii) the degree of representativeness in terms of the area of their extension and access to the population. All of this is described in Table 4.

Table 4. Relation between georesources, geosites, and geotourism according to this study.

Location	Geosites	Interest According to Disciplines of Geology	Georesources	Geotourism
Ancón	Ecuador's first oil well **Figure 3a**	Stratigraphy, sedimentology, petrology, geomorphology, and history of geology	Oil fields	Traditional industrial oil structures
Ancón—Anconcito	Cliffs–badlands–stratigraphy **Figure 3b**	Stratigraphy, sedimentology, geomorphology, tectonics, and structural geology	Cliffs and badlands/existing tourism infrastructure	Coastlines of marine erosion and deposition
Santa Paula	Swamps–bituminous exudations **Figure 3c**	Geomorphology and petrology	Swamps and oil fields	Bituminous exudation
Salinas	The Chocolatera **Figure 4a**	Stratigraphy, geomorphology, mineralogy, sedimentology, history of geology, and structural geology	Cliffs/existing tourism infrastructure	Coastlines of marine erosion and deposition
La Libertad	Megatherium Paleontological Museum **Figure 4b**	Mineralogy and paleontology	Megafauna fossils	Museum
Baños de San Vicente	Hot springs and mud volcano **Figure 4c**	Hydrogeology and petrology	Thermal waters and muds are of natural origin	Thermal water and mud volcano springs

The technical description of the six selected areas is presented below:

3.1.1. Ecuador's First Oil Well in Ancon Oil Field

Geological relevance: The territory is located in the uplifting Santa Elena geological unit and comprises a sedimentary sequence from the Cretaceous to the Lower Tertiary (Paleocene–Eocene), developed on oceanic crust including the following formations in chronological order: Clay Pebble

Beds (CPB), Socorro, Seca, and Punta Ancon [52]. These formations are grouped together in the so-called Ancon Group. The CPB Formation includes the Passage Beds and the Santo Tomas sandstone. It is characterized as a sedimentary formation limiting with the Andean continental margin, ranging from the Upper Cretaceous to the Early Tertiary. The Ancon Group comprises Eocene siliciclastic sedimentary rocks that take their name from the Ancon oil field. The Atlanta Formation constitutes the main reservoirs of the Ancon oil field [53]. This thick sequence of turbiditic origin is composed of medium to thick sandstones, conglomerates with siliceous cement and abundant clay matrix, and compact, massive, and poorly stratified conglomerates.

Representativeness: The territory is surrounded by beaches, cliffs, and dry forests. It lays on a rugged rocky coast that is arid and rich in shales and is severely eroded by water and wind in less compact zones. Bays, reefs, rocky, and intertidal areas follow each other in turn displaying cliffs, coastal viewpoints, areas of hydrocarbon exudations, and badlands. The landscape possesses scenic beauty (Figure 3a) and also has a historical value: this was the first mining (i.e., oil) concession to be granted in Ecuador (1878). Today, 1200 oil wells are in production in Ancon with API gravity of 35.5° API on average.

Geotouristical prominency: About 3600 people visited this geosite during 2013. The oil wells and seesaws along the access routes (i.e., Atahualpa-Ancon, Anconcito-Ancon, Salinas-Ancon, and Santa Elena-Ancon) have proved a popular attraction for visitors. The site can be accessed from Salinas by taking the Salinas Punta Carnero-Anconcito-Ancon road or from the Sumpa Regional Terrestrial Terminal of Santa Elena by the Santa Elena-Ancon route. At some points, the territory reaches up to 100 m height above sea level, offering viewpoints with adequate infrastructure to observe the diversity of marine and terrestrial birds. Other sights of interest include Ecuador's first oil well, the oil rig seesaw called "Little horse of oil", and buildings created under English influence, such as housing complexes like the Ancon Club, English Neighborhood, and Workers Neighborhood. There is no need to pay entrance fee, but guided tours may have a cost. No seasonal limitations are to be considered [32].

Interpretation: The area is of high scientific interest, and it is used to study geological formations and structures. Professors of several universities, such as ESPOL, do geological, geomorphological, and heritage and culture-related fieldwork with their students, here. The San Jose de Ancon Community Intercultural Center and the Ancon Tourist Information Center organize cultural events to promote the Ancon oil history, highlighting the Copey Route, the Acapulco Viewpoint, the Los Tambos Viewpoint, the Los Tintines Path, and the Paseo de Los Nidos.

Conservation: The history of Ancon oil dates back to the Pre-Columbian era, when native Americans used oil in its natural state for the construction of boats and to alleviate ailments and fatigue of the body in general. The year 1911 is remembered as the true beginning of the hydrocarbon exploitation in Ecuador, when a British company called Anglo Ecuadorian Oilfields Limited obtained concessions in Ancon. The company constituted oil camps, and it created neighborhoods where foreign and national technicians and workers dwelled. Ancon was declared by Ecuador's Ministerial Agreement N° 233 Cultural Heritage of Ecuador on October 27, 2011, because the country's first oil well was drilled here, in November 1911 [27]. Its management is public; the 5th Regional Directorate of the Ecuador Cultural Heritage National Institute is in charge of the technical control according to public policies regarding preservation, conservation, and adequate use of heritage through the Cultural Heritage Protection and Recovery Plan and the 2017–2021 National Development Plan.

3.1.2. Cliffs–Badlands–Stratigraphy in Ancon-Anconcito Rural Communities

Geological relevance: The territory is constituted by tertiary rocks and by marine quaternary terraces raised a few meters above sea level. Its most singular features are unstable high cliffs that are formed due to normal faulting parallel to the coast, where rocks degrade in blocks. Cross stratification, gradual stratification, and slump structures are other elements of geological interest. In normal failure, one side of the fault moves in the downward direction with respect to other fault side, and it is generated by extensive stresses [54]. Cross stratification is characterized by inclined sedimentary layers limited by flat surfaces formed according to the direction of the current and the angle of support of the sediment. Gradual stratification is characterized by the layers of some meters where the particle size goes from coarse to fine upwards, due to a relatively fast sedimentation stage. Slumps are characterized by fast sedimentation on unstable slopes causing deformation due to bank slippage.

Representativeness: The area is dominated by a spectacular rugged coastline. In this arid environment, the shale-rich rocks eroded by seawater and wind present a ruiniform, irregular, and, mostly, inaccessible landscape. Besides the fantastic forms that demonstrate the work of structurally controlled weathering, the stratigraphy between Ancon and Anconcito is also unique. Normal faults, gravity faults, slumps, graded stratification, cross stratification, ripple marks, laminar stratification, and impregnated strata of bitumen are among the geological singularities displayed here.

Geotouristically prominent site: Ancon and Anconcito are parishes visited mainly for their marine and coastal ecosystems. They are part of a tourist route of Ecuador called "Ruta Del Spondylus", which offers different tourism options, such as sun and beach, cultural–archaeological tourism, handicrafts, gastronomy, ecotourism, nature tourism, sports, and adventures. Humpback whale sightings can be made from June to September each year. There are public transport buses from the Sumpa Regional Terrestrial Terminal of Santa Elena, and the Santa Elena-Ancon-Anconcito route can be taken at affordable costs. There is no need to pay entrance fee, nor there are seasonal limitations.

Interpretation: Ancon has well-established interpretation centers as it is part of the cultural heritages of Ecuador. On the other hand, Anconcito does not have a fixed site for the interpretation of the territory, but Community Intercultural Centers and Tourist Information Centers are in development.

Conservation: Local and regional authorities manage the Ancon Cultural Heritage since 2011 [27], whereas in Anconcito, local authorities manage the territory. Anconcito Government is in charge of supervising environmental, socioeconomic, sociocultural issues, human settlements, mobility, energy, and communication systems. Public awareness regarding natural resources for tourism, recreational, and educational development is a primary focus of their efforts.

3.1.3. Swamps–Bituminous Exudations in Santa Paula

Geological relevance: Most of the area is covered by the Tablazo Formation, which consists of agglomerates, sandstones, and fossiliferous (molluscan) sands. Wide plateaus dominate the morphology. The marine terrace called Muey is the lowest one in the Santa Elena province. Accumulations of hydrocarbon associated with Cretaceous rocks are present [55], the source rocks of which probably lay deeper in the sedimentary sequence. The relief is flat, and abundant clays and salts predominate. Beaches are formed of fine to medium-sized sand of local carbonates with gravel and shell remains. Swamps of brackish water have developed mainly from fine detrital materials in the coastal or fluvial-marine environment. There are bituminous sands and shales that contain bitumen, a substance similar to petroleum that can also be refined to obtain fuel and other organic compounds. There are natural oil outcrops, bituminous sands and shales, and outcrops of salt that are singular features in the area.

Representativeness: The properties and interest of the studied swamps–bituminous exudations are representative of this type of natural oil outcrops in the world. Hydrocarbon-bearing rocks outcrop here, naturally, in the form of cliffs with a thickness of 60–90 m [54,56] or over large expanses of lowlands as coastal swamps that are periodically flooded by seawater. These swamps constitute a border ecosystem between the continental and marine media. Different species of marine benthic macroinvertebrates occupy both soft sandy bottoms and hard rock bottoms. This environment is exceptional because it combines marine life, birds, swamps, and bituminous exudations, naturally [34].

Geotouristical prominency: The area is easily accessible due to its proximity to Salinas city, one of the most important beaches in Ecuador; however, it has a high rate of traffic congestion during the touristic high season. It is close to Santa Elena Puntilla, an important Coastal Marine Fauna Production Reserve and one of the most visited protected natural areas in Ecuador. Oil wells have been in operation for years. Most seesaws and oil pipes are located in urban zones, close to residences. Several swamps have been exploited as salt mines and fish farms. These activities have become the main means of subsistence for the local population.

Interpretation: The area is not supplied with specific infrastructure for geotouristic interpretation; however, there are recreational spaces for cultural, sports, and social activities, which can be adapted for this purpose. The proximity to outstanding touristic sites secures adequate accessibility.

Conservation: The Andipetroleos SEOG Oil & Gas Anonymous Society (PACIFPETROL S.A., by its Spanish acronym) administers the Santa Paula Oil Field. This is a group of companies which has been associated with the Ecuadorian state since 2002. It has a total of 1233 productive wells in the Gustavo Galindo Velasco Block, which includes the Santa Paula Oil Field. Santa Paula is a neighborhood within the Jose Luis Tamayo rural parish, and the Government of Jose Luis Tamayo, as local authority, manages the territory. They promote and guarantee the management of sustainable economic activities in order to preserve the natural resources and the recuperation of beaches and natural vegetation for ecological tourism.

3.1.4. The Chocolatera in Salinas

Geological relevance: The area is mostly characterized by the Cayo Formation that is made up of sandstones, cherts, silicified clays, quaternary deposits of calcareous sandstones, and conglomerates with abundant fossils in the lower parts constituted by the Tablazo Formation, of Pleistocene age [52,57]. The depth of the seabed is between 30 and 50 m, and its altitudinal range is up to 96 m.a.s.l. Three categories of seabeds are presented in the subtidal area: sandy, rocky sandy, and mixed. Fine sand, medium sand, and silt characterize the sandy category; fine gravel and medium gravel predominate, although there are also sand and small rocks, in the mixed category; and there are rocks of different sizes and shapes (flat and rounded) together with fine and medium sand, on the rocky sandy bottom. The area stands out for its aesthetic and environmental value, geological formations, and rocks related to volcanic origin.

Representativeness: The Santa Elena Puntilla Coastal Marine Fauna Production Reserve (REMACOPSE, by its Spanish acronym) has an area of 52,231.75 marine hectares and 203.82 terrestrial hectares. The terrestrial part is a very dry area with shrub vegetation and herbs adapted to the shortage of water. The Chocolatera cliffs are the highest point of continental Ecuador and the second highest point in the South Pacific. It is also a reference point to measure the maritime territory that belongs to Ecuador. This is the best-known site of the reserve. The waves break against the rocky coast at this point (Figure 4a), and the cliffs are subject to severe erosion by the action of the sea, which causes the aspect and shape of The Chocolatera cliffs to change continuously. The name of The Chocolatera is due to the convergence of the intertropical currents, which causes the lifting of the darker sand of the bottom of the sea and the formation of a lot of foam, which gives the impression of a big bowl of chocolate [58].

Geotouristical prominency: In 2015, the Santa Elena Puntilla Coastal Marine Fauna Production Reserve was the most-visited natural area in Ecuador. A total of 334,121 visitors were registered, and 6.98% of them were foreigners. All visits to the area are registered through a short form, where their identification number, name, and country/city of residence are requested. There is no need to pay entrance fee, and no seasonal limitations need to be considered. It is about 13 min from the General Ulpiano Paez Airport of Salinas, which serves only domestic flights. The territory generates an important local income through complementary activities, such as the artisanal production of earrings, necklaces and bracelets with materials from the ocean, and handicrafts in woods of guayacan, laurel, tagua, among others, which are endemic species in the area. The reserve has a cafeteria and stores of crafts and souvenirs.

Interpretation: Ecological, self-guided routes have been designed for this site given the existence of available tourist signs and information. The provided information is often insufficient, but there are guided tours offered by private companies. This geotouristic site has four main elements, namely, the El Morro Viewpoint, The Puntilla, areas of the coast inhabited by sea lions, and beaches. Singular landforms can also be observed, such as The El Morro hill or the arches-caves formed in the rocky outcrops by marine erosion.

Conservation: The REMACOPSE is located in the Naval Base of Salinas a few kilometers away from the urban areas of Salinas, La Libertad, and Santa Elena. Since 2008, it is part of the National System of Protected Areas of Ecuador. It is managed by the Ministry of Environment of Ecuador, and the Committee of Management and Citizen Participation of the protected area is the body in charge of the conservation in order to promote the participation of local stakeholders. Its public management counts on a Management Plan, a Research, Monitoring and Scientific Cooperation Program and an Environmental Communication, Interpretation and Education Program mainly focused on the biodiversity of the territory including dry forest species and, both migratory and nonmigratory, marine species. It is one of the sites with the highest concentration of fish on the Ecuadorian coast and also of species of mobile macroinvertebrates, algae and sessile invertebrates, and marine mammals.

3.1.5. Megatherium Paleontological Museum in La Libertad

Geological relevance: Fossil deposits in petroleum-rich sediments of the Santa Elena Peninsula contain some of the largest and best-preserved Pleistocene megafauna remains, contributing significantly to the knowledge about the extinction event of the Late Quaternary in the region. The Tanque Loma megafauna deposit is one of the largest fossil deposits in South America, where 2969 fragments were found such as tibiae, ribs, pelvises, femurs, and mandibles of approximately 26,000 years of age. The outcrop comprises several superimposed stratigraphic levels of fossiliferous character, including deposits from the Last Glacial to the Late Holocene. At the base of the Tanque Loma stratigraphic sequence, there is a dense accumulation of fossils of large mammals of the Upper Pleistocene in soils saturated with hydrocarbons. Fossils have remained well preserved, thanks to the oil that exists in the area [40].

Representativeness: A remarkable finding in prehistoric Ecuador can also be found in the Santa Elena province. It is related to the Las Vegas culture, the antiquity of which is between 8300 and 6600 years. This is the first known archaeological culture that settled in the current territory of Ecuador. It developed between the Holocene and Late Pleistocene. Las Vegas settled near the present city of La Libertad in the Santa Elena province. The hunting of mammal fauna was an important cultural activity as proved by the large number of remains of at least 15 species of mammals found (Figure 4b). Up to 4-m high Late Pleistocene megafauna (50,000–8,000 b.p.), such as the Megatherium and Eremotherium genera, was discovered at this geosite. Other families of outstanding abundance in bone remains were the Didelphidae, Myrmecophagidae, Leporidae, and Canidae, together with the Sigmodon and Proechimys genera.

Geotouristical prominency: The Megatherium Paleontological Museum is a well-known institution, since it is the first paleontological museum in Ecuador. It began its activities in 2008, and it was named in honor of the Pilosa Megatheriidae Megatherium fossils found in 2003 in the Tanque Loma megafauna deposit. The Santa Elena Peninsula State University in La Libertad (UPSE, by its Spanish acronym) established a program to divulgate the archaeological knowledge within the university. A total of 6434 visitors were registered in 2017. The majority of visits were recorded between June and August. It is located in the city of La Libertad, at a distance of 7 km from Salinas.

Interpretation: The Megatherium Paleontological Museum has received visits from locals and foreigners, mainly from educational institutions: schools, colleges, and universities. Scientific purposes related to the paleontology, especially to megatherium prehistoric mammal fossils, were in the focus of the visits. Information is available in English and Spanish, and visits can be either self-guided or with guides.

Conservation: The Archaeological, Paleontological, and Tourism areas of the UPSE University manage the museum through the Megatherium Paleontological Museum Management Annual Plan. There is no need to pay entrance fee, nor there are seasonal limitations.

3.1.6. Hot Springs and Mud Volcano in Baños de San Vicente Rural Community

Geological relevance: The Baños de San Vicente rural community is located on a fractured forearc zone with predominance of sedimentary materials showing slump structures. The territory corresponds to the Azúcar Group (Paleocene) constituted mainly by sandstones, argillaceous sandstones, and shales with quartz–albite–kaolinite–illite mineralogical composition. The Azúcar Group is divided into the Santo Tomás Formation, the Atlanta Formation and the San José Formation. The Santo Tomás Formation mainly consists of conglomerate sandstones, while the Atlanta Formation comprises a sandy lower unit and an upper unit of shale-sandstone alternation similar to the Clay Pebble Beds Formation (Middle Eocene) of the Ancon Group (Middle to Upper Eocene). The San José Formation comprises a lower unit of dark micaceous sandstones and an upper unit of shales and dark fossiliferous silts. It is in contact with the Guayaquil Member of the Cayo Formation (Upper Cretaceous). These formations are fissured oil reservoirs, and traces of oil and gas were found in pore water. The oil and gas probably have a connate origin according to chlorides and sodium concentrations, and marine water was found in pores of the deepest formations. The emerging thermal waters have a magmatic origin according to stable oxygen ($\delta^{18}O$) and deuterium (δD) isotopes [41].

Representativeness: The hot springs are natural and thermal waters with therapeutic and medicinal properties. The mud volcano contains a large amount of natural components, such as chlorine, bromine, iodine, sodium, calcium, magnesium, iron, aluminum, and silicon. The water is discharged naturally due to the pressure; in this area, the topography is relatively flat and with low relief. Muds are originated by the continuous erosion of the deep clay–sandstone rocks, produced by the softening and dissolving action of the water on the layers of ancient saline deposits and on underlying rocks.

Geotouristically prominent site: Tourist accommodations have been established since 1922 to exploit the natural thermal waters as medicinal treatments. Springs come from natural aquifers with a temperature between 32 °C and 43 °C, while the mud has an average temperature of 29 °C. Mud volcano is a point of fracture in the soil through which sediments flow; the material that comes out has a little amount of water that, together with the sediments, form a pasty mass naturally rich in minerals. Therefore, the water is dark with many solids in suspension, with oil stains and a smell similar to the oil that is exploited in the Ancon oil field. It is of great medicinal value in the treatment of inflammatory problems and lesions. The area has an extension of 4 ha. About 126,000 people visited this site during 2014. It is located to 29 km from Salinas and 24 km from Ancon, next to the road to the coast, taking a detour of 20 km before reaching Santa Elena. There is an entrance fee, and paid services of body massage of aloe, medicinal mud, and hydromassage (Figure 4c) are available. No seasonal limitations are to be considered.

Interpretation: Guides explain briefly the history of the territory while people are waiting for the service. The site also houses the fossil remains of a quadruped. Visits can be self-guided. This site has become a natural laboratory to investigate the origin of water, characterize its medicinal mineral use and its relationship with mud volcanoes. It requires a very strict environmental analysis because there are possible sources of contamination and urgent measures must be taken for the preservation of the site.

Conservation: It is administered by the Santa Elena Municipal Autonomous Decentralized Government through the Santa Elena Municipal Tourism Company (EMUTURISMO by its Spanish acronym), since 2013, according to the "Strategic Plan for the Development of Sustainable Tourism in Ecuador by 2020." Community-based initiatives such as the Association of Restaurants are promoted, generating employment and local income.

3.2. Georesources/Geosites Quantitative Assessment (GRECSIC Methodology)

The degree of geotouristic interest of the selected areas within the Santa Elena Peninsula Geopark Project was determined according to the criteria of analysis and weights listed in Tables 1–3, and a score given by researchers. The scores were decided on by consensus among experts and researchers of this paper. The obtained results regarding the degree of geotouristic interest of areas are shown in Table 5.

Table 5. Characterization of areas of interest according to criteria of analysis.

	Sites of Interest	Scores According to Five Criteria					Results	Interest
		1	2	3	4	5		
1.	Ecuador's first oil well in Ancon oil field	3	3	1	3	3	280	Very high
2.	Cliffs– badlands–stratigraphy in Ancon-Anconcito	2	2	1	3	1	170	High
3.	Swamps–bituminous exudations in Santa Paula	2	2	1	2	1	160	High
4.	The Chocolatera cliffs in Salinas	2	3	3	2	3	265	Very high
5.	Megatherium Paleontological Museum in La Libertad	3	3	3	3	3	300	Very high
6.	Hot springs and mud volcano in Baños de San Vicente	2	2	2	2	1	170	High

3.3. Assessment through Questionnaires

The assessment was based on the univariate analysis of the 700 questionnaires (Supplementary Figure S1).

First, the general profile of the respondents from the Santa Elena province was determined. Results show that majority of the respondents are male (423 respondents, 60.43% of the total). Regarding the level of education, 342 respondents (48.86% of the total) completed secondary education, followed by 197 (28.14%) who only finished primary school, and a total of 161 are university students (23.00%).

The population of Santa Elena is familiar with some of the terms and concepts related to earth science, such as "heritage" (64.70% of the total of questionnaires), "protected area" (68.30%), "geology" (43.30%), "fossils" (35.20%), whereas other terms are less well known, such as "tectonics" (20.3%), "outcrop" (15.10%), "geomorphology" (11.50%), "sedimentary structures" (9.90%), "stratigraphy" (9.70%), and "swamp" (8.10%). Moreover, a total of 87.90% of the surveyed population is willing to learn about earth sciences through visits to different places of the province. These results are shown in Figure 5a.

A total of 73.50% of the population considers that in the Santa Elena province, there are sites of international relevance and touristic interest, which is in accordance with the permanent visits of foreigners at the studied geological sites. Figure 5b shows the most outstanding sites of international relevance and touristic interest in the Santa Elena province as judged by the local population. The results are as follows: the beaches in Salinas (28.80%), in Montañita (28.10%), in Olón (6.20%), in Ballenita (3.00%), and in Ayangue (1.20%), the Chocolatera (14.20%), Valdivia Museum (1.20%), Megatherium Museum (1.20%), the first oil well in Ancon (3.10%), Ruta del Sol (4.30%), El Tablazo Viewpoint (1.80%), the fishing port in Anconcito (0.60%), Blanca Estrella de la Mar Sanctuary in Olón (3.70%), and handcrafted furniture in Atahualpa (1.20%). Regarding the tourism activities at the six sites of the study, on average, 60.22% of the population has heard about some of these geosites, 39.92% have visited some of these sites, and 20.77% expressed a very high level of tourist satisfaction (regarding infrastructure and service). Further information is shown in Figure 5c,d.

As regards to the motivation to visit some of the six studied geosites or any other geosites in the Geopark Project, we must mention that 79.20% of the population rates most highly the tourism for fun and leisure. Other valued aspects are sharing time with family (60.60%), biodiversity (50.10%), landscape and geology (47.50%), education (46%), heritage areas (42.30%), and protected areas (12.80%). Although only 28.20% is familiar with the term "geopark" and 17.70% knows the term "geotourism," it is important to note that 95.90% wish to support the Santa Elena Peninsula Geopark Project, 46.40% are willing to attend meetings, workshops, and trainings, 41.80% to share information with family, at work, and in social networks, 9.30% to produce information and knowledge (theses and publications), and 2.50% to contribute economically.

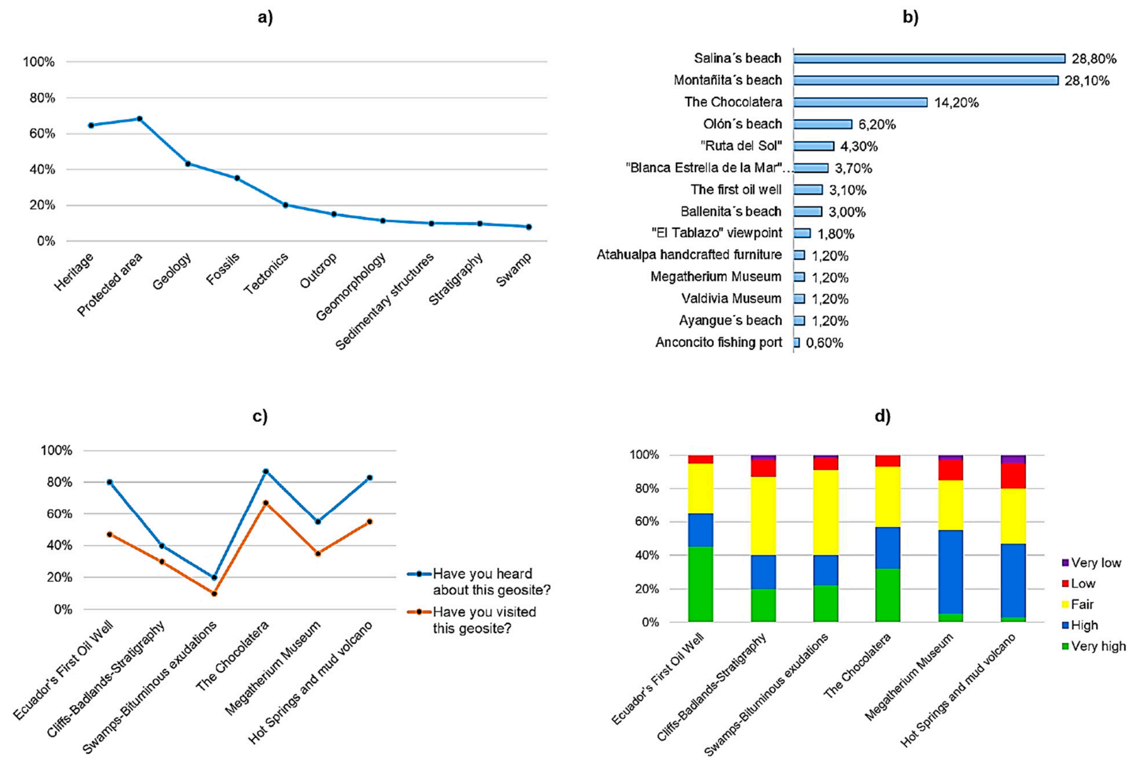

Figure 5. (**a**) Level of knowledge of the local population regarding terms related to the earth sciences, (**b**) the most outstanding sites of international relevance and touristic interest in the Santa Elena province according to local population, (**c**) perception about geosites of this study by local population, and (**d**) level of satisfaction on the geosites of this study by local population.

In addition, 89.20% of the population is satisfied in their communities and named the following positive aspects: good tourist service (27.20%), productivity of businesses mainly related to tourism (17.80%), tranquility in the area (9.40%), gastronomy (8.60%), artisanal production (4.70%), and beaches and piers as highly valued touristic assets (8.90%). Nevertheless, there are issues to be solved, related to tourist activities, such as the improvement of infrastructure, tourist signs, advertising and information accessible to tourists (38%), cleaning and maintenance of beaches and piers (7.20%), sewage and wastewater management (11.90%), generation of employment opportunities for the local population (7.60%), and improvement of facades of residences, hospitals, and schools (6.50%).

3.4. SWOT Plus Analysis

A SWOT Plus matrix was designed to capture significant factors related to the Santa Elena Peninsula Geopark Project and geosites of the study, as shown in Table 6. Our aim was to identify strategies to foster geotourism in the territory.

It was possible to synthetize the results of the joint analysis in five strategies focused on promoting the geotourism through the Santa Elena Peninsula Geopark Project:

- Establishing alliances with the institutions in charge of each site to carry out actions that advance the geological and touristic potential of the resources.
- Involve local communities in the sustainable management of georesources and in sharing geoscientific, historical, and cultural knowledge through socialization and participatory workshops.
- Promoting scientific research in earth sciences and tourism to contribute to the geotourism potential of the studied geosites, through studies at national and international level.

- Developing education programs and activities for students from elementary schools, high schools, and universities at the local, regional, and national level promoting the geoscientific knowledge and the geotourism in the Santa Elena province.
- Supporting the establishment of information centers at each geosite, where printed material and video material about geoscientific, historical, and cultural information of the territories would be handed to the visitors.

Table 6. SWOT Plus matrix.

Existing Factors	
Internal factors	**External factors**
Favorable factors	**Favorable factors**
• Links to other national heritages such as cultural, historical, protected areas, tourist complexes, museums, and others. • Historical and traditional infrastructure. • Tourism infrastructure. • More of visits by national and foreign tourists than other provinces of the Ecuadorian coast. • Legal protection due to heritage values.	• Support of national and regional government entities. • Acknowledgement of the geopark project by national universities. • Proximity to outstanding tourist destinations of the territory such as Salinas and La Libertad.
Unfavorable factors	**Unfavorable factors**
• Incomplete recognition of geosites by local population. • Technical improvement required. • Lack of accommodation. • Lack of centers for geoscientific knowledge interpretation. • Lack of information about the geosite presented at information centers. • Scarce surveillance and patrol posts near geosites.	• High level of poverty in local communities. • Water shortage in rural areas. • Loss of traditions and ancestral knowledge. • Scarce public transportation.
Potential factors	
Internal factors	**External factors**
Favorable factors	**Favorable factors**
• Expansion of the tourist offer to the interpretation of the geoscientific knowledge. • Opportunity for the preservation of geological areas and geodiversity of the territory. • Highly qualified professionals to interpret the geoscientific knowledge of the territory. • Interest and motivation to be part of a network of geoparks.	• Promotion of local economic activities such as ancestral gastronomy and crafts in stone and ceramics. • Preservation and strengthening of ancestral practices for community growth and conservation of resources.
Unfavorable factors	**Unfavorable factors**
• Low budget for the management of geosites. • Little cooperation between geosites managers. • Lack of norms/regulations to safeguard the geological heritage.	• Inability to solve problems related to basic needs, population growth, oil activities, and climate change. • Conflict of interest between local population, tourism organizations, and other interest groups.

4. Discussion

Initially, the Santa Elena Geopark Project was an academic research initiative, called the Ancón Santa Elena Geopark Project [28], but participants agreed on finding a name that represents and identifies all of the involved parties. The Santa Elena Peninsula Geopark Project includes natural, historical, touristic, and cultural geosites as valuable resources for geotourism, which is an alternative to extend the country's tourism offer. The importance of the tourist sector is cardinal, since tourism is the main economic activity that generates local income for the communities of the province. Geodiversity, biodiversity, and sociocultural aspects are associated in the geopark project framework; the selected geosites (e.g., the Chocolatera cliffs) are among the most popular sights of the continental part of Ecuador.

According to [59,60], different assessment methods produce different results. This reveals the need to apply several parallel methods at a given site, since a universal system that allows correlating different values have not been found yet. By the GREGSIC methodology, semiquantitative and qualitative values can be given to geological and tourist resources of the Santa Elena Peninsula Geopark Project. Thanks to the integration of the IELIG [36] and MINTUR [42] methodologies, we have a more representative set of data that integrates and synthesizes parameters related to geodiversity, geoconservation, geoeducation, and issues related to tourist facilities and local development. Our results offer at the same time, a significant contribution to the evaluation of geosites of Geopark Projects in Ecuador and a methodology that adds value to geodiversity and geotourism.

At a national level, natural resources belong to the state, and the national government is in charge of their management. Although, biodiversity is the most important resource in natural protected areas managed by the Ministry of the Environment and touristic areas managed by MINTUR, many of these resources, such as mountains or lakes, are considered both touristic and natural attractions. Moreover, recently, georesources and geological heritage have experienced an increase in tourist interest due to the creation of the Ecuadorian Committee of Geoparks that contributes to the development of sustainable geotourism. The creation of the recently declared Imbabura UNESCO Global Geopark gave yet another impulse to the growth of the sector.

According to the SWOT Plus analysis, the development of proposals for the use of areas of geological, geological-mining, and paleontological interest could [9,10,20]: (i) promote the protection of these sites, (ii) spread knowledge of these areas, and (iii) offer new economic alternatives for the local population. This would contribute to improving the quality of life and to social development in harmony with the environment [61–63].

In this specific case, the alternative use of geological resources through geotourism would be compatible with the economic activities in the area (handicrafts, gastronomy, and tourism). At the same time, if properly managed, geotourism would benefit the protection of these geological sites of interest [10]. Furthermore, the perspective and development offered by geotourism offers an innovative solution to current problems in the Santa Elena Peninsula, caused by constant water shortages and lack of support from the local government. A clear example is the case of the Manglaralto aquifer, where various projects carried out by universities and the International Atomic Energy Agency (IAEA) has made the inhabitants of the Manglaralto parish aware of the current situation of the river-aquifer system, creating a water culture using what is known as "sowing and harvesting water" [28,64].

The success of geoparks depends on two main parameters: the efficiency of explanation of the geological phenomena (interpretation of geological heritage) and the intensity of tourist flow [65]. Fossils, palaeoecosystems, landforms, and water objects are considered valuable features with high potential for geoparks [66]. The geosites proposed within the Santa Elena Peninsula Geopark Project are natural, historical, touristic, and cultural sites that include fossils, badlands, bituminous exudations forming pools of fluid oil, springs of thermal water and a mud volcano, swamps, rocky coast, cliffs subjected to further wave erosion, and water objects (i.e., coastal aquifers). Moreover, the sites are managed by public entities, and the geopark concept could be integrated into the national legislation of the country focusing on the sustainable use of the territory, as it has been suggested in other countries [67].

5. Conclusions

The research presented in this document reveals the existence of several areas of geological and mining interest within the framework of the Santa Elena Peninsula Geopark Project. Following the example of similar initiatives launched around the world, these sites could be exploited through the development of geotourism.

The evaluation of the six possible geosites, using the GREGSIC methodology, established high and very high geotouristic potential value, validated by experts, researchers, and the local population. At the same time, assessments by inhabitants, owners and workers of businesses, park rangers, and local authorities prove that the geosites are highly recognized. About 60.22% of the population has heard about some of the geosites and 47.94% has a high to very high tourist satisfaction after visiting one or more of the sites. Moreover, surveyed population considered that there are sites of international relevance in the Santa Elena province. The support of the geopark initiative by the local population (about 95.90% of surveyed population), the inventory and the assessment of geological sites of interest based on technical criteria are key to continue developing the project and aspiring to become a member of the UNESCO Global Geoparks.

The SWOT Plus analysis of the Santa Elena Peninsula Geopark project led to the following conclusions: (i) by the extended SWOT analysis, it is possible to broaden the understanding of existing and potential factors that have (or may have) impact on geotourism development in the region; (ii) SWOT Plus analysis is a valuable strategic tool for the analysis of the local development of an organization or region; and (iii) as opposed to typical SWOT (which focuses on the present), the SWOT Plus extends its vision towards the future.

Finally, we found that the GREGSIC methodology offers a pragmatic approach and advance on traditional methodologies (MINTUR and IGME). It presents a more global vision regarding geotourism and may lead to the development of plans and strategies linked to sustainability of areas of geological interest.

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