

Article

Georesources as an Alternative for Sustainable Development in COVID-19 Times—A Study Case in Ecuador

Fernando Morante-Carballo ^{1,2,3} , Miguel Gurumendi-Noriega ⁴, Juan Cumbe-Vásquez ⁴ ,
Lady Bravo-Montero ^{1,2,5,*}  and Paúl Carrión-Mero ^{1,6} 

- ¹ Centro de Investigaciones y Proyectos Aplicados a las Ciencias de la Tierra (CIPAT), ESPOL Polytechnic University, Guayaquil P.O. Box 09-01-5863, Ecuador; fmorante@espol.edu.ec (F.M.-C.); pcarri@espol.edu.ec (P.C.-M.)
- ² Facultad de Ciencias Naturales y Matemáticas (FCNM), Campus Gustavo Galindo, ESPOL Polytechnic University, Km 30.5 Vía Perimetral, Guayaquil P.O. Box 09-01-5863, Ecuador
- ³ Geo-Recursos y Aplicaciones GIGA, Campus Gustavo Galindo, ESPOL Polytechnic University, Km 30.5 Vía Perimetral, Guayaquil P.O. Box 09-01-5863, Ecuador
- ⁴ Junta Administradora de Agua Potable de Manglaralto (JAAPMAN), Manglaralto 241754, Ecuador; migangur@espol.edu.ec (M.G.-N.); jcumbe@espol.edu.ec (J.C.-V.)
- ⁵ Centro de Agua y Desarrollo Sustentable (CADS), ESPOL Polytechnic University, Guayaquil P.O. Box 09-01-5863, Ecuador
- ⁶ Facultad de Ingeniería en Ciencias de la Tierra (FICT), ESPOL Polytechnic University, Guayaquil P.O. Box 09-01-5863, Ecuador
- * Correspondence: lkbravo@espol.edu.ec; Tel.: +593-95-914-1436



Citation: Morante-Carballo, F.; Gurumendi-Noriega, M.; Cumbe-Vásquez, J.; Bravo-Montero, L.; Carrión-Mero, P. Georesources as an Alternative for Sustainable Development in COVID-19 Times—A Study Case in Ecuador. *Sustainability* **2022**, *14*, 7856. <https://doi.org/10.3390/su14137856>

Academic Editor: Nicoletta Santangelo

Received: 17 May 2022

Accepted: 17 June 2022

Published: 28 June 2022

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.



Copyright: © 2022 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

Abstract: Georesources comprise spaces of relevant geological value with the potential to be used and managed as a resource. Therefore, georesources are an essential development factor in the world, mainly oriented to their rational use to improve the quality of life of the surrounding population. This work aims to analyze the main applications, conservation strategies and sustainable use of georesources in the rural area of Manglaralto (Ecuador) through their inventory, assessment and analysis for the adaptation of alternative uses to particular circumstances (e.g., the COVID-19 pandemic). The method used consists of four phases: (i) inventory and mapping of georesources; (ii) description and assessment of georesources using international methodologies (e.g., GtRAM for georoute assessment, hydrogeological characterization using GeoModeller for groundwater assessment, GIS tools for assessing materials with industrial–artisanal interest, and KFM matrix method for the assessment of the level of construction difficulty of sanitary landfills); (iii) georesources complementary applications and (iv) SWOT analysis (Strengths, Weaknesses, Opportunities, Threats) and TOWS matrix preparation (Threats, Opportunities, Weaknesses, Strengths), seeking strategies to guarantee the viability of the use of georesources. As a main result of the investigation, the geolocation of the georesources of the area was obtained. In addition, the assessment of the main georesources such as (i) potential geosites and sites of geological interest (e.g., beaches, cliffs, waterfalls, capes), (ii) groundwater (aquifers), and (iii) materials with artisanal and industrial interest (e.g., clays, sands). Finally, the study allowed us to define areas to develop landfill infrastructure, identify ecosystem services, and construct tsunami refuge site proposals. The case study addressed shows that the inventory and definition of the use of geological resources constitute a fundamental process for the economic, social, and environmental development of the population.

Keywords: geological resources; geosites; geotourism; sustainability; SDGs; Manglaralto-Ecuador

1. Introduction

Geodiversity is defined as “the range of geological, geomorphological and soil features” [1]. The appreciation of abiotic natural resources manifests this [2]. Geodiversity reflects the geological processes and events that have taken place throughout its history.

From prehistory to the present, the planet's geodiversity has supplied resources to the cultures and civilizations that inhabit it.

Georesources or geological resources are elements in a liquid, solid or gaseous state, susceptible to exploitation on or within the earth's crust, depending on their concentration (e.g., industrial rocks, metallic or non-metallic minerals). They also include those non-renewable elements of the earth that have their use and value for the science, economy and education of humans [3–6]. Georesources supply raw materials for different industries. However, they are limited resources that require rational extraction [7]. For this reason, their conservation faces new challenges in all sectors of society [8]. One of these challenges is the current mining policy that tries to solve problems related to exploiting quarries and drilling wells that disturb the environment [9,10]. In addition, greater attention to geoscientific aspects is required in land-use decisions since most georesources are non-renewable resources [11–13].

Non-renewable georesources include: minerals, rocks, fossils, petrogenetic features, mines, landforms, glaciers, ice age phenomena, and some geomorphological features [14–16]. Their main applications include building construction [17,18]; development of smartphones and computers [19,20]; illumination [21]; farming [22,23]; jewelry (gemstones) [24,25], drinking water supply, and development of renewable energies [26].

Within non-renewable georesources are geosites, which are places with one or more geographic elements of geodiversity that have a unique intrinsic, scientific, tourism, and management tourist, cultural or scientific value [27–29]. They also associate geology, environment, culture, aesthetics, heritage and well-being of their residents [30]. Also, they are considered recreation sites that allow economic income to be obtained from a place of geological interest [31]. The quantitative and qualitative assessment of the geosites follows a process of inventory, evaluation and selection that contributes to developing a threat management and prevention plan [32]. Geoheritage or geological heritage is a fundamental part of cultural heritage [33–35]. However, Reynard and Brilha state that mining heritage is at the interface between geoheritage (georesource) and cultural heritage, establishing that these two are not joined together [36]. Geoheritage includes geosites and elements of geodiversity with scientific, educational and aesthetic significance [27,37–39].

Geoconservation is another critical term in understanding geodiversity, which focuses on managing geological components of scientific, tourist and cultural importance within a responsible social context [8,40]. Correct management helps to adequately protect the geological heritage [41], where the scientific knowledge of the community is essential to implement conservation strategies [42,43]. Figure 1 summarizes the concepts related to geodiversity.

The production of georesources reduces poverty standards and allows the development of a nation [26], because developing countries focus on the sustainable use of natural resources [44]. Moreover, these resources have a positive and significant impact on the economic growth of all countries [45]. An example is the case of Brazil, which is a producer of mineral resources that foster the conservation and promotion of sustainable development through geotourism (e.g., Araripe UNESCO Global Geopark) [46] and the conservation of its paleontological heritage in initiatives related to the use of mineral resources [47].

Geotourism provides information on geological elements, landscapes, and history to travelers who visit specific places on Earth (including urban places). Their interest in these natural areas seeks to motivate the protection of geoheritage and geodiversity. Hence, geotourism is the basis for converting a locality into a geopark [15].

In Ecuador, there are non-renewable georesources such as rocks of industrial interest, including igneous rocks (e.g., granite and basalt), metamorphic rocks (e.g., slate and schist) and sedimentary rocks (e.g., gypsum and clay) [48–59]. In addition, this country has metallic mineral resources (e.g., Au and Ag) [60–65] and non-metallic mineral resources (e.g., sands, kaolin, fluorite) [66–68]. Water is a renewable georesource in Ecuador, and it is an essential element in the country's management, having a record of the hydrographic division since 2002 [69–74].

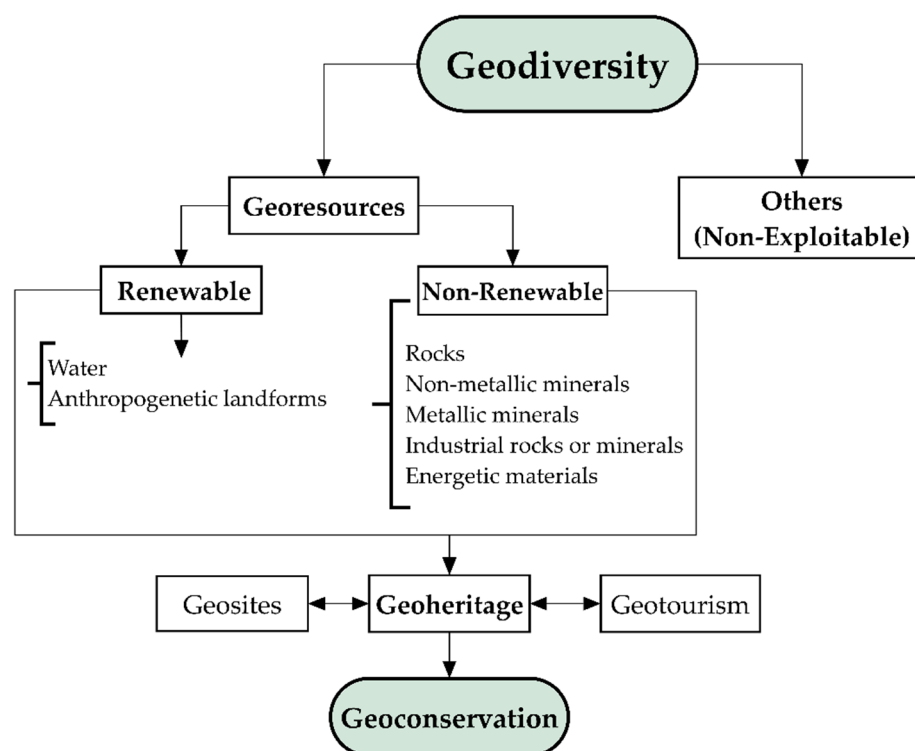


Figure 1. Georesources Conceptual Scheme. Source: Adapted from [14].

In the study area, there is no evidence of metallic minerals (e.g., Au, Cu, Ag) but non-metallic minerals (e.g., gypsum, zeolites), which have not been well explored. Therefore, there is a potential possibility of finding significant volumes for exploitation. The potential consumers of geotourism in the sector are the inhabitants of the neighboring parishes and national-foreign tourists who have already visited certain study areas (e.g., Montañita beach). However, these visits would not be in a geological context but for recreation. On the other hand, regarding the educational potential of georesources, it would be valued by the country's educational institutions, mainly by third-level institutions related to geosciences, to carry out geotourism plans and other contributions aligned to this area of research.

Regarding the presence of geosites, the country has broad potential in this area [75], and great potential for geotourism development. However, this activity was seriously affected by the SARS-CoV-2 (which causes COVID-19 [76–78]) pandemic due to the restrictions imposed to contain its spread [79,80]. As a result, the decline in tourism is estimated at between 60 and 80% compared to pre-pandemic values, representing economic losses of 1.1 billion dollars in 2020 [81].

In Ecuador, tourism was also affected by the state of health emergency declared on 16 March 2020, which included restrictions on mobility and free association [82–84]. Consequently, it is imperative to value the georesources of a defined area, which need to be developed to alleviate the effects of the pandemic, climate change and other factors. It is recorded that existing businesses in the Manglaralto parish had to close, leading to financial decline during the restrictions, with 68% of people earning less than 200 USD/per month [85,86].

The study area includes the upper part of the Manglaralto River basin (Santa Elena). Also, there is an important aquifer, where its geometry, flow, and transport have been modeled in a previous study [87]. This work aims to analyze the main applications, conservation strategies and sustainable use of georesources in the rural area of Manglaralto (Ecuador) through their inventory, assessment and analysis for the adaptation of alternative uses to particular circumstances (e.g., COVID-19 pandemic).

Literature Review

In the Republic of Ecuador, a geopark recognized by UNESCO Global Geoparks was established in 2019 [88]. The place called “Imbabura Geopark” is characterized by its geological and cultural wealth. It encompasses volcanic complexes, archaeological remains, mines and cultural heritage, where sustainable development has also been a fundamental part of the protection of ecosystems [89,90].

According to the Ministry of Tourism, the tourist offer in Ecuador in 2020 had 19,490 tourist activity establishments, where 87.78% was comprised of microenterprises (1 to 9 employees), 11.72% of small businesses (10 to 49 employees), 0.46% of medium-sized companies (50 to 199 employees) and 0.05% large companies (more than 200 employees) [91]. Regarding tourist demand, in 2020, the primary source was international arrivals by air, comprised mainly of United States citizens, represented by 140,484 arrivals and participation of 29.9% [92].

In the pandemic context (COVID-19), at the national level, there was a significant impact on the tourism sector since in 2019, before the pandemic, tourism contributed 2.2% to the gross domestic product (GDP), while in 2020, the percentage dropped to 1.2% [93]. Therefore, the economic sector of the local communities was mainly based on sun and beach tourism, which was seriously affected. Given this, new sources of economic development have been identified, made up of the geological resources that its territory possesses, such as the establishment of geosites, geotourism routes and construction materials.

2. Geographical and Geological Setting

2.1. Geographical and Geological Situation of the Area

The study area is located in the Manglaralto River watershed, which belongs to the north of the Santa Elena province. This watershed has an area of 132.38 km² [94], which includes the Manglaralto, Cadeate and Simón Bolívar Rivers sub-catchments (see Figure 2).

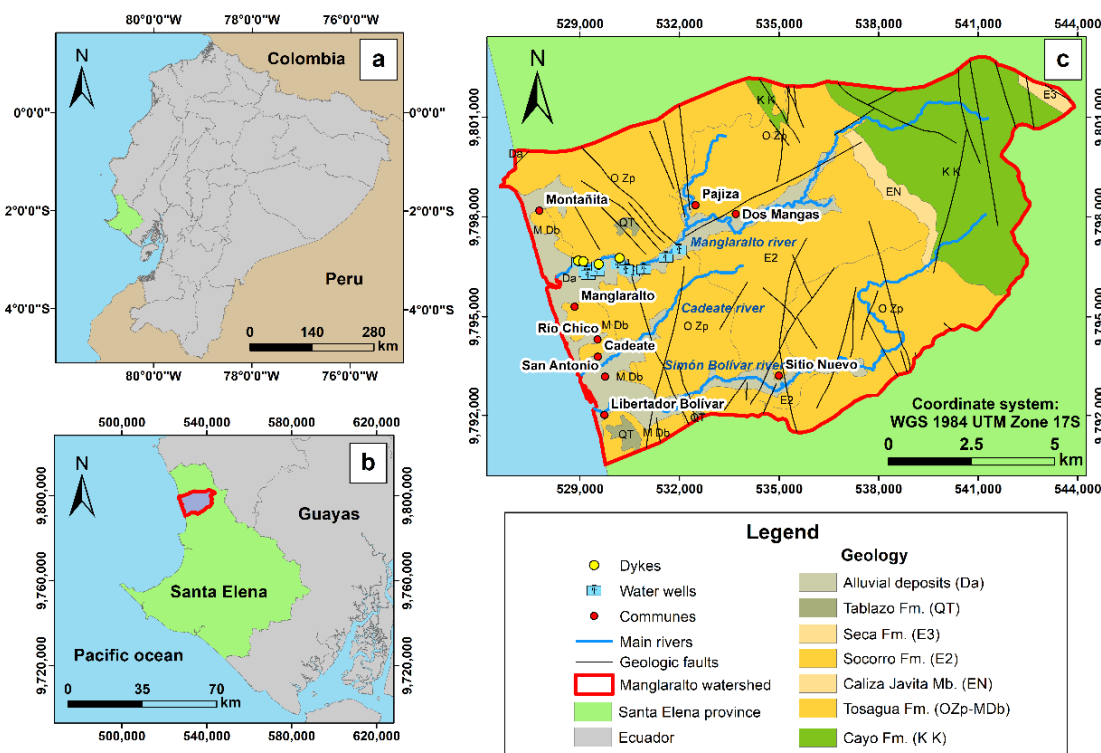


Figure 2. Location of the study area: (a) continental Ecuador; (b) Santa Elena province; (c) Geology of the Manglaralto River watershed. Source: Adapted from [74].

The geology of the area comprises sedimentary rocks, volcanic rocks of basic composition and alluvial deposits made up of gravel and sand, which make up the aquifers of the sector [95]. In the geological-mining aspect, two essential resources stand out: (i) zeolite, which has beneficial surface and structural properties applied in agriculture and the environment [96], and (ii) the Manglaralto River aquifer, the primary water source [97,98]. Among the applications in the environment of zeolite is the use of zeolite to neutralize a heavy metal (Nickel) in a soil environment [99]. Also, in the Al-Ahyuq sector, Yemen, the zeolite showed effectiveness as an adsorbent for the ammonium and phosphate as single and binary components from an aqueous solution [100]. The main applications of zeolite worldwide focus on water treatment (e.g., drinking water, wastewater, grey water), removal of heavy metals, ammonium, ammonia and construction [101]. Finally, in Ecuador, it was shown that cation exchange through zeolite represents an economically affordable, environmentally compatible and highly selective and effective way of removing cations, which are generally found in acid mine drainage and municipal and agricultural wastewater [102].

2.2. Socio-Economic Aspect

The rural parish of Manglaralto's main economic activities is tourism, agriculture, livestock and fishing. In addition, there are other activities such as construction, transportation and teaching [103]. According to Ron-Chóez [104], 60.1% of the region's economically active population receives a monthly income below Ecuador's Unified Basic Salary (UBS). In addition, this economic activity corresponds to activities derived from tourism (hotels, restaurants, recreational activities) concentrated on weekends and holidays.

The Manglaralto Regional Potable Water Management Board (JAAPMAN, acronym in Spanish) is the entity in charge of supplying water to ~38,830 inhabitants of the six communities of the Manglaralto parish (Montañita, Río Chico, Cadeate, San Antonio, Libertador Bolívar, and Manglaralto). JAAPMAN had 3866 users by 2021, where each user corresponds to a family, between six and eight people [105]. Furthermore, in the organization and water resources management, the women's participation is relevant in the organization of community boards and associations, specifically through women's groups (i.e., Ana Mar Women's Organization, Association of Autonomous Women Artisans of Dos Mangas, Ruta del Sol Women's Association) [103,106–108].

The area stands out for being a tourist site since, by hosting beaches, national and foreign tourists can enjoy the landscape and the local gastronomy. For this reason, the economy of these communities lies primarily in sun and beach tourism [94]. Dos Mangas commune, located in the northern part of the Manglaralto parish, is characterized by the development of ecological tourism (visits to waterfalls and natural pools), handicrafts (products made with toquilla straw and tagua), and hiking (congregates 60 beneficiaries). It is highlighted in the existing sustainability plan [109–111]. Likewise, in the Libertador Bolívar commune, there are craft areas with various products (e.g., rigid-soft fabrics, looms, pottery or ceramics, carving, ornaments, hunting instruments, fishing, music, utensils) [112]. Finally, in the Cadeate commune, they use the clays to construct bread ovens.

In the Montañita commune, 56% of the population is within the group of economically active people whose income areas in which they operate are commerce, agriculture, tourism, crafts and fishing [113]. The income received by 72% of this group is below UBS, and 83% are not affiliated with social security. The type of tourism recognized in this commune is sun and beach, where rest, relaxation, entertainment and fun are enjoyed [113–116].

3. Methodology

This work is based on a methodology that comprises four phases (see Figure 3): (i) inventory and mapping of georesources; (ii) description and assessment of georesources using international methodologies (e.g., Brilha method for geosites [27], the Geotouristic Routes Assessment Matrix (GtRAM) for georoute assessment [117]); (iii) georesources complementary applications and (iv) SWOT analysis (Strengths, Weaknesses, Opportunities, Threats)

and TOWS matrix preparation (Threats, Opportunities, Weaknesses, Strengths), seeking strategies to achieve the Sustainable Development Goals (SDGs) and thus guarantee the viability of the use of georesources.

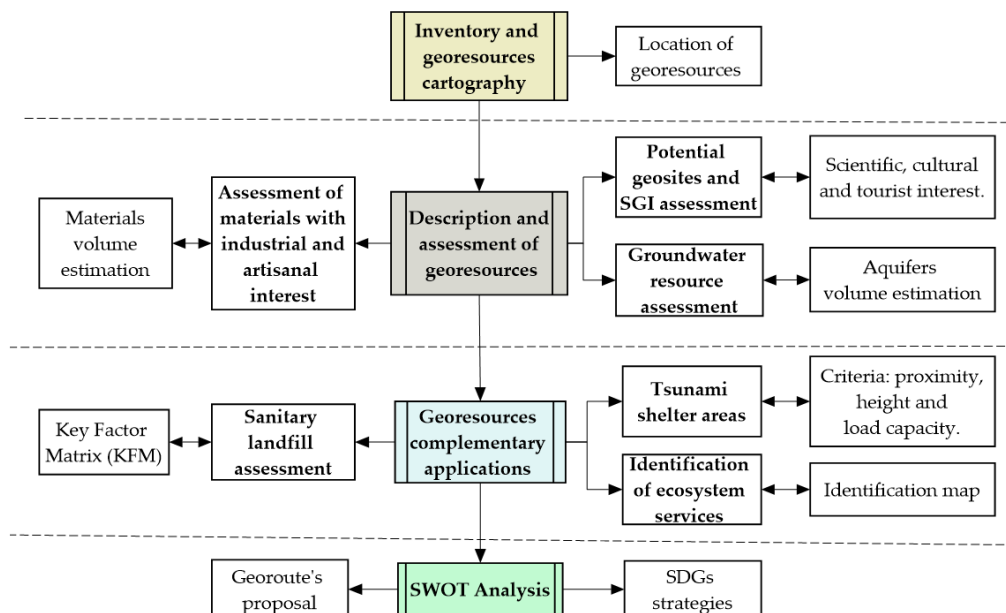


Figure 3. Methodological Scheme.

3.1. Inventory and Georesources Cartography

This phase included field trips to georeference the georesources of the Manglaralto River watershed (e.g., waterfalls, natural pools, coastal aquifers, a cape and some beaches). Coastal aquifers are the primary source of water for the communities. Additionally, the description of various geological environment elements was included in the characterization of sedimentary rock outcrops (e.g., conglomerates, sandstones and claystones) and sand and gravel deposits. In addition, cartographic information was used to obtain primary data from the rocks of the study area previous to the field trips [95].

3.2. Description and Assessment of Georesources

3.2.1. Sites of Geological Interest (SGI) and Potential Geosites Assessment

For the evaluation of SGI and geosites, the inventory method proposed by Brilha [27] was considered. This method has the advantage of being adaptable to particular in situ characteristics in different regions, having mixed analysis parameters (qualitative and quantitative), of defining the protection level of potential geosites and sites of geological interest [27]. Also, this method has been applied to other locations in the country [75,118–123]. This method consists of a quantitative evaluation, considering the four criteria: scientific, educational, tourism and risk of degradation, with their respective indicators and sub-indicators. These criteria contain indicators, whose assessment is in the range of 1 to 4 (see Table S1) [122]. The value attributed depends on the situation or state that characterizes the potential geosite, with the final score being the weighted sum of the assigned values.

3.2.2. Groundwater Resource Assessment

There are three aquifers in the sector: (i) coastal aquifer of the Manglaralto River, (ii) aquifer of the Cadeate River, and (iii) aquifer of the Simón Bolívar River. For evaluating the volume of the Manglaralto aquifer, a geological-hydrogeological characterization of a previous study was used [124]. Subsequently, in estimating the volume of the other two aquifers, the GeoModeller software was used, considering three parameters: Digital Elevation Model (DEM), geology, and processing of Vertical Electrical Soundings (VESs).

The VESs were interpreted based on the permeability of subsurface rock materials. In addition, the value of the average porosity of the permeable materials (gravel and sand) of said aquifers was also considered.

3.2.3. Assessment of Materials with Industrial-Artisanal Interest

This phase included field trips to outcrops of sedimentary rocks (e.g., conglomerates, sandstones and claystones). These materials with industrial-artisanal interest are considered rocks with industrial interest and used as construction materials. Complementarily, according to previous interpretations of VESs, zones with materials such as clays and sands were also considered materials with industrial interest. On the other hand, outcrops, where clays predominate, were visited to identify materials of artisanal interest, which are used in the construction of bakery ovens.

Once the places with materials of industrial-artisanal interest were defined and represented in the ArcGis Pro program [125]. Also, base information was used that included: (i) DEM of the Manglaralto River watershed, (ii) delimitation of the watershed, (iii) aquifers, (iv) visited outcrops, and (v) VESs. The representation of the outcrops and VESs allowed the selection of lands between 5 and 10 m deep in materials with industrial-artisanal interest (e.g., sands and clays). Once we identified these zones, the polygons were digitized by extracting the DEM area and applying Surface Volume's 3D Analyst Tools tool. In this way, the volume of materials with industrial-artisanal interest was calculated, considering the determining elevation.

3.3. Georesources Complementary Applications

Human population growth and rising rates of resource use per person have greatly expanded the human ecological footprint [126]. Therefore, the sustainable use of the intangible resources of the sector was considered, such as tsunami refuge areas, landfill areas, and Ecosystem Services (ES).

Identifying refuge zones before tsunamis is of vital importance, especially in coastal areas in subduction zones, as is the case in Ecuador [127]. Historically, Ecuador has been impacted by the effects of tsunamis in the years 1906 [128], 1933, 1953 [129], 1942, 1958, and 1979 [130,131]. Given this, the refuge areas include meeting places as a form of response by the communities to this type of geological event, which seeks to significantly minimize the impact on human life [132,133].

The value of building a sanitary landfill site (SL) technically would prevent the creation of improvised and illegal landfills [134]. Likewise, solid waste management through landfills indirectly benefits the water georesource since it would prevent the content of gases and leachates from contaminating such geological resources. In addition, having a site where all solid waste is collected offers a more efficient way to collect material that can be used as nutrients for the crop soil [135]. Also, the recycling of certain products (e.g., plastics, glass, metals) would lead to the generation of economic resources for the population [136].

Environmental awareness of ES implies the preservation of species and their habitats, providing economic benefits in the form of ecotourism. Ecotourism promotes conservation, low environmental impact, respect for local cultures, and support for local economies [137]. The ES represent a comprehensive approach to incorporating the environmental dimension in decision-making and promoting human well-being, favoring the articulation between the scientific system and decision-makers, public and private [138,139]. Therefore, compliance with the principles of the ecological economy is ensured in a practical way [140].

3.3.1. Sanitary Landfill (SL) Assessment

This phase includes the selection of sanitary landfill sites. First, some parameters were considered, such as the watershed's water table, the permeability of the lithological material (according to the interpretation of VESs), and the distance to surface water sources. Subsequently, to evaluate the level of construction difficulty of these sites, the Key Factor Matrix (KFM) method was applied [141]. This method considers emplacement area,

socio-economic analysis, volume and area of SL, demographic aspects and landfill infrastructure. It is possible to manage georesources sustainably through the analyses destined for this application [134]. The KFM method requires some parameters of the study area: groundwater, wind direction and solar radiation [142], temperature and precipitation [143], population [144–147], and permeability [148], as shown in [141]. The general equation that governs the Key Factors Matrix method is shown below.

$$TV = 2 \times Tp + 3 \times Gw + 3 \times SW + W + 2 \times SR + T + 2 \times P + Po + 2 \times k + 2 \times ST + DC \quad (1)$$

3.3.2. Tsunamis Shelter Areas

The coast of Ecuador is located in the Pacific Ring of Fire, presenting high seismic activity [149], so the study area is exposed to frequent earthquakes with high repercussions on its inhabitants. For example, on 16 April 2016, there was an earthquake in the vicinity of the area, magnitude of $M_w = 7.8$, and catastrophic consequences [150,151]. Therefore, it is imperative to locate tsunami protection areas in the sector because these events put human lives, infrastructure, and the development of geotourism at risk.

Tsunami shelters proposed by the National Secretariat for Risk and Emergency Management (SNGRE, acronym in Spanish) were considered and other shelter sites were included considering three main criteria: (i) proximity, (ii) elevation and (iii) load capacity. For the geographical representation of these sites, Geographic Information Systems (GIS) were employed and sites were located at a shorter distance and access time. In addition, they have a good load capacity that ensures the protection of those potentially affected and high levels that generate safety in this type of disaster.

3.3.3. Identification of Ecosystem Services (ES)

This phase identifies the ecosystem services present in the Manglaralto River watershed. The ES represents humanity's benefits from geodiversity and biodiversity, related to the functioning between all organisms and abiotic bodies and their characteristics [152–155]. Another way of perceiving ecosystem services is considering the biophysical structure and its interactive processes, which are the “means” to generate the “good or final product” for human well-being; this model is known as “waterfall” [156,157].

Subsequently, with the GIS application, the ecosystem service areas were represented. In the watershed of the Manglaralto River, there is an ecological reserve declared by the Ministry of the Environment, Water and Ecological Transition. In addition, JAAPMAN has considered a protection zone for its coastal aquifer within this watershed.

3.4. SWOT Analysis

This phase includes the approach of mechanisms based on the fundamental pillars of sustainable development (economic, social, environmental and cultural) through a SWOT matrix, which includes internal (strengths and weaknesses) and external (opportunities and threats) aspects. In addition, sustainable development strategies were established considering the SDGs. Additionally, this phase includes the proposal of a georoute, evaluating the 16 sites of geological interest using the Geotouristic Routes Assessment Matrix (GtRAM) method [158]. The GtRAM method was used because it is based mainly on evaluating tourist characteristics concerning what the Ministry of Tourism of Ecuador establishes about a tourist site [121,159]. Additionally, this method has already been applied in some case studies in the country [158–160].

This method considers six parameters, evaluated in the range between 1 and 5, established in four categories (see Table 1). Sites whose scores are below the value are discarded from the georoute.

Table 1. Parameters used for the geotouristic routes assessment through the GtRAM method. Source: Adapted from [158].

Qualitative Parameters	Value Range	Category
Accessibility	1–5	1–1.9 (low)
Preparation and logistics		2–2.9 (medium)
Registration with the Ministry of Tourism		3–3.9 (high)
Regarding heritage		4–5 (very high)
Contribution to scientific knowledge		
Ecotourism		

4. Results

4.1. Location of Georesources

The existing georesources in the Manglaralto River watershed were identified, including 16 potential geosite zones in the sector (e.g., aquifers, waterfalls, natural pools, a cape and some beaches). In addition, three zones with materials of industrial interest (construction materials) and an area for materials of artisanal interest (raw material extraction) were also represented, as shown in Figure 4.

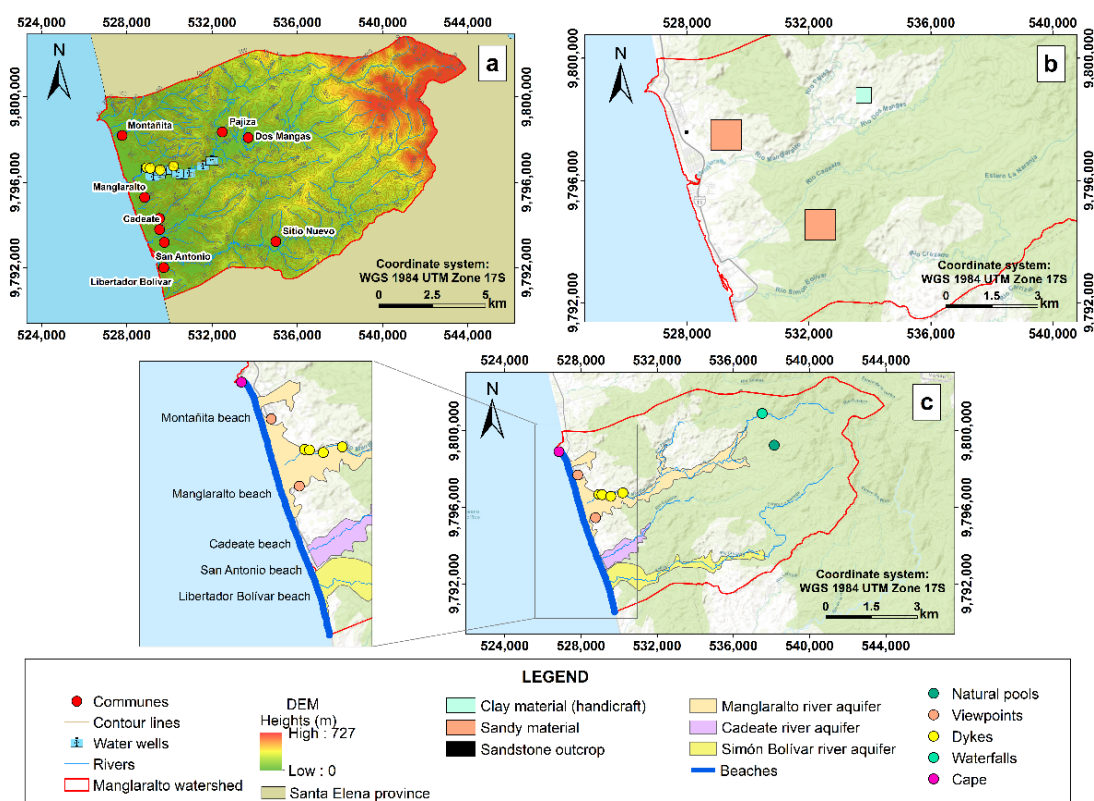


Figure 4. Location of georesources: (a) DEM, communes, water wells and dykes (tapes); (b) construction materials and handicrafts; (c) potential geosites. Source: Adapted from: [74].

4.2. Potencial Geosites and SGI Assessment

Within the study area, 16 Sites of Geological Interest (SGI) were identified, of which four have been previously evaluated (sites from 13 to 16). The selected sites have characteristics that highlight their geological potential (see Table 2).

In the SGI, the following features are highlighted: the hydrological, ecological, fluvial, landscape, erosive, cumulative, edaphological and geomorphological (see Figure 5).

Table 2. Characteristics of geosites, potential geosites and Sites of Geological Interest (SGI).

N	Sites	Main Features	Secondary Features	Site Classification
1	Dos Mangas natural pools	river	ecological and hydrological	SGI
2	Manglaralto dykes (tapes)	hydrological	river	Potential Geosite
3	San Antonio beach	erosive and cumulative	geomorphological	SGI
4	Manglaralto viewpoint	landscaped	-	SGI
5	Cadeate River aquifer	hydrological	ecological, fluvial and landscaped	Potential Geosite
6	Simón Bolívar River aquifer	hydrological	ecological, fluvial and landscaped	Potential Geosite
7	Libertador Bolívar beach	erosive and cumulative	geomorphological	SGI
8	Cadeate beach	erosive and cumulative	geomorphological	SGI
9	Manglaralto beach	erosive and cumulative	geomorphological	SGI
10	Montañita beach	erosive and cumulative	geomorphological	SGI
11	Dos Mangas ecological reserve	ecological	edaphological, fluvial and landscaped	Potential Geosite
12	Montañita cape	geomorphological	erosive and landscaped	SGI
13	Manglaralto River aquifer	hydrological	ecological, fluvial and landscaped	Geosite (prior evaluation)
14	Dos Mangas waterfalls	landscaped	ecological, hydrological and fluvial	Geosite (prior evaluation)
15	Dos Mangas trails	ecological	edaphological and landscaped	Geosite (prior evaluation)
16	Montañita viewpoint	landscaped	-	Geosite (prior evaluation)

Note: N: Number.

Figure 6 shows the results corresponding to the evaluation of the SGI and potential geosites based on scientific, educational, tourism and degradation risk criteria using the Brilha method [27]. According to scientific criteria, the ecological reserve in Dos Mangas and the cape in Montañita have the highest score (310 points). In the educational criterion, Libertador Bolívar beach stands out (325 points). Finally, in the tourist criteria, Libertador Bolívar beach stands out (290 points).

The risk of degradation of sites of geological interest and potential geosites is organized into three categories (low, moderate, and high), with 17% in the low category and the rest in the medium category. Sites such as the Ecological Reserve and the natural pools of Dos Mangas have the lowest risk of degradation since the reserve is a protected area where entry to the site requires the company of a guide, guaranteeing protection and care of flora and fauna. Therefore, the risk of degradation was calculated, where 83.33% (10) of the potential geosites and sites of geological interest presented a medium risk of degradation, including aquifers, beaches, cape, dikes (tapes), and viewpoint of Mangrove tall. On the other hand, 16.67% (2) have a low risk of degradation, including the ecological reserve and natural pools of Dos Mangas. For a better understanding of the results obtained with the Brilha method, a figure was generated for each value evaluated in this method: Scientific (S) (see Figure S1), Educational Potential Use (EPU) (see Figure S2), Potential Tourism Use (PTU) (see Figure S3), and Degradation Risk (DR) (see Figure S4).

4.3. Groundwater Resource Assessment

With the application of the GeoModeller software in previous studies, three-dimensional (3D) models were generated, which allowed estimating the volume of the aquifer capacity in the coastal aquifer of the Manglaralto River [97]. In this study, 3D models of the Cadeate River and Simón Bolívar River aquifers were generated. Table 3 summarizes the groundwater volume of the three aquifers mentioned.



Figure 5. Manglaralto watershed geological sites: (a) Manglaralto aquifer, (b) Dos Mangas ecological reserve, (c) Dos Mangas natural pools, (d) Dos Mangas waterfalls, (e) Montañita cape, (f) Libertador Bolívar Beach.

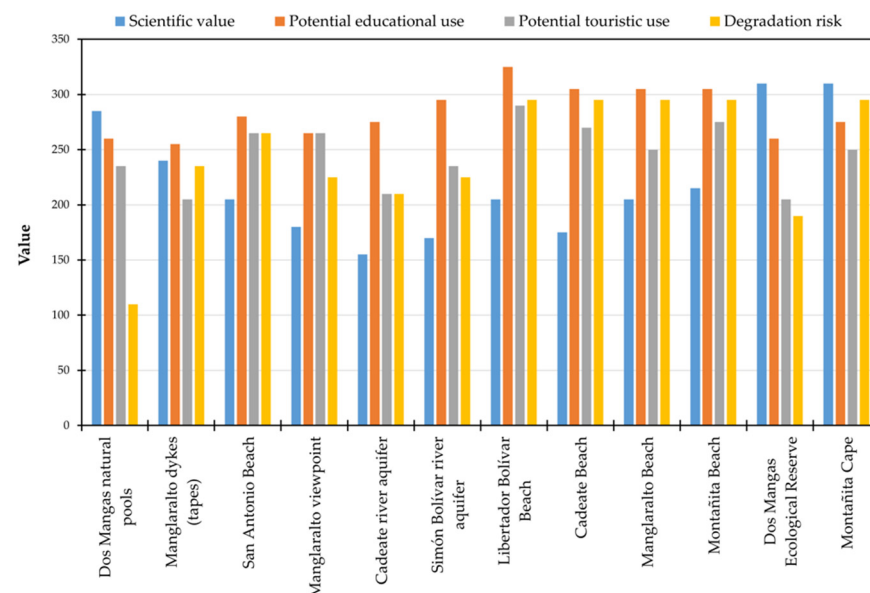


Figure 6. Distribution of scores of potential geosites and SGI.

4.4. Assessment of Materials with Industrial and Artisanal Interest

The VESs with the same lithology (clay and sand) that were closer to each other were chosen. As a result of estimating the volume of materials of industrial interest, we had a volume of 37,519 m³ of sand. Regarding the materials of artisanal interest, 2499 m³ of clay materials were obtained (see Table 4).

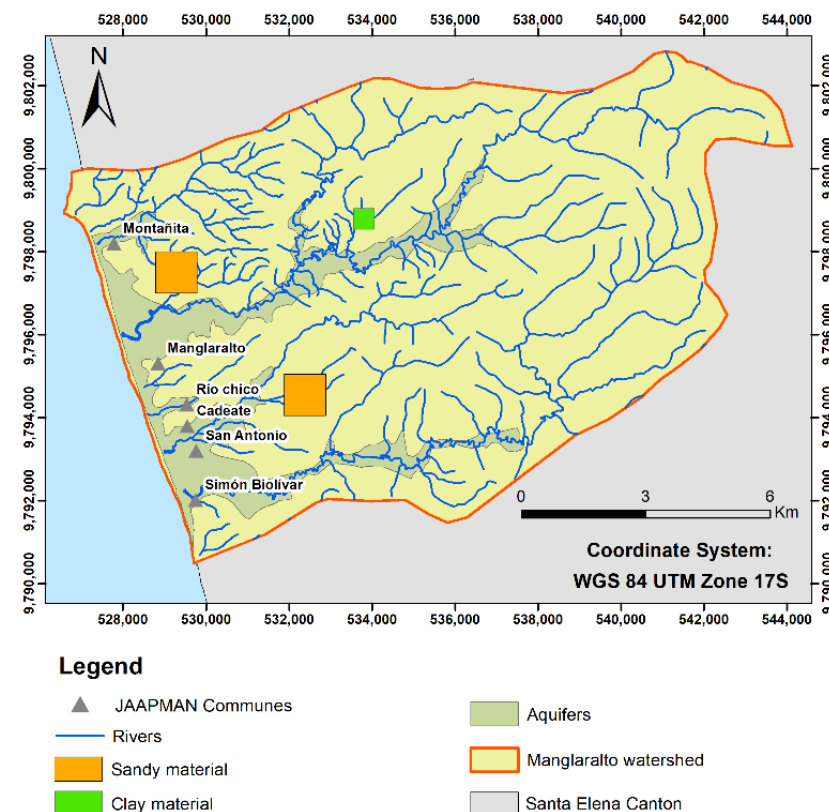
Table 3. Estimation of aquifers volumes of the Manglaralto watershed. Source: Adapted from [97].

Aquifer Name	Volume (Hm ³)	Area ($\times 10^6$ m ²)	Average Thickness (m)	Porosity (%)
Manglaralto	9.88	8.87	17.6	0.2
Cadeate	7.1	3.76	9.03	0.2
Simón Bolívar	3.76	3.92	7.83	0.2

Table 4. Materials with industrial and artisanal interest.

Materials Type	Thickness (m)	Volume (m ³)	Interest
Sands	10	37,519	Industrial
Clays	5	2499	Artisanal

In Figure 7, the sandy material is located in the western part of the watershed (green color) and the clay material in the north-central part (orange color). The size difference in the boxes representing the clay and sand resources is because previous geophysical studies [97,161], and Google Earth satellite images were considered. With the previous geophysical studies, it was analyzed that there were concentrated points of such interpreted lithology and validated with experts on the size of the chosen area. On the other hand, with the satellite images of Google Earth, it was verified that there was no interception with vegetation in those areas.

**Figure 7.** Location of materials with industrial and artisanal interest. Source: Adapted from [74].

The materials with artisanal interest (clays) are extracted mainly from the beaches to make bracelets and bread ovens in the commune of San Antonio, Libertador Bolívar, and mainly in Cadeate (see Figure 8).



Figure 8. Materials with artisanal interest: (a) Bread ovens built with clay in the San Antonio commune, (b) Crafts in the Libertador Bolívar commune, and (c) Bread ovens built with clay in the Cadeate commune.

4.5. Tsunamis Shelter Areas

In the area, there are 10 refuges against tsunamis proposed by the SNGRE, located between 500 m and 2 km from each other. Additionally, in this study, three additional sites have been proposed (see Figure 9). Three main parameters were considered: elevation, distance from the coast and the carrying capacity of the three proposed refuges (see Table 5).

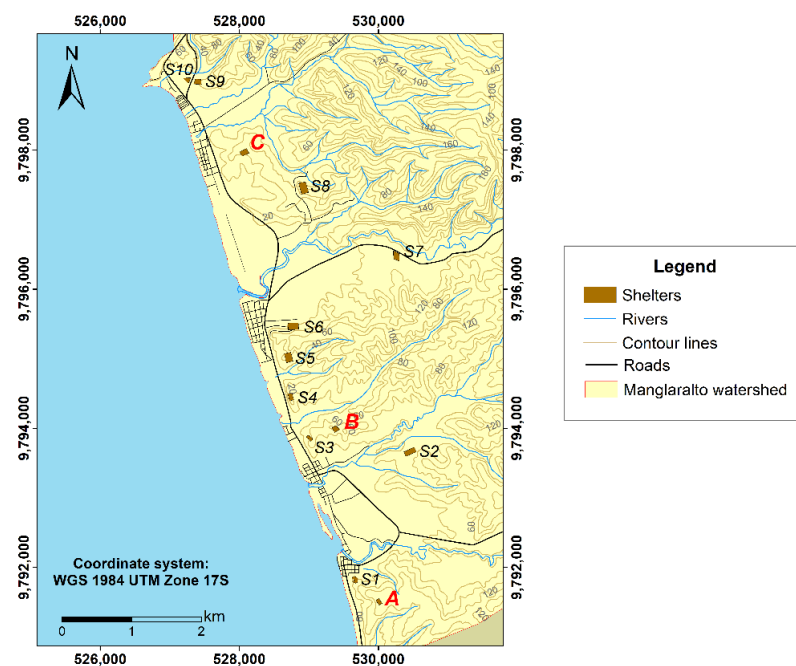


Figure 9. Tsunami shelter sites proposed by the SNGRE (S1–S10) and by the authors (A, B, C). Source: Adapted from [74,162].

Table 5. Proposals for tsunami refuge zones. Source: Adapted from [162].

Refuge	Height (m)	Distance to the Coast (m)	Effective Load Capacity (People)
A	81	385	2233
B	45	640	3477
C	45	600	4574

The three proposed refuges meet the primary criteria established by the SNGRE [162], where parameters such as the distance to the coast are established, considering a minimum approximate distance of 400 m from the coastline. Another parameter considered is the height where the refuge is located, with a minimum height of 20 m above sea level (see Figure 10). In addition, a third parameter was incorporated, represented by the adequate carrying capacity, which indicates the maximum number of people who can stay in each shelter [163,164], as shown in Table 5.



Figure 10. The authors proposed the following tsunami shelter zones: (a) Shelter A in Libertador Bolívar commune, (b) Shelter B in Cadeate commune, and (c) Shelter C in Montañita (Mirador) commune.

4.6. Assessment of Areas for Sanitary Landfill (SL)

This section was analyzed based on information on the characteristics of the terrain and the watershed's water table [165,166]. According to the geological characteristics of the sector, two sites showed suitable qualities for the establishment of a sanitary landfill. These sites met the soil-type criteria (silt-clay material with low permeability) and a water table depth of 10 m in the Manglaralto River watershed. These considerations made it possible to establish sites with the probability of no contamination in the water sources, including the rivers and the coastal aquifer (see Figure 11). However, prior to the recommendation of landfill sites, it should be considered how to avoid the agglomeration of homes near these sites, which is the sole responsibility of the political authorities [167].

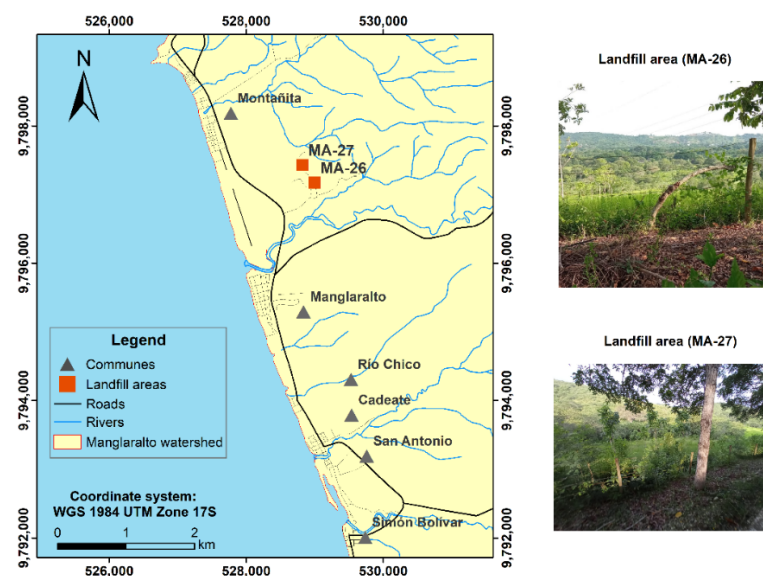


Figure 11. Proposed Landfill Sites. Source: Adapted from [74].

The KFM method was applied to evaluate possible landfill sites since this tool is based on technical-environmental foundations and considers human health [141]. Finally, the Total Value (TV) is rated according to this range:

- TV > 50: Constructible with minor precautions;
- 35 < TV < 50: Constructible under essential considerations;
- TV < 35: Not buildable.

The parameters evaluated by this matrix are shown in Table 6.

Table 6. Values assigned to the parameters evaluated by the Key Factors Matrix. Source: Adapted from: [141].

Site 1: MA-26										
Tp	Gw	SW	W	SR	T	P	Po	K	ST	DC
3	1	1	3	2	2	3	3	1	3	2
TV					Interpretation					
40					Constructible under essential considerations					
Site 2: MA-27										
Tp	Gw	SW	W	SR	T	P	Po	K	ST	DC
3	1	2	3	2	2	3	3	1	3	2
TV					Interpretation					
43					Constructible under essential considerations					

Note: Total Value: TV; Topography: Tp; Groundwater: Gw; Surface Water: SW; Wind direction: W; Solar Radiation: SR; Temperature: T; Precipitation: P; Population: Po; Permeability: k; Soil Type: ST; and Distance to Commune: DC.

4.7. Ecosystem Services (ES) Identification

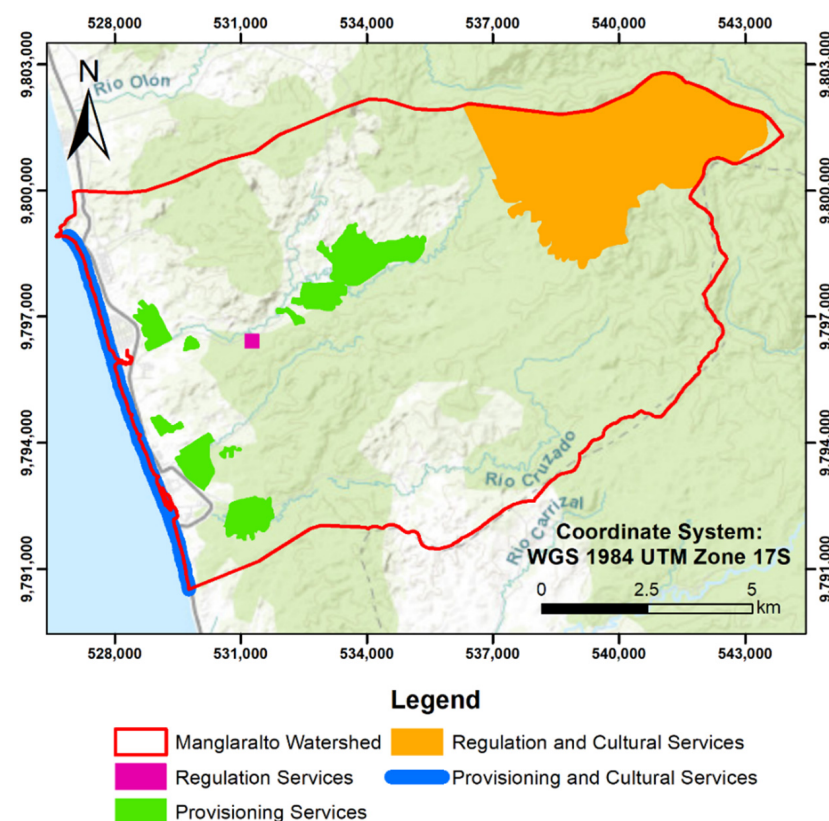
There is a widely recognized classification of ecosystem services, divided into four categories [152]: (i) provisioning ecosystem services are the products that are obtained directly from nature (e.g., fiber, food, genetics, natural chemicals, water, and plant and animal ornaments) [168]; (ii) regulation ecosystem services are the processes that lead to a balance between all ecosystems for the conservation of each one, and mitigation of environments harmful to humanity (e.g., climate control processes, water, air, waste, pests and natural hazards) [156]; (iii) cultural ecosystem services that include indirect goods, to which an abstract meaning is assigned (e.g., spiritual experiences, cognitive development, recreation and aesthetics) [153]; (iv) supporting ecosystem services that very often indirectly and long-term support other systems to function correctly (e.g., photosynthesis, soil and rock formation) [169]. In some cases, the products of this last service described can fall into the category of regulatory systems, such as the water cycle.

The ES identified in the Manglaralto watershed belong to “provisioning services”, “regulation services” and “cultural services”. In each service, some specific activities and processes are mentioned in Table 7 and include the geographical distribution of each service in Figure 12.

The ecosystems in which the ES are developed are mangrove, marine-coastal, humid coastal forest and western dry forest. These ES present geological elements such as cliffs, beaches, and waterfalls, whose places are the habitat of bird species (e.g., *Ardea alba*), fish (e.g., *Centropomus armatus*) and crustaceans (e.g., *Uca* sp.) [143]. In these ecosystems, the fishing activity of the communes takes place, but in turn, it is affected by contamination by residual water waste. There is also the Dos Mangas Protected Forest, which is a protected ecosystem [143].

Table 7. Ecosystem Services (ES) in the Manglaralto River watershed. Source: Adapted from [170].

Category	Activities and Processes
Provisioning	Fishing Agriculture Cattle raising
Regulation	Air purification Species habitat Water monitoring Erosion control Coastline defense
Cultural	Ecotourism Recreation Sun and beach tourism Environmental education Cultural identity Spiritual experiences

**Figure 12.** Geographic location of ES in the Manglaralto watershed. Source: Adapted from [74].

4.8. SWOT Analysis

The SWOT matrix analysis of the georesources provided essential information on the strengths, weaknesses, opportunities and threats, highlighting the geological and cultural richness of the study region (see Table 8). Moreover, it allowed the implementation of socio-economic development strategies through the relationship of external and internal qualities.

Table 8. Georesources SWOT Analysis Matrix.

Strengths (S)		Weaknesses (W)
Internal Panorama vs. External Panorama	1. Presence of geosites. 2. Scientific research in the study area (hydrogeology, tourism, ecology, chemistry). 3. Proximity to recreational places (beaches). 4. First order pathway (Spondylus route). 5. Geomorphological processes of educational and scientific relevance (Montañita cape). 6. Cultural heritage. 7. Tropical climate.	1. Lack in the evaluation of geosites. 2. Some sites are exposed to human activity. 3. Ignorance of the geological resources of the sector. 4. Absence of geotourism promotion. 5. Difficult accessibility to certain geosites.
Opportunities (O)	Strategies: S + O	Strategies: W + O
a. Economic development alternatives. b. Incorporation into projects of international significance (Santa Elena Geopark Project). c. Creation of scientific dissemination centers. d. Cultural enhancement of communities. e. Exploitation of certain georesources.	1-a. Promote the relevant characteristics of geosites through tourist centers. 6-d. Disseminate cultural particularities through documentaries in educational institutions. 2-b. Cooperation between scientific organizations for the dissemination of geosites. 4-e. Scientific research provides tools for the use of georesources in the sector. 5-e Use the geological knowledge of georesources as a new offer within the popular and solidarity economy.	1-b. Additional evaluations of scientific, educational and tourism criteria. 3-d. Use of geological resources for the preservation of local cultural practices.
Threats (T)	Strategies: S–T	Strategies: W–T
a. Decrease in the national economy due to restrictions in the face of the pandemic. b. Reduced funding for scientific research. c. Little culture of geosites.	1-c. Training (workshops) for communities on the importance of geosites for their sustainable management. 2-b. Technical reports show the favorable profitability of managing geosites.	4-b. Creation of a website with images, videos and virtual tours through geosites to encourage visits to such places. 5-b. Obtaining investment credits with the lowest interest rates and extended payment terms for the infrastructure and signage of the geosites.

4.9. Georoute Proposal

The mapping and evaluation of these georesources allowed for the proposal of a georoute that contributes to the tourist reactivation of the sector and the socialization of places of geological and geotouristic interest. Concerning the information obtained in the field, an itinerary is proposed that includes various geological, biological, cultural and recreational components (see Figure 13). The route in the proposed itinerary considers the accessibility to the sites and the contact with the natural environment (coastal marine environment, ecological reserve, mangroves, forests). Two entry forms are shown, one in a north–south direction and the second in a south–north direction, both through the Spondylus Route, a first-order road. In addition, the georoute has a total estimated distance of 27 km with an approximate time of five hours.

The south–north entrance begins in the Libertador Bolívar commune, where there are two options: to the east (New Site) or to the north, where the other communities are found, such as San Antonio, which has a sanctuary; Cadeate for being a place recognized for hosting bakery artisans, followed by Manglaralto for its mangroves and coastal aquifer. Then, there are two more options: to the east are the communities of Pajiza and Dos Mangas, where horseback riding is offered through trails that lead to waterfalls and natural pools in the Cordillera Chongón Colonche.

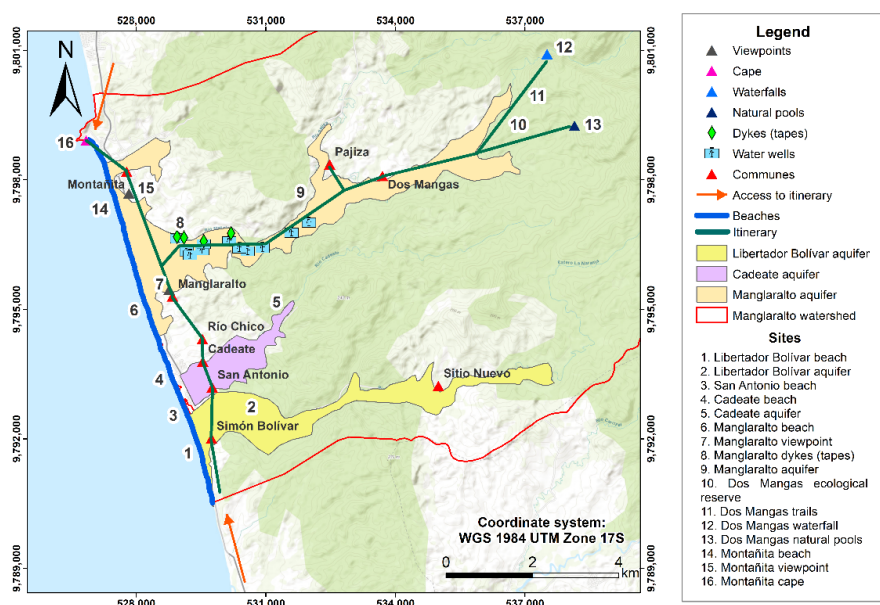


Figure 13. Georoute Proposal in the study area. Source: Adapted from [74].

Finally, suppose a person chooses the north direction. In that case, that person will reach the commune of Montañita, renowned for its nightlife and surfing and from whose beach the person can see a geoform (cape) that characterizes the sector and houses a sanctuary on its top. The itinerary can be completed in three or four days, being a potential geotourism route that seeks to promote the sustainable development of the communities.

The application of the GtRAM method in the 16 sites (SGI and potential geosites) allowed the evaluation of the proposed georoute in the sector. As a result, it shows a general average value of 3.69/5, considered a high value where eight sites present a very high value (4–5) in which the trails and the Dos Mangas ecological reserve stand out (see Figure 14). As a result, four sites have a high value (3–3.9) in which the dikes (tapes) stand out in Manglaralto. Three sites present an average value (2–2.9) in which the Cadeate beach and the Manglaralto viewpoint stand out. Finally, one site has a low value (1–1.9) comprised of the Simón Bolívar River aquifer. The disaggregated results of the six parameters evaluated with the GtRAM method [160] in the 16 sites (SGI and geosites) are shown in Figure S5.

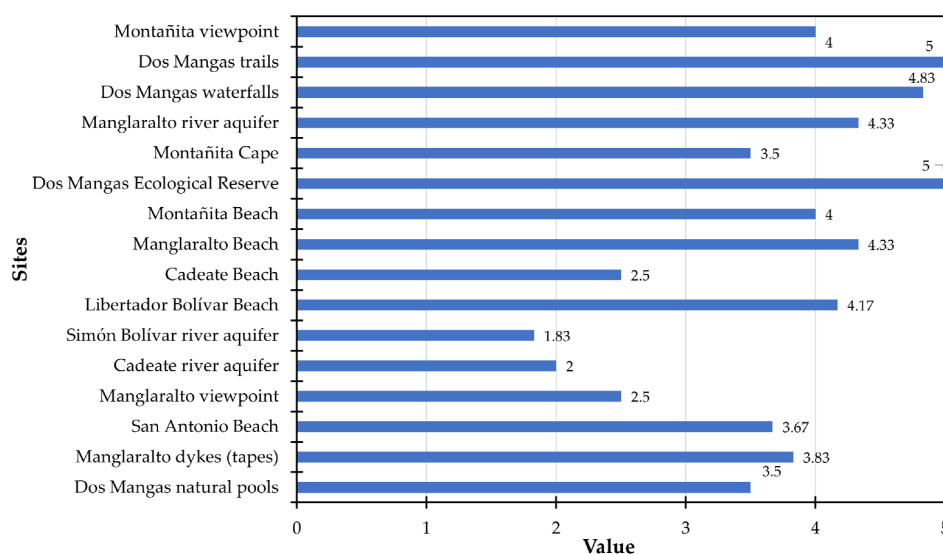


Figure 14. Results of the evaluation of the GtRAM method at the 16 sites (geosites and SGI).

5. Discussion

In the present study, a georesources analysis of the Manglaralto River watershed was carried out through its registration and evaluation (SGI, potential geosites, groundwater reserves and materials of industrial–artisanal interest), focused on sustainable development and proposing strategies framed in the SDGs, as has been applied in some studies [171,172]. Similar studies show that geotourism allows the establishment of geoeducational trails and viewpoints [173], and promotes knowledge of earth sciences through geology and landscape [174]. Additionally, the authors proposed complementary applications of the sector's georesources (tsunami refuge areas, proposed landfill sites, and ES identification).

The COVID-19 pandemic has notably affected the sector, as communities depend mainly on sun and beach tourism [175]. However, people could take advantage of their georesources for sustainable development with the valuation and aesthetic adaptations (sites of geological interest and geosites). In this way, they would be prepared for any adverse event that might come their way. Likewise, the commercialization of some industrial resources (sands) and the use of materials with artisanal interest for the elaboration of bread ovens and other handicrafts in the communities of the sector would be promoted, which would promote the socio-economic development of the communes. Finally, it is essential to mention that in the sector, there are non-exploitable geo-resources such as groundwater, represented by the three coastal aquifers that belong to the Manglaralto River watershed, to comply with the SDGs.

The SGI and potential geosites were evaluated by applying the Brilha method to expose the value of the 16 sites evaluated [27]. This method allowed estimating the scientific value and educational and tourist potential of geodiversity sites in different geological scenarios and areas of different sizes. As a result, 25% of the sites have a high scientific value, highlighting the Ecological Reserve of Dos Mangas and Cabo de Montañita, which reflects in the edaphological, fluvial and landscape characteristics that have given rise to the Ecological Reserve. On the other hand, the cape stands out for its geomorphological characteristics shaped by the action of wind and water. Furthermore, the Brilha method was applied due to its high frequency of use in other geosite evaluations [120,176,177], validating its excellent quantification in different geosites, highlighting the proposed criteria for geoeducational activity since these qualify the geological characteristics of geosites in a profound and objective manner [27]. In addition, with the application of the Brilha method, it is possible to bring geoscientific knowledge to the different levels of education (primary, secondary and third levels) [178,179]. In the study sector, since 2016, support has been provided in strengthening geotourism with the Santa Elena Peninsula Geopark Project and, thus, expanding the tourist offer by taking advantage of geographic resources strengthening the sustainable development of local communities [180,181]. Additionally, the coastal aquifer of the Manglaralto River located in the Manglaralto parish represents the primary source of groundwater and is considered a highly relevant geosite [98]. In this way, an efficient application of geoscientific knowledge is evidenced due to communication between the community and academy [105,182].

Materials with industrial interest include sands and clays. The applications of the sand include constructing houses, study centers, hospitals, and water supply wells. As agriculture is one of the main activities of the parish, it is necessary to correct the sand for crops concerning its acidity and its use as a filter for the water destined for this activity [183]. On the other hand, clay is used by combining it with limestone to forge cement [184] and concrete (avoiding the excessive use of clay). Clays represent the materials of artisanal interest since they are used to elaborate vessels with details of the cultural habits of the sector [143]. In addition, clay handicrafts show the skills, knowledge, and experience of those who made them and support other types of craftwork within the home, creating communities of different craft disciplines [185].

There are tsunami shelter zones among the complementary applications of georesources to mitigate the risk of these geodynamic events since the study area is close to a subduction zone [186]. These areas are considered a meeting point when these types of

events occur. Three refuge zones distributed along the coastal profile were identified in the study area, contributing to more areas through GIS than those previously established by the SNGRE. In Mauritius, a country in the Indian Ocean, GIS tools have been applied to map accessible refuge areas [187]. Other studies show that GIS has favored the analysis and models, obtaining refuge maps of which the purpose is to safeguard the lives of people who live in coastal areas susceptible to tsunamis [117,188,189].

In response to the problem of the solid waste generation that can affect health and the environment in the sector, two landfill sites were considered in relation to the possibility of their construction, considering the variables of the evaluation through the KFM method [141]. With the construction of a sanitary landfill, solid waste management would be responsible for environmental, economic, and hygienic matters [167,190]. Furthermore, from sanitary landfills, services of high benefit to humans can be obtained, such as thermal or electrical energy by processing gases and liquids from accumulated solid waste [191].

This study identified three types of ecosystem services (provisioning, regulation and cultural) in the Manglaralto River watershed. Awareness of these ecosystem services would allow the goods and services they provide to be managed to maintain a constant flow of ecosystem services for citizens [152]. Therefore, the authors propose the implementation of some management tools for these ecosystem services:

1. An online database.
2. Spatial visualization of ecosystems allows the design of indicators formulated by specialists and the local population, merging knowledge scientific-ancestral for correct decision-making [157,192–196].
3. Delimit strictly protected areas that contribute preserving species, geological landscapes and ecosystems.
4. Selection of areas for scientific use, monitoring, education and training.
5. Areas for economic activities responsible for the socio-cultural and ecological aspects of the communities [197].

The geodiversity sites inventory allowed to establish a georoute that links geology, culture, biodiversity, and tourist wealth features. It promotes a new alternative to sustainable development for the communities. According to Brundtland [198], sustainable development is based on meeting the needs of the present without compromising those of future generations, using this type of strategy in various studies [159,199–202]. The case study in Zaruma-Portovelo focuses on the geotourism part and the geoheritage of the routes to expand the knowledge of georoutes and their use for local development [159]. However, this article evaluated geosites and SGI from a conservation approach. Additionally, this study includes the applications and evaluations of georesources that can be exploited under a sustainable context and global impact.

In Santa Elena province, the productive activity and the popular solidarity economy strategies have been evaluated, as well as the yield generated by the elaboration and commercialization of salt as a raw material [203]. However, due to human interventions, commercial fishing has devastated local marine resources in the last decade, mangroves and estuaries have been seasonally flooded, and wetlands in the west of the province have disappeared, affecting the conservation of natural resources of local communities [204]. In previous studies of the Manglaralto parish, the quality and quantity of groundwater have been evaluated, evidencing problems such as the advance of saline intrusion and increased demand for water [98,124,182]. Finally, this study identifies deficiencies in the use and exploitation of georesources in the sector and proposes strategies to implement to ensure the sustainable development of local communities.

In the economic aspect, it is recommended to promote the necessary tools to strengthen the value chain in its different phases: in the provision of primary inputs, in the transformation of the raw material, which in many cases is done manually, in the direct marketing or through intermediaries, and finally in the sale [205]. The operating cost of a sanitary landfill is less than solid waste treatment [206]. Therefore, the cost of a sanitary landfill is indicated by Toro [207], stipulating the price at 20,270 USD/kg. Regarding the cost per

landfill construction area, the United States Environmental Protection Agency indicates a range of costs from 74,131,500 to 19,684,000 USD/Km² [208].

Work with the community has been demonstrated since 2005 up to the present, beginning with a project of cooperation with the International Atomic Energy Agency (IAEA) of the United Nations, supporting projects and scientific articles. Additionally, in 2018, a project was implemented in a Linking program of the ESPOL Polytechnic University. This project provides technical support to rural communities, such as in the Manglaralto parish, where some problems have arisen and have been addressed mainly with meetings with the leaders of JAAPMAN and local governments. Also, fieldwork to monitor water quality from wells in the sector [105]. As a result, it has contributed to constructing a technical-artisanal dyke (tape) to contribute to the water supply [209]. During the COVID-19 pandemic, several activities have been carried out to ensure the application of the circular economy through (i) wastewater treatment projects with green filters [141], (ii) socialization of the problems of the sector through informative brochures, (iii) model 3D of green filters and (iv) educational videos on the problems. Therefore, this article's development represents a contribution to the community. Furthermore, it also addresses a problem due to lack of tourism, proposing strategies for the geotourism development of the sector through a degree thesis. From this thesis, much of the information has been obtained for the preparation of this article [210].

6. Conclusions

The present study allowed the registration and georesources evaluation of the Manglaralto watershed, to respond to the critical situation during COVID-19; the area need not depend entirely on sun and beach tourism but should promote other socio-economic activities concerning the territory and its georesources. As a result, a considerable number of geological resources and various applications were shown to contribute to society's sustainable development through the establishment of geosites and SGI, water supply to communities (e.g., rivers and coastal aquifers), and the exploitation of materials of industrial-artisanal interest. Additionally, three main complementary applications of georesources were recognized: (i) evaluation of landfill sites, (ii) establishment of refuge zones in the event of tsunamis, and (iii) identification of ecosystem services in the sector.

According to the Brilha method, the study area is characterized by hosting potential geosites and SGI with a medium-to-high scientific assessment between 155 and 310 points. The degradation risk values show favorable results since the present site scores are low to medium (110–295).

A georoute was established that connects the geological wealth, biodiversity, tourist sites, and communities' cultural heritage. Another way of taking advantage of the sector's georesources is using the clay used in handicrafts and industrial rocks (sand, clay) to construct houses and centers of commerce. Moreover, 37,519 m³ of sand and 2499 m³ of clay were calculated, representing a premise of discovering new areas with content, not only of these materials found but also of other characteristics through technical processes, for the strengthening of economic activities and living place.

With the application of a SWOT Matrix, some strategies framed in the SDGs were established:

1. Creation of a website with images, videos and virtual tours through geosites to encourage visits to such places;
2. Training for communities on the importance of geosites for their sustainable management;
3. Cooperation between scientific organizations to disseminate geosites;
4. Use of georesources for the preservation of local cultural practices.

One of the georesources complementary applications of the sector was evaluating the construction of sanitary landfills through the KFM methodology application. It demonstrated that its implementation requires fundamental technical parameters to achieve a structure that efficiently complies with the country's solid waste regulations to avoid human health diseases and deterioration of the environment in which the communities settle.

In addition, appropriate supervision is necessary so as not to reduce the useful life of the built landfill and the synergy of each of the responsibilities that correspond to the residents and parish authorities.

Three refuge zones were also identified for the occurrence of tsunamis apart from those suggested by the SNGRE. These zones are intended to show a significant distribution of meeting points and the coastal profile. Another georesources application is the ecosystem services recognition of the sector, which is related to the knowledge of its products and services, relationships between them, participation of the inhabitant, authorities, public institutions and the academy, where each makes their knowledge and tools available to the other.

Some limitations were identified in this study. The Brilha method does not show an average score of the values and the risk of degradation of the places of geological interest and potential geosites since they are different criteria. Therefore, in future studies, it is recommended to complement the method of the Spanish Inventory of Places of Geological Interest (IELIG), and the Geosite Assessment Model (GAM). Another limitation would be the ignorance of the benefits of the sanitary landfill by the citizens and the distrust of the control authorities, which would generate a conflictive environment in the decision to build it. Finally, the artisans of the rural communities do not have adequate knowledge of productivity and commercialization of the rocks with industrial–artisanal interest. Additionally, there is evidence of a lack of promotion of the existing workforce in the area, limiting the local market.

This study contributes to the extensive use of the diverse geological wealth of the sector and how it contributes to the sustainable and economic development of a community, thus diversifying its sources of income. Furthermore, using elements of the natural environment guarantees the improvement of the community's lifestyle, generating work in areas that concern the geosites (e.g., geotourism guides, transportation, lodging, food, recreation areas), materials for crafts and construction (non-metallic mining), and water resources. Therefore, a way to link the various geosites would be through the georoute establishment, which would be promoted through local organizations (e.g., JAAPMAN, GAD of Manglaralto), the Ministry of Tourism of Ecuador and the academy through publications and the creation of websites that include images, videos and virtual tours. This work forms an elementary investigation for similar national or international studies, especially in rural communities, since it considers geological and cultural aspects, ensuring a better future for our society.

Finally, from this study, some lines of future research emerge, including (i) modelling, (ii) GIS analysis and remote sensing of tsunami events in the coastal communities of the Manglaralto parish, (iii) seismic evaluation of the areas of refuge proposals, (iv) economic analysis and (v) environmental impact assessment for the establishment of geosites.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/su14137856/s1>, Figure S1: Distribution of scientific values of potential geosites and SGI; Figure S2: Distribution of potential educational use values of potential geosites and SGI; Figure S3: Distribution of potential touristic use values of potential geosites and SGI; Figure S4: Distribution of degradation risk values of potential geosites and SGI; Figure S5: Evaluation of geosites and through GtRAM method; Table S1: Evaluation criteria for each type of value (S, UEP, PTU and DR) del método Brilha, with their respective scores and weight. Source: Adapted from [122] (Navarrete et al., 2022).

Author Contributions: Conceptualization, F.M.-C. and P.C.-M.; methodology, F.M.-C., P.C.-M., L.B.-M., M.G.-N. and J.C.-V.; software, L.B.-M., M.G.-N., J.C.-V.; validation, F.M.-C. and P.C.-M.; formal analysis, F.M.-C., P.C.-M. and L.B.-M.; investigation, F.M.-C., P.C.-M., M.G.-N., J.C.-V. and L.B.-M.; resources, F.M.-C., P.C.-M., L.B.-M., M.G.-N., J.C.-V.; data curation, M.G.-N., J.C.-V. and L.B.-M.; writing—original draft preparation, F.M.-C., P.C.-M. and L.B.-M.; writing—review and editing, F.M.-C. and P.C.-M.; visualization, M.G.-N., J.C.-V. and L.B.-M.; supervision, P.C.-M., F.M.-C. and L.B.-M.; project administration, F.M.-C. and P.C.-M.; funding acquisition, F.M.-C. and P.C.-M. All authors have read and agreed to the published version of the manuscript.

Funding: The APC was funded by ESPOL Polytechnic University. The financial support of this article is in charge of (i) Registro del Patrimonio Geológico y Minero y su incidencia en la defensa y preservación de la geodiversidad en Ecuador (Registry of Geological and Mining Heritage and its impact on the defense and preservation of geodiversity in Ecuador), with code No. CI-PAT-01-2018, and (ii) Siembra y Cosecha de Agua ante el COVID-19, Manglaralto 2022 (Sowing and 463 Harvesting of Water before COVID-19, Manglaralto 2022), with code No. PG03-PY22-03.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Acknowledgments: The financial support of this article is in charge of (i) Registro del Patrimonio Geológico y Minero y su incidencia en la defensa y preservación de la geodiversidad en Ecuador (Registry of Geological and Mining Heritage and its impact on the defense and preservation of geodiversity in Ecuador), with code No. CIPAT-01-2018, and (ii) Siembra y Cosecha de Agua ante el COVID-19, Manglaralto 2022 (Sowing and 463 Harvesting of Water before COVID-19, Manglaralto 2022), with code No. PG03-PY22-03. The authors thank the researcher Edgar Berrezueta for his constant reviews and support. The authors are thankful with the JAAPMAN (Water Community Board). The authors would also like to thank the editorial office and four anonymous reviewers for their constructive observations and corrections.

Conflicts of Interest: The authors declare no conflict of interest.

References

- Gray, M. *Geodiversity—Valuing and Conserving Abiotic Nature*; John Wiley & Sons: London, UK, 2004; ISBN 0470848960.
- Gray, M. Geodiversity. In *Geoheritage*; Elsevier: Amsterdam, The Netherlands, 2018; pp. 13–25.
- Megía, M.V.; Alarcón, J.C.B.; Romero, J.S.G.; Pérez Muñoz, A.B. El inventario andaluz de georrecursos culturales. In *De re metallica (Madrid) Revista de la Sociedad Española para la Defensa del Patrimonio Geológico y Minero*; Dialnet: Madrid, Spain, 2004; Volume 3, pp. 9–22.
- Ruban, D.A. Karst as important resource for Geopark-Based Tourism: Current state and biases. *Resources* **2018**, *7*, 82. [[CrossRef](#)]
- Villalobos, M. Estrategias en la protección del patrimonio geológico andaluz. *Medio Ambient.* **2001**, *31*, 36–39.
- Brilha, J.; Gray, M.; Pereira, D.I.; Pereira, P. Geodiversity: An integrative review as a contribution to the sustainable management of the whole of nature. *Environ. Sci. Policy* **2018**, *86*, 19–28. [[CrossRef](#)]
- Ruban, D.A.; Tiess, G.; Sallam, E.S.; Ponedelnik, A.A.; Yashalova, N.N. Combined mineral and geoheritage resources related to kaolin, phosphate, and cement production in Egypt: Conceptualization, assessment, and policy implications. *Sustain. Environ. Res.* **2018**, *28*, 454–461. [[CrossRef](#)]
- Henriques, M.H.; dos Reis, R.P.; Brilha, J.; Mota, T. Geoconservation as an emerging geoscience. *Geoheritage* **2011**, *3*, 117–128. [[CrossRef](#)]
- Tiess, G. *General and International Mineral Policy*; Springer: Vienna, Austria, 2011; ISBN 978-3-211-89004-2.
- Wimbledon, W.A.P. Geosites a new conservation initiative. *Episodes* **1996**, *19*, 87–88. [[CrossRef](#)]
- Lamelas, M.T.; Hoppe, A.; de la Riva, J.; Marinoni, O. Modelling environmental variables for geohazards and georesources assessment to support sustainable land-use decisions in Zaragoza (Spain). *Geomorphology* **2009**, *111*, 88–103. [[CrossRef](#)]
- Ayala, J.N.S. Geoparque en Potosí-Bolivia. Sus potencialidades y avance. I Simposio Red REUSE y Seminario Internacional de Reconversión de Territorios-Belo Horizonte 2012. In *Reutilización Sostenible del Espacio Minero*; Aja, A.H., Meza, M.I.L., Eds.; Universidad Federal de Minas Gerais (UFMG): Belo Horizonte, Chile, 2013; pp. 81–89, ISBN 978-84-9728-455-4.
- Gordon, J.E. Geoconservation principles and protected area management. *Int. J. Geoheritage Park.* **2019**, *7*, 199–210. [[CrossRef](#)]
- Singtuen, V.; Gałka, E.; Phajuy, B.; Won-In, K. Evaluation and geopark perspective of the geoheritage resources in Chiang Mai area, northern Thailand. *Geoheritage* **2019**, *11*, 1955–1972. [[CrossRef](#)]
- Newsome, D.; Dowling, R. Geoheritage and geotourism. In *Geoheritage*; Elsevier: Amsterdam, The Netherlands, 2018; pp. 305–321.
- Joyce, E.B. Australia's geoheritage: History of study, a new inventory of geosites and applications to geotourism and geoparks. *Geoheritage* **2010**, *2*, 39–56. [[CrossRef](#)]
- Gray, M. Geodiversity, geoheritage and geoconservation for society. *Int. J. Geoheritage Park.* **2019**, *7*, 226–236. [[CrossRef](#)]
- Nasier, S. Utilization of recycled form of concrete, E-wastes, glass, quarry rock dust and waste marble powder as reliable construction materials. *Mater. Today Proc.* **2021**, *45*, 3231–3234. [[CrossRef](#)]
- Chakhmouradian, A.R.; Wall, F. Rare earth elements: Minerals, mines, magnets (and more). *Elements* **2012**, *8*, 333–340. [[CrossRef](#)]
- Bookhagen, B.; Bastian, D.; Buchholz, P.; Faulstich, M.; Oppen, C.; Irrgeher, J.; Prohaska, T.; Koeberl, C. Metallic resources in smartphones. *Resour. Policy* **2020**, *68*, 101750. [[CrossRef](#)]
- Wei, G.C. Transparent ceramics for lighting. *J. Eur. Ceram. Soc.* **2009**, *29*, 237–244. [[CrossRef](#)]

22. Murray, H.H. Traditional and new applications for kaolin, smectite, and palygorskite: A general overview. *Appl. Clay Sci.* **2000**, *17*, 207–221. [\[CrossRef\]](#)
23. Vaneeckhaute, C.; Meers, E.; Michels, E.; Buysse, J.; Tack, F.M.G. Ecological and economic benefits of the application of bio-based mineral fertilizers in modern agriculture. *Biomass Bioenergy* **2013**, *49*, 239–248. [\[CrossRef\]](#)
24. Cartier, L.E. Gemstones and sustainable development: Perspectives and trends in mining, processing and trade of precious stones. *Extr. Ind. Soc.* **2019**, *6*, 1013–1016. [\[CrossRef\]](#)
25. Intarasiri, S.; Wijaiakhum, A.; Bootkul, D.; Suwannakachorn, D.; Tippawan, U.; Yu, L.D.; Singkarat, S. Development of vertical compact ion implanter for gemstones applications. *Appl. Surf. Sci.* **2014**, *310*, 94–99. [\[CrossRef\]](#)
26. Jalloh, A.B.; Sasaki, K.; Thomas, M.O.; Jalloh, Y. The geology, mineral resources of Sierra Leone and how the resources can be used to develop the nation. *Procedia Earth Planet. Sci.* **2013**, *6*, 131–138. [\[CrossRef\]](#)
27. Brilha, J. Inventory and quantitative assessment of geosites and geodiversity sites: A review. *Geoheritage* **2016**, *8*, 119–134. [\[CrossRef\]](#)
28. Ruban, D.A.; Sallam, E.S.; Khater, T.M.; Ermolaev, V.A. Golden triangle geosites: Preliminary geoheritage assessment in a geologically rich area of eastern Egypt. *Geoheritage* **2021**, *13*, 54. [\[CrossRef\]](#)
29. Ferreira, A.R.R.; Lobo, H.A.S.; de Jesus Perinotto, J.A. Inventory and quantification of geosites in the State Tourist Park of Alto Ribeira (PETAR, São Paulo State, Brazil). *Geoheritage* **2019**, *11*, 783–792. [\[CrossRef\]](#)
30. European Geoparks Network. *The Arouca Declaration*; European Geoparks Network: Arouca, Portugal, 2012.
31. Pérez-álvarez, R.; Torres-Ortega, S.; Díaz-Simal, P.; Husillos-Rodríguez, R.; De Luis-Ruiz, J.M. Economic valuation of mining heritage from a recreational approach: Application to the case of El Soplao Cave in Spain (Geosite UR004). *Sustainability* **2016**, *8*, 185. [\[CrossRef\]](#)
32. Prosser, C.D.; Díaz-Martínez, E.; Larwood, J.G. The conservation of geosites. In *Geoheritage*; Elsevier: Amsterdam, The Netherlands, 2018; pp. 193–212.
33. Kubalíková, L.; Kirchner, K.; Bajer, A. Secondary geodiversity and its potential for urban geotourism: A case study from Brno city, Czech Republic. *Quaest. Geogr.* **2017**, *36*, 63–73. [\[CrossRef\]](#)
34. Kubalíková, L.; Kirchner, K.; Kuda, F.; Machar, I. The role of anthropogenic landforms in sustainable landscape management. *Sustainability* **2019**, *11*, 4331. [\[CrossRef\]](#)
35. Kubalíková, L.; Zapletalová, D. Geo-cultural aspects of building stone extracted within Brno city (Czech Republic): A bridge between natural and cultural heritage. *Geoheritage* **2021**, *13*, 78. [\[CrossRef\]](#)
36. Reynard, E.; Brilha, J. Geoheritage: Inventories and evaluation. In *Geoheritage Assessment, Protection, and Management*; Emmanuel Reynard, J.B., Ed.; Elsevier: Amsterdam, The Netherlands, 2018; pp. 3–9, ISBN 9780128095423.
37. Spyrou, E.; Triantaphyllou, M.V.; Tsourou, T.; Vassilakis, E.; Asimakopoulos, C.; Konsolaki, A.; Markakis, D.; Marketou-Galari, D.; Skentos, A. Assessment of geological heritage sites and their significance for geotouristic exploitation: The case of Lefkas, Meganisi, Kefalonia and Ithaki Islands, Ionian Sea, Greece. *Geosciences* **2022**, *12*, 55. [\[CrossRef\]](#)
38. McBriar, M. A report prepared for the Australian Heritage Commission by the Standing Committee for the Geological Heritage. *J. Geol. Soc. Aust.* **1995**, *12*, 21.
39. Vujčić, M.D.; Vasiljević, D.A.; Marković, S.B.; Hose, T.A.; Lukić, T.; Hadžić, O.; Janičević, S. Preliminary geosite assessment model (gam) and its application on Fruška gora mountain, potential geotourism destination of Serbia. *Acta Geogr. Slov.* **2011**, *51*, 361–376. [\[CrossRef\]](#)
40. Henriques, M.H.; Tavares, A.O.; Bala, A.L.M. The geological heritage of Tundavala (Angola): An integrated approach to its characterisation. *J. Afr. Earth Sci.* **2013**, *88*, 62–71. [\[CrossRef\]](#)
41. De Lima, F.F.; Brilha, J.B.; Salamuni, E. Inventorying Geological Heritage in Large Territories: A Methodological Proposal Applied to Brazil. *Geoheritage* **2010**, *2*, 91–99. [\[CrossRef\]](#)
42. Brilha, J. Geoconservation and protected areas. *Environ. Conserv.* **2002**, *29*, 273–276. [\[CrossRef\]](#)
43. Sallam, E.S.; Ruban, D.A.; Mostafa, M.T.; Elkhodery, M.K.; Alwilily, R.L.; Molchanova, T.K.; Zorina, S.O. Unique desert caves as a valuable geological resource: First detailed geological heritage assessment of the Sannur Cave, Egypt. *Arab. J. Geosci.* **2020**, *13*, 141. [\[CrossRef\]](#)
44. Huang, Y.; Raza, S.M.F.; Hanif, I.; Alharthi, M.; Abbas, Q.; Zain-ul-Abidin, S. The role of forest resources, mineral resources, and oil extraction in economic progress of developing Asian economies. *Resour. Policy* **2020**, *69*, 101878. [\[CrossRef\]](#)
45. Haseeb, M.; Kot, S.; Iqbal Hussain, H.; Kamarudin, F. The natural resources curse-economic growth hypotheses: Quantile-on-Quantile evidence from top Asian economies. *J. Clean. Prod.* **2020**, *279*, 123596. [\[CrossRef\]](#)
46. Davis, G.A. Brazil's comparative advantage in the global economy. *Miner. Energy-Raw Mater. Rep.* **1995**, *11*, 4–10. [\[CrossRef\]](#)
47. Carvalho, I.S.; Henriques, M.H.; Castro, A.R.S.F.; Félix, Y.R. Promotion of the geological heritage of Araripe Unesco Global Geopark, Brazil: The Casa da Pedra Reference Center. *Geoheritage* **2020**, *12*, 17. [\[CrossRef\]](#)
48. IIGE Mapa Geológico de la República del Ecuador, Escala 1:1000000. Available online: <https://www.geoenergia.gob.ec/mapas-geologicos/> (accessed on 21 February 2022).
49. BGS; CODIGEM. *Geological and Metal Occurrence Maps of the Southern Cordillera Real and El Oro Metamorphic Belts, Ecuador Escala 1:500000*; British Geological Survey: Nottingham, UK, 1994.
50. Winkler, W.; Villagómez, D.; Spikings, R.; Abegglen, P.; Tobler, S.; Eguez, A. The Chota basin and its significance for the inception and tectonic setting of the Inter-Andean Depression in Ecuador. *J. S. Am. Earth Sci.* **2005**, *19*, 5–19. [\[CrossRef\]](#)

51. Berrezueta, E.; López, K.; González-Menéndez, L.; Ordóñez-Casado, B.; Benítez, S. Ophiolitic rocks and plagioclites from SW Ecuador (Cerro San José): Petrology, geochemistry and tectonic setting. *J. Iber. Geol.* **2021**, *47*, 367–386. [CrossRef]
52. BGS; CODIGEM. Geological and Metal Occurrence Maps of the Northern Cordillera Real Metamorphic Belts, Ecuador Escala 1:500000. Available online: <https://www.worldcat.org/title/geological-and-metal-occurrence-maps-of-the-northern-cordillera-real-metamorphic-belt-ecuador/oclc/891455130?referer=di&ht=edition#borrow> (accessed on 7 March 2022).
53. A.S.W. Sauer 1971. *Geologie von Ecuador*, ix + 316 pp., 29 figs, 15 tables, 4 folded figs. 2 folded maps. In German. Gebrüder Borntraeger, Berlin, Stuttgart. Price DM 130. *Geol. Mag.* **1973**, *110*, 189–190. [CrossRef]
54. Reyes, P.; Michaud, F. *Mapa Geológico del Margen Costero Ecuatoriano*; Springer: Quito, Ecuador, 2012.
55. Luzieux, L.; Heller, F.; Spikings, R.; Vallejo, C.; Winkler, W. Origin and Cretaceous tectonic history of the coastal Ecuadorian forearc between 1°N and 3°S: Paleomagnetic, radiometric and fossil evidence. *Earth Planet. Sci. Lett.* **2006**, *249*, 400–414. [CrossRef]
56. Eguez, A.; Gaona, M.; Albán, A. *Mapa Geológico de la República del Ecuador 2017*; Instituto Nacional de Investigación Geológica Minero Metalúrgica: Quito, Ecuador, 2017; p. 37.
57. BGS; CODIGEM. *Mapa Geológico de la Cordillera Occidental del Ecuador entre 3°–4° S. Escala 1:200.000*; British Geological Survey: Nottingham, UK, 1997.
58. BGS; CODIGEM. *Mapa Geológico de la Cordillera Occidental del Ecuador entre 0°–1° N. Escala 1:200.000*; British Geological Survey: Nottingham, UK, 1997.
59. Litherland, M.; Aspden, J.A.; Jemielita, R.A. *The Metamorphic Belts of Ecuador*; British Geological Survey: Nottingham, UK, 1994.
60. IIGE. Mapa Metalogénico de la República del Ecuador Escala 1:1000000. Available online: <https://www.geoenergia.gob.ec/mapa-metalogenetico-de-ecuador-escala-11-000-000-version-2019/> (accessed on 5 February 2022).
61. Goossens, P.J. Metallogeny in Ecuadorian andes. *Econ. Geol.* **1972**, *67*, 458–468. [CrossRef]
62. Stoll, W.C. Notes on the mineral resources of Ecuador. *Econ. Geol.* **1962**, *57*, 799–808. [CrossRef]
63. DGGM; IIGE. Mapa Metalogénico de la República del Ecuador, 1980 Escala 1:1'000.000. Available online: <https://www.geoenergia.gob.ec/mapas-tematicos-11000-000/> (accessed on 2 February 2022).
64. INIGEMM. Mapa de Indicios de Metales Metálicos de la República del Ecuador, 2009, escala 1:1'000.000. Available online: https://drive.google.com/file/d/12x2aEqdRHAqM3xtBbsrl1SVj_1HEcTkj/view (accessed on 2 February 2022).
65. Berrezueta, E.; Ordóñez-Casado, B.; Espinoza-Santos, C.; Loayza-Ramírez, J.; Carrión-Mero, P.; Morante-Carballo, F.; Bonilla, W. Caracterización mineralógica y petrográfica de las vetas Vizcaya, Octubrina y Gabi del yacimiento aurífero epitermal Zaruma-Portovelo, Ecuador. *Bol. Geol. Min.* **2021**, *132*, 421–437. [CrossRef]
66. INIGEMM. Mapa de Ocurrencias de Metales no Metálicos, 2011, Escala 1:1'000.000. Available online: https://drive.google.com/file/d/1htTEX0_tYWKIRamP4vc7GvCqnHWHqUx/view (accessed on 2 February 2022).
67. Goossens, P.; INIGEMM. Mapa de Índice Mineralógico de la República del Ecuador, 1969, Escala 1:1'000.00. Available online: <https://drive.google.com/file/d/1RwYVeQp4akCSs3OL34IJJNDCZAQoqIUz/view> (accessed on 2 February 2022).
68. Machiels, L.; Garcés, 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. *Appl. Clay Sci.* **2014**, *87*, 108–119. [CrossRef]
69. Ministerio del Ambiente; Consejo Nacional de Recursos Hídricos. *División Hidrográfica del Ecuador*; Ministerio del Ambiente; Consejo Nacional de Recursos Hídricos: Quito, Ecuador, 2002.
70. INAMHI. *Cuencas Hidrográficas del Ecuador*; INAMHI: Quito, Ecuador, 2014.
71. INAMHI. *Mapa de Ubicación de la Red Hidrológica en Operación por Cuencas Hidrográficas del Ecuador*; INAMHI: Quito, Ecuador, 2007.
72. UICN. *Delimitación y Codificación de Unidades Hidrográficas del Ecuador. Escala 1:250000*; UICN: Quito, Ecuador, 2009.
73. Gallardo, G.; Melia, E.; García, M.; Artacho, M. Identification and measurement of complementarity variables in strategic projects of water irrigation from the sustainability practices. Case: Republic of Ecuador. In *Project Management and Engineering Research*; Springer: Cham, Switzerland, 2017; pp. 121–136.
74. CIPAT-ESPOL; SENAGUA; AECID. *Proceso: Re-Senagua-026-2012. Proyecto: Elaboración del mapa hidrogeológico a escala 1:250.000. Informe Final*; CIPAT-ESPOL, SENAGUA, AECID: Guayaquil, Ecuador, 2014.
75. Berrezueta, E.; Sánchez-Cortez, J.L.; Aguilar-Aguilar, M. Inventory and characterization of geosites in Ecuador: A review. *Geoh Heritage* **2021**, *13*, 93. [CrossRef]
76. Chang, C.; McAleer, M.; Ramos, V. A charter for sustainable tourism after COVID-19. *Sustainability* **2020**, *12*, 3671. [CrossRef]
77. Romagosa, F. The COVID-19 crisis: Opportunities for sustainable and proximity tourism. *Tour. Geogr.* **2020**, *22*, 690–694. [CrossRef]
78. Cave, J.; Dredge, D. Regenerative tourism needs diverse economic practices. *Tour. Geogr.* **2020**, *22*, 503–513. [CrossRef]
79. OECD. *Tourism Policy Responses to the Coronavirus (COVID-19)*; OECD: Paris, France, 2020; pp. 1–75.
80. ONU. *Informe de Políticas: La COVID-19 y la Transformación del Turismo*; ONU: Madrid, Spain, 2020.
81. OMT. COVID-19 y Sector Turístico 2020: Análisis del Año. Available online: <https://www.unwto.org/es/covid-19-y-sector-turistico-2020> (accessed on 4 February 2022).
82. Secretaría General de Comunicación de la Presidencia. *El presidente Lenín Moreno Declara Estado de Excepción para Evitar la Propagación del COVID-19*; Secretaría General de Comunicación de la Presidencia: Quito, Ecuador, 2021.
83. Llor Bravo, L.; Plaza Macías, N.; Medina Valdés, Z. Turismo comunitario en Ecuador: Apuntes en tiempos de pandemia. *Rev. Cienc. Soc.* **2021**, *26*, 266–277.

84. Diaz, C.; Torres, J. *Analysis of the Measures Taken by the Governments of Colombia and Ecuador in Favor of the Tourism Industry during the Pandemic Generated by COVID-19*; RISTI: Lousada, Portugal, 2020; Volume 36, pp. 127–139.
85. Guerrero, G.; Noblecilla, F. *Análisis Socioeconómico de la Incidencia del COVID-19 en el Turismo de la Parroquia Manglaralto, año 2020*; UG: Guayaquil, Ecuador, 2021.
86. Marie-Therese, L. Las comunas costeras del Ecuador frente al COVID-19: Alianzas sociales, territorio, autonomía y dependencia. *Perif. Rev. Investig. Form. Antropol.* **2020**, *25*, 30–51. [\[CrossRef\]](#)
87. Carrión-Mero, P.; Montalván-Burbano, N.; Herrera-Narváez, G.; Morante-Carballo, F. Geodiversity and mining towards the development of geotourism: A global perspective. *Int. J. Des. Nat. Ecodynamics* **2021**, *16*, 191–201. [\[CrossRef\]](#)
88. UNESCO List of Geoparks and Regional Networks. Available online: <https://en.unesco.org/global-geoparks/list> (accessed on 3 February 2022).
89. UNESCO Imbabura UNESCO Global Geopark (Ecuador). Available online: <https://en.unesco.org/global-geoparks/imbabura> (accessed on 7 April 2022).
90. Geoparque Imbabura Geoparque Imbabura. Available online: <https://geoparque.imbabura.gob.ec/> (accessed on 11 April 2022).
91. Ministerio de Turismo Establecimientos Registrados. Portal Servicios MINTUR. Available online: <https://servicios.turismo.gob.ec/index.php/turismo-cifras/2018-09-18-21-11-17/establecimientos-registrados> (accessed on 9 April 2022).
92. Ministerio de Turismo Indicadores de Turismo. Portal Servicios MINTUR. Available online: <https://servicios.turismo.gob.ec/index.php/turismo-cifras/2018-09-24-21-06-03/indicadores-de-turismo> (accessed on 10 April 2022).
93. Ministerio de Turismo Visualizador económico. Portal Servicios MINTUR. Available online: <https://servicios.turismo.gob.ec/visualizador-economico> (accessed on 12 April 2022).
94. GAD. *Parroquia Manglaralto Plan de Desarrollo y Ordenamiento Territorial (PDOT) de la Parroquia Rural Manglaralto 2014-2019*; GAD: Manglaralto, Ecuador, 2015.
95. DGGM; IIGE. Hoja Geológica Manglaralto-Escala 1:100.000. Available online: <https://www.geoenergia.gob.ec/mapas-tematicos-1-100-000/> (accessed on 3 February 2022).
96. Morante-Carballo, F.; Montalván-Burbano, N.; Carrión-Mero, P.; Espinoza-Santos, N. Cation exchange of natural zeolites: Worldwide research. *Sustainability* **2021**, *13*, 7751. [\[CrossRef\]](#)
97. Carrión-Mero, P.; Quiñonez-Barzola, X.; Morante-Carballo, F.; Montalván, F.J.; Herrera-Franco, G.; Plaza-Úbeda, J. Geometric model of a coastal aquifer to promote the sustainable use of water. Manglaralto, Ecuador. *Water* **2021**, *13*, 923. [\[CrossRef\]](#)
98. Carrión-Mero, P.; Montalván, F.J.; Morante-Carballo, F.; Loo-Flores de Valgas, C.; Apolo-Masache, B.; Heredia, J. Flow and transport numerical model of a coastal aquifer based on the hydraulic importance of a dyke and its impact on water quality. Manglaralto—Ecuador. *Water* **2021**, *13*, 443. [\[CrossRef\]](#)
99. Boros-Lajszner, E.; Wyszowska, J.; Kucharski, J. Use of zeolite to neutralise nickel in a soil environment. *Environ. Monit. Assess.* **2018**, *190*, 54. [\[CrossRef\]](#)
100. Alshameri, A.; Xinghu, W.; Dawood, A.; Assabri, A.; Xin, C.; Yan, C. Characterization of Yemeni natural zeolite (Al-Ahyuq area) and its environment applications: A review. *J. Ecol. Eng.* **2019**, *20*, 157–166. [\[CrossRef\]](#)
101. Morante-Carballo, F.; Montalván-Burbano, N.; Carrión-Mero, P.; Jácome-Francis, K. Worldwide research analysis on natural zeolites as environmental remediation materials. *Sustainability* **2021**, *13*, 6378. [\[CrossRef\]](#)
102. Malamis, S.; Katsou, E. A review on zinc and nickel adsorption on natural and modified zeolite, bentonite and vermiculite: Examination of process parameters, kinetics and isotherms. *J. Hazard. Mater.* **2013**, *252*–253, 428–461. [\[CrossRef\]](#)
103. Lalangui Roldán, K.L.; Cruz Arreaga, G.R. *Análisis de los Procesos de Desarrollo Local: Caso, el Rol de la Junta Administradora de Agua Potable Regional de Manglaralto (JAAPMAN). Santa Elena-Ecuador. Periodo 2008-2017*; UG: Guayaquil, Ecuador, 2020.
104. Ron-Chóez, F.J.; Arévalo-Ávila, F.A. *Análisis Socioeconómico de la Parroquia Manglaralto. Cantón Santa Elena. Periodo 2015–2019*; UG: Guayaquil, Ecuador, 2021.
105. Carrión-Mero, P.; Morante-Carballo, F.; Herrera-Franco, G.; Jaya-Montalvo, M.; Rodríguez, D.; Loo-Flores de Valgas, C.; Berrezueta, E. Community-university partnership in water education and linkage process. Study case: Manglaralto, Santa Elena, Ecuador. *Water* **2021**, *13*, 1998. [\[CrossRef\]](#)
106. León-Castro, C.M. *La Economía Popular y Solidaria. Análisis y Perspectivas de Desarrollo Económico y Territorial de la Provincia de Santa Elena-Ecuador*; Universidad de León: León, Spain, 2018.
107. Mendoza Tarabó, A.E.; Ramírez Frías, C.H.; Yumisaca Tuquinga, J.E.; Peralta Mendoza, S.P. Artesanías autóctonas como atractivo turístico en la provincia de Santa Elena, Ecuador. *Explor. Digit.* **2019**, *3*, 5–15. [\[CrossRef\]](#)
108. García Espinoza, L.C.; Sarabia Molina, M.Y.; Mendoza Trabó, A.E. Turismo comunitario y responsabilidad social en Santa Elena: Un modelo para armar. *Estud. Turísticos* **2018**, *211*–2012, 171–187.
109. Yumisaca Tuquinga, J.E.; Bohórquez Armijos, E.A.; Mendoza Tarabó, E.A.; Gonzabay Rosales, J. Cadena de valor del destino Dos Mangas como herramienta para el análisis de la sostenibilidad de la oferta turística. *Univ. Soc.* **2020**, *12*, 88–96.
110. Sarabia Molina, M.Y.; García Espinoza, L.C.; Mendoza Tarabó, A.E. Small businesses like a sign of innovation and sustainable development in the community tourism centers in Santa Elena. In *Innovation and Entrepreneurial Opportunities in Community Tourism*; ICI Global: Hershey, PA, USA, 2021; pp. 15–36, ISBN 9781799848554.
111. Yumisaca, J.; Mendoza, E.; Silvia, P. Planificación turística: Perspectivas desde las comunidades de Santa Elena. *Espirales* **2019**, *3*, 131–141. [\[CrossRef\]](#)

112. Gavilanes Sánchez, M.S.; Soriano Miranda, J.I. *Estudio Técnico para la Exportación de Artesanías de Madera y Caña GUADUA como Elemento Fundamental del Comercio Internacional y su Incidencia en el Desarrollo Socioeconómico de los Artesanos de la Asociación Herencia Cultural de la Comuna Atravezado*, PAR; Universidad de Guayaquil: Guayaquil, Ecuador, 2016.
113. Guapi Flores, S.J. *Plan de Desarrollo Económico para la Comuna Montañita, Parroquia Manglaralto, Cantón Santa Elena, Provincia de Santa Elena, año 2015*; UPSE University: Santa Elena, Ecuador, 2015.
114. Carvache Franco, W.; Torres Naranjo, M.; Carvache Franco, M. Análisis del perfil y satisfacción del turista que visita Montañita–Ecuador. *Cuad. Tur.* **2017**, *39*, 113–129. [[CrossRef](#)]
115. Gálvez-Izquieta, P.C.; Mendoza-Tarabó, A.E. Capacidad de carga turística como herramienta para el desarrollo sostenible de playas: Caso Montañita, provincia de Santa Elena, Ecuador. *Empresarial* **2020**, *14*, 1–7. [[CrossRef](#)]
116. Yumisaca Tuquinga, J.E.; Mendoza Tarabó, A.E.; Villón Perero, S.G. Perfil sociodemográfico del turista de la provincia de Santa Elena en Ecuador. Referencias para nuevas propuestas de desarrollo. *Univ. Soc.* **2017**, *9*, 52–59.
117. Nakai, H.; Itatani, T.; Kaganoi, S.; Okamura, A.; Horiike, R.; Yamasaki, M. Needs of children with neurodevelopmental disorders and geographic location of emergency shelters suitable for vulnerable people during a tsunami. *Int. J. Environ. Res. Public Health* **2021**, *18*, 1845. [[CrossRef](#)]
118. Picchi, D.; Caballero, J.P. Employment of three methodologies of geosities inventory for geoconservation. Case study: Grutas del Palacio geosite. *Soc. Urug. Geol.* **2018**, *21*, 53–65.
119. Poch Serra, J. *Revisión y Propuesta de Mejora del Modelo de Gestión de la Geodiversidad de los Geoparques Mundiales de la UNESCO*; Universitat Autònoma de Barcelona: Barcelona, Spain, 2019.
120. Herrera-Franco, G.; Carrión-Mero, P.; Mora-Frank, C.; Caicedo-Potosí, J. Comparative analysis of methodologies for the evaluation of geosites in the context of the Santa Elena-Ancón geopark project. *Int. J. Des. Nat. Ecodynamics* **2020**, *15*, 183–188. [[CrossRef](#)]
121. Turner-Carrión, M.; Carrión-Mero, P.; Turner-Salamea, I.; Morante-Carballo, F.; Aguilar-Aguilar, M.; Zambrano-Ruiz, K.; Berrezueta, E. A mineralogical museum as a geotourism attraction: A case study. *Minerals* **2021**, *11*, 582. [[CrossRef](#)]
122. Navarrete, E.; Morante-Carballo, F.; Dueñas-Tovar, J.; Carrión-Mero, P.; Jaya-Montalvo, M.; Berrezueta, E. Assessment of geosites within a natural protected area: A case study of Cajas National Park. *Sustainability* **2022**, *14*, 3120. [[CrossRef](#)]
123. Herrera-Franco, G.; Erazo, K.; Mora-Frank, C.; Carrión-Mero, P.; Berrezueta, E. Evaluation of a paleontological museum as geosite and base for geotourism. A case study. *Heritage* **2021**, *4*, 1208–1227. [[CrossRef](#)]
124. Carrión-Mero, P.; Montalván, F.J.; Morante-Carballo, F.; Heredia, J.; Elorza, F.J.; Solórzano, J.; Aguilera, H. Hydrochemical and isotopic characterization of the waters of the Manglaralto river basin (Ecuador) to contribute to the management of the coastal aquifer. *Water* **2021**, *13*, 537. [[CrossRef](#)]
125. ESRI ArcGIS Desktop. Available online: <https://www.esri.com/en-us/arcgis/products/arcgis-pro/overview> (accessed on 2 February 2022).
126. Miller, G.T.; Spoolman, S.E. *Living in the Environment*; Nineteenth; National Geographic Learning: Boston, USA, 2016; ISBN 978-1-337-10010-6.
127. Gutscher, M.-A.; Malavieille, J.; Lallemand, S.; Collot, J.-Y. Tectonic segmentation of the North Andean margin: Impact of the Carnegie Ridge collision. *Earth Planet. Sci. Lett.* **1999**, *168*, 255–270. [[CrossRef](#)]
128. Pulido, N.; Yoshimoto, M.; Sarabia, A.M. Broadband wavelength slip model of the 1906 Ecuador-Colombia megathrust-earthquake based on seismic intensity and tsunami data. *Tectonophysics* **2020**, *774*, 228226. [[CrossRef](#)]
129. Ioualalen, M.; Monfret, T.; Béthoux, N.; Chlieh, M.; Ponce Adams, G.; Collot, J.Y.; Martillo Bustamante, C.; Chunga, K.; Navarrete, E.; Montenegro, G.; et al. Tsunami mapping in the Gulf of Guayaquil, Ecuador, due to local seismicity. *Mar. Geophys. Res.* **2014**, *35*, 361–378. [[CrossRef](#)]
130. Herd, D.G.; Youd, T.L.; Meyer, H.; Arango C., J.L.; Person, W.J.; Mendoza, C. The Great Tumaco, Colombia earthquake of 12 December 1979. *Science* **1981**, *211*, 441–445. [[CrossRef](#)]
131. Kanamori, H.; McNally, K.C. Variable rupture mode of the subduction zone along the Ecuador-Colombia coast. *Bull. Seismol. Soc. Am.* **1982**, *72*, 1241–1253. [[CrossRef](#)]
132. Zhang, W.; Wu, J.; Yun, Y. Strategies for increasing tsunami shelter accessibility to enhance hazard risk adaptive capacity in coastal port cities: A study of Nagoya city, Japan. *Nat. Hazards Earth Syst. Sci.* **2019**, *19*, 927–940. [[CrossRef](#)]
133. Fadly, U.; Ruslin, A.M.; Keisuke, M.; Fadhilatus, S.; Sari Indah, C. Evacuation road, shelter plan and preparedness for Tsunami disaster mitigation in Watulimo District, Trenggalek Regency, Indonesia. *Disaster Adv.* **2020**, *13*, 23–31.
134. Langa, C.; Hara, J.; Wang, J.; Nakamura, K.; Watanabe, N.; Komai, T. Dynamic evaluation method for planning sustainable landfills using GIS and multi-criteria in areas of urban sprawl with land-use conflicts. *PLoS ONE* **2021**, *16*, e0254441. [[CrossRef](#)] [[PubMed](#)]
135. Maheshwari, S.; Deswal, S. Role of waste management at landfills in sustainable waste management. *Int. J. Emerg. Technol.* **2017**, *8*, 324–328.
136. Nanda, S.; Berruti, F. Municipal solid waste management and landfilling technologies: A review. *Environ. Chem. Lett.* **2021**, *19*, 1433–1456. [[CrossRef](#)]
137. Kiper, T. Role of ecotourism in sustainable development. In *Advances in Landscape Architecture*; Ozyavuz, M., Ed.; InTech: Tekirdağ, Turkey, 2013; pp. 773–802, ISBN 9789535111672.
138. Wegner, G.; Pascual, U. Cost-benefit analysis in the context of ecosystem services for human well-being: A multidisciplinary critique. *Glob. Environ. Chang.* **2011**, *21*, 492–504. [[CrossRef](#)]

139. Schleyer, C.; Görg, C.; Hauck, J.; Winkler, K.J. Opportunities and challenges for mainstreaming the ecosystem services concept in the multi-level policy-making within the EU. *Ecosyst. Serv.* **2015**, *16*, 174–181. [\[CrossRef\]](#)
140. Costanza, R.; Erikson, J.D.; Farley, J.; Kubiszewski, I. How ecosystem services research can advance ecological economics principles. In *Sustainable Wellbeing Futures: A Research and Action Agenda for Ecological Economics*; Edward Elgar: Trotterham, UK, 2020; pp. 127–150.
141. Morante-Carballo, F.; Apolo-Masache, B.; Carrión-Mero, P.; Cedeño, B.; Montalvan-Toala, J. Considerations in the Methodology for the Technical-Environmental Viability of Sanitary Landfills in Rural Communities. Northern Case of the Province of Santa Elena, Ecuador. *Int. J. Sustain. Dev. Plan.* **2021**, *16*, 317–325. [\[CrossRef\]](#)
142. INAHMI Instituto Nacional de Meteorología e Hidrología. Available online: <http://www.inamhi.gob.ec/> (accessed on 7 August 2021).
143. GAD. *Manglaralto Actualización del Plan de Desarrollo y Ordenamiento Territorial (PDOT) 2019–2023*; GAD: Manglaralto, Ecuador, 2019.
144. Holguín Ramírez, K.M. *Componentes de la Sostenibilidad Turística en la Comuna Dos Mangas, Parroquia Manglaralto, año 2019*; UPSE University: Manglaralto, Ecuador, 2019.
145. Muñoz Catuto, M.J. *Potencialidades del Agroturismo en la Comuna Sitio Nuevo*; UPSE University: La Libertad, Ecuador, 2019.
146. Salazar Párraga, M.J. *Plan de Desarrollo Económico para la Comuna Pajiza de la Parroquia Manglaralto, Cantón de Santa Elena, Provincia de Santa Elena, año 2015*; UPSE University: La Libertad, Ecuador, 2015.
147. Valencia, J. *Análisis Hidrogeológico de la Cuenca del río Manglaralto para la Caracterización de sus Sistemas Acuíferos*; UPSE University: Manglaralto, Ecuador, 2017.
148. Angelone, S.; Garibay, M.T.; Casaux, M.C. *Geología y Geotecnia-Permeabilidad de Suelos*; Universidad Nacional del Rosario: Santa Fe, Argentina, 2006.
149. Parraga-Alava, J.; Garzon, G.M.; Alcivar Cevallos, R.; Inostroza-Ponta, M. Unsupervised pattern recognition for geographical clustering of seismic events Post Mw 7.8 Ecuador earthquake. In Proceedings of the 37th International Conference of the Chilean Computer Science Society (SCCC), Santiago, Chile, 5–9 November 2018; IEEE: Piscataway, NJ, USA, 2018; pp. 1–8.
150. Cando-Jácome, M.; Martínez-Graña, A.; Chunga, K.; Ortiz-Hernández, E. Satellite radar interferometry for assessing coseismic liquefaction in Portoviejo city, induced by the Mw 7.8 2016 Pedernales, Ecuador earthquake. *Environ. Earth Sci.* **2020**, *79*, 467. [\[CrossRef\]](#)
151. Meltzer, A.; Beck, S.; Ruiz, M.; Hoskins, M.; Soto-Cordero, L.; Stachnik, J.C.; Lynner, C.; Porritt, R.; Portner, D.; Alvarado, A.; et al. The 2016 Mw 7.8 Pedernales, Ecuador, Earthquake: Rapid Response Deployment. *Seismol. Res. Lett.* **2019**, *90*, 1346–1354. [\[CrossRef\]](#)
152. Millenium Ecosystem Assessment. *Ecosystems and Human Well-being: Synthesis*; Island Pre.: Washington, DC, USA, 2005.
153. The Economics of Ecosystems and Biodiversity. *Ecological and Economic Foundations*; Kumar, P., Ed.; Routledge: London, UK, 2010; ISBN 9781849712125.
154. *Mapping Ecosystem Services*; Burkhard, B.; Maes, J. (Eds.) Pensoft Publishers: Sofia, Bulgaria, 2017; ISBN 0632049987.
155. Danley, B.; Widmark, C. Evaluating conceptual definitions of ecosystem services and their implications. *Ecol. Econ.* **2016**, *126*, 132–138. [\[CrossRef\]](#)
156. Ruskule, A.; Vinogradovs, I.; Viloslada, M. *The Guidebook on “The Introduction to the Ecosystem Service Framework and its Application in Integrated Planning”*; Kasparinskis, R., Ed.; University of Latvia: Riga, Latvia, 2018; ISBN 9789934556395.
157. Müller, F.; Fohrer, N.; Chicharo, L. (Eds.) The basic ideas of the ecosystem service concept. In *Ecosystem Services and River Basin Ecohydrology*; Springer: Dordrecht, The Netherlands, 2015; p. 341, ISBN 9789401798464.
158. Carrión-Mero, P.; Turner-Carrión, M.; Herrera-Franco, G.; Bravo-Murillo, G.; Aguilar-Aguilar, M.; Paz-Salas, N.; Berrezueta, E. Geotouristic route proposal for touristic development in a mining area. Case study. *Resources* **2022**, *11*, 25. [\[CrossRef\]](#)
159. Carrión-Mero, P.; Herrera-Narváez, G.; Herrera-Franco, G.; Sánchez-Zambrano, E.; Mata-Perelló, J.; Berrezueta, E. Assessment and promotion of geotouristic and geomining routes as a basis for Local development: A case study. *Minerals* **2021**, *11*, 351. [\[CrossRef\]](#)
160. Herrera-Franco, G.; Mora-Frank, C.; Kovács, T.; Berrezueta, E. Georoutes as a basis for territorial development of the Pacific Coast of South America: A case study. *Geoheritage* **2022**, *14*, 78. [\[CrossRef\]](#)
161. Carrión-Mero, P.; Morante-Carballo, F.; Toalombo, M.; Mora, D.; Briones, J.; Berrezueta, E. Exploración de aguas subterráneas para un plan de abastecimiento sostenible en una comunidad rural: Caso Cadeate, Santa Elena, Ecuador. In Proceedings of the 18th LACCEI International Multi-Conference for Engineering, Education, and Technology: Engineering, Integration, And Alliances for A Sustainable Development “Hemispheric Cooperation for Competitiveness and Prosperity on A Knowledge-Based Economy”, Virtual, 27–31 July 2020; Latin American and Caribbean Consortium of Engineering Institutions: Buenos Aires, Argentina, 2020; pp. 1–10.
162. SNGRE. *Manual Técnico para Elaboración del Plan de Evacuación ante Tsunami*; SNGRE: Guayaquil, Ecuador, 2020; Volume 1.
163. Cifuentes, M. *Determinación de Capacidad de Carga Turística en Áreas Protegidas*; Centro Agronomico Tropical de Investigacion y Ensenanza Catie: Turrialba, Costa Rica, 1992.
164. Rodríguez, S. *Propuesta Metodológica para la Medición de la Capacidad de carga Turística del Haynes Cay en San Andrés Isla*; Universidad Externado de Colombia: Bogotá, Colombia, 2018.

165. Jaramillo, J. *Guía para el Diseño, Construcción y Operación de Rellenos Sanitarios Manuales*; Centro Panamericano de Ingeniería Sanitaria y Ciencias del Ambiente: Lima, Perú, 2002.
166. Marco Arévalo Ulloa; Arévalo, M. *Propuesta de Diseño de Construcción, Acondicionamiento de un pozo de Agua y su Incidencia en la Vulnerabilidad del Acuífero Costero en MANGLARALTO*; ESPOL University: Guayaquil, Ecuador, 2017.
167. Gran Castro, J.A.; Bernache Pérez, G. Gestión de residuos sólidos urbanos, capacidades del gobierno municipal y derechos ambientales. *Soc. Ambient.* **2016**, *1*, 73–101. [\[CrossRef\]](#)
168. Liu, Y.; Bailey, J.L.; Davidsen, J.G. Social-cultural Ecosystem Services of Sea Trout Recreational Fishing in Norway. *Front. Mar. Sci.* **2019**, *6*, 1–13. [\[CrossRef\]](#)
169. The National Wildlife Federation Ecosystem Services. Available online: <https://www.nwf.org/Educational-Resources/Wildlife-Guide/Understanding-Conservation/Ecosystem-Services#:~:text=RegulatingServices,inplacetopreventerosion> (accessed on 2 February 2022).
170. Herrera-Franco, G.; Alvarado-Macancela, N.; Gavín-Quinchuela, T.; Carrión-Mero, P. Participatory socio-ecological system: Manglaralto-Santa Elena, Ecuador. *Geol. Ecol. Landsc.* **2018**, *2*, 303–310. [\[CrossRef\]](#)
171. Herrera-Franco, G.; Carrión-Mero, P.; Morante-Carballo, F.; Herrera-Narváez, G.; Briones-Bitar, J.; Blanco-Torrens, R. Strategies for the development of the value of the mining-industrial heritage of the Zaruma-Portovelo, Ecuador, in the context of a geopark project. *Int. J. Energy Prod. Manag.* **2020**, *5*, 48–59. [\[CrossRef\]](#)
172. Carrión-Mero, P.; Morante-Carballo, F. The Context of Ecuador's World Heritage, for Sustainable Development Strategies. *Int. J. Des. Nat. Ecodynamics* **2020**, *15*, 39–46. [\[CrossRef\]](#)
173. Telbisz, T.; Čalić, J.; Kovačević-Majkić, J.; Milanović, R.; Brankov, J.; Micić, J. Karst Geoheritage of Tara National Park (Serbia) and Its Geotouristic Potential. *Geoheritage* **2021**, *13*, 88. [\[CrossRef\]](#)
174. Afrasiabian, A.; Sivand, S.M.; Dogančić, D.; Plantak, L.; Đurin, B. Geological features for geotourism in the Zanjan and Hamadan area, northern Iran. *Sustainability* **2021**, *13*, 6587. [\[CrossRef\]](#)
175. Herrera-Franco, G.; Alvarado, J.; Gordillo, P.; Veintimilla, L.; Merchan, B.; Carrión-Mero, P.; Berrezueta, E. Communication methods on water care during the COVID-19 pandemic and its impact on the resilience of the rural community of “Libertador Bolívar”, Ecuador. In Proceedings of the Sustainable Water Resources Management XI, Online, 18–20 May 2021; WIT Press: Bristol, UK, 2021; pp. 109–118.
176. Maghsoudi, M.; Moradi, A.; Moradipour, F.; Nezammahalleh, M.A. Geotourism development in world heritage of the Lut desert. *Geoheritage* **2019**, *11*, 501–516. [\[CrossRef\]](#)
177. Tavares, G.N.D.; Boggiani, P.C.; de Moraes Leme, J.; Trindade, R.I. The inventory of the geological and paleontological sites in the area of the aspirant geopark Bodoquena-Pantanal in Brazil. *Geoheritage* **2020**, *12*, 22. [\[CrossRef\]](#)
178. Zafeiropoulos, G.; Drinia, H. Comparative analysis of two assessment methods for the geoevaluational values of geosites. A case study from the Volcanic Island of Nisyros, SE Aegean Sea, Greece. *Geosciences* **2022**, *12*, 82. [\[CrossRef\]](#)
179. Németh, B.; Németh, K.; Procter, J.N.; Farrelly, T. Geoheritage conservation: Systematic mapping study for conceptual synthesis. *Geoheritage* **2021**, *13*, 45. [\[CrossRef\]](#)
180. Herrera-Franco, G.; Carrión-Mero, P.; Alvarado, N.; Morante-Carballo, F.; Maldonado, A.; Caldevilla, P.; Briones-Bitar, J.; Berrezueta, E. Geosites and georesources to foster geotourism in communities: Case study of the Santa Elena Peninsula geopark project in Ecuador. *Sustainability* **2020**, *12*, 4484. [\[CrossRef\]](#)
181. Herrera-Franco, G.; Alvarado-Macancela, N. Ancón-Santa Elena geopark in the context of regional planning. In *Libro de Actas del Cuarto Congreso Internacional sobre Geología y Minería Ambiental para el Ordenamiento del Territorio y el Desarrollo*; Mata-Perelló, J.M., Monasterio, M., Eds.; Sociedad Española para la Defensa del Patrimonio Geológico y Minero: Molina de Aragón, Spain, 2016; pp. 185–198, ISBN 9788469316719.
182. Herrera-Franco, G.; Carrión-Mero, P.; Aguilar-Aguilar, M.; Morante-Carballo, F.; Jaya-Montalvo, M.; Morillo-Balsera, M.C.C. Groundwater resilience assessment in a communal coastal aquifer system. The case of Manglaralto in Santa Elena, Ecuador. *Sustainability* **2020**, *12*, 8290. [\[CrossRef\]](#)
183. Meradi, H.; Atoui, L.; Bahloul, L.; Boubendira, K.; Bouazdia, A.; Ismail, F. Characterization by thermal analysis of natural Kieselguhr and sand for industrial application. *Energy Procedia* **2015**, *74*, 1282–1288. [\[CrossRef\]](#)
184. Earle, S. *Physical Geology*, 2nd ed.; BCcampus: Victoria, BC, Canada, 2019; Volume 1986, ISBN 978-0-387-35416-3.
185. Joyce, R.A.; Hendon, J.A.; Lopiparo, J. Working with clay. *Anc. Mesoamerica* **2015**, *25*, 411–420. [\[CrossRef\]](#)
186. Trindade, A.; Teves-Costa, P.; Catita, C. A GIS-based analysis of constraints on pedestrian tsunami evacuation routes: Cascais case study (Portugal). *Nat. Hazards* **2018**, *93*, 169–185. [\[CrossRef\]](#)
187. Mudhawa, A.I.; Subramani, S.E. Tsunami impact assessment and evacuation strategy for grand sable village, mauritius, using remote sensing and geographical information system (GIS). *Int. J. Eng. Trends Technol.* **2020**, *68*, 43–49. [\[CrossRef\]](#)
188. Sambuaga, R.D.; Lee, H.S. Optimized evacuation plan and decision support system development with Agent-Based modelling and GIS analysis for Tsunami events in Pandeglang, Banten, Indonesia. *J. Coast. Res.* **2021**, *114*, 509–513. [\[CrossRef\]](#)
189. Nakai, H.; Itatani, T.; Horiike, R.; Kyota, K.; Tsukasaki, K. Tsunami evacuation simulation using geographic information systems for homecare recipients depending on electric devices. *PLoS ONE* **2018**, *13*, e0199252. [\[CrossRef\]](#) [\[PubMed\]](#)
190. Castro, R.; Perez, R. *Saneamiento Rural y Salud: Guía para Acciones a Nivel Local*; OPS: Ciudad de Guatemala, Guatemala, 2009.
191. Sáez, A.; Urdaneta G., J.A. Manejo de residuos sólidos en América Latina y el Caribe. *Omnia* **2014**, *20*, 121–135. [\[CrossRef\]](#)

192. Layke, C. *Measuring Nature's Benefits: A Preliminary Roadmap for Improving Ecosystem Service Indicators*; World Resources Institute: Washington, DC, USA, 2009.
193. UNESCO Geología, Ecosistemas y Biodiversidad. Available online: <https://es.unesco.org/themes/geologia-ecosistemas-y-biodiversidad#:~:text=Losecosistemasylabiodiversidad,ambientales%2Csocialesydedesarrollo> (accessed on 2 January 2022).
194. UNESCO Indigenous Knowledge and Biodiversity. Available online: <https://en.unesco.org/links/biodiversity> (accessed on 5 January 2022).
195. Daily, G.C.; Polasky, S.; Goldstein, J.; Kareiva, P.M.; Mooney, H.A.; Pejchar, L.; Ricketts, T.H.; Salzman, J.; Shallenberger, R. Ecosystem services in decision making: Time to deliver. *Front. Ecol. Environ.* **2009**, *7*, 21–28. [\[CrossRef\]](#)
196. De Groot, R.S.; Wilson, M.A.; Boumans, R.M.J. A typology for the classification, description and valuation of ecosystem functions, goods and services. *Ecol. Econ.* **2002**, *41*, 393–408. [\[CrossRef\]](#)
197. UNESCO. What are Biosphere Reserves? Available online: <https://en.unesco.org/biosphere/about> (accessed on 9 January 2022).
198. Brundtland, G.H. *Informe de la Comisión Mundial Sobre el Medio Ambiente y el Desarrollo: Nuestro futuro común*; NACIONES UNIDAS: Oxfordshire, UK, 1987.
199. Rais, J.; Barakat, A.; Louz, E.; Ait Barka, A. Geological heritage in the M'Goun geopark: A proposal of geo-itineraries around the Bine El Ouidane dam (Central High Atlas, Morocco). *Int. J. Geoheritage Park.* **2021**, *9*, 242–263. [\[CrossRef\]](#)
200. Santangelo, N.; Amato, V.; Ascione, A.; Russo Ermolli, E.; Valente, E. GEOTOURISM as a Tool for Learning: A Geoitinerary in the Cilento, Vallo di Diano and Alburni Geopark (Southern Italy). *Resources* **2020**, *9*, 67. [\[CrossRef\]](#)
201. Filocamo, F.; Roskopf, C.M. The geological heritage for the promotion and enhancement of a territory. A proposal of geological itineraries in the Matese area (Molise, Southern Italy). *Rend. Online Soc. Geol. Ital.* **2019**, *49*, 142–148. [\[CrossRef\]](#)
202. Rapidah, M.S.; Mohamed, K.R.; Ali, C.A.; Leman, M.S.; Saidin, M. A geotouristic itinerary: A proposal for geotourism and archaeotourism development of Lenggong valley, Perak, Malaysia. *Geoj. Tour. Geosites* **2018**, *22*, 597–624. [\[CrossRef\]](#)
203. Solorzano, V.; García, L.; Ramos, M.; Vargas, O. Economic value added (EVA) as an indicator for financial decisions An Application to the Province of Santa Elena, Ecuador. *Ecorfan J.* **2013**, *4*, 1077–1086.
204. Stothert, K.E. Coastal resources and the early Holocene Las Vegas adaptation of Ecuador. In *Trekking the Shore Changing Coastlines and the Antiquity of Coastal Settlement*; Bicho, N.F., Ed.; Springer: New York, NY, USA, 2011; pp. 355–382, ISBN 978-1-4419-8218-6.
205. Padilla Pérez, R.; Oddone, N. *Manual para el Fortalecimiento de la Cadena de Valor*; FIDA, CEPAL: México, México, 2016.
206. Barragán, E.A.; Arias, P.D.; Terrados, J. Fomento del Metabolismo Energético Circular Mediante Generación Eléctrica Proveniente de Rellenos Sanitarios. *Ingenius* **2016**, *16*, 36–42. [\[CrossRef\]](#)
207. Toro, E.R.; Narea, M.S.; Pacheco, J.F.; Contreras, E.; Gálvez, A. *Guía General para la Gestión de Residuos Sólidos Domiciliarios*; CEPAL: Santiago, Chile, 2016.
208. United States Environmental Protection Agency. *Municipal Solid Waste Landfills: New Source Performance Standards (NSPS), Emission Guidelines (EG) and Compliance Times*; EPA: New York, NY, USA, 2014.
209. Carrión-Mero, P.; Morante-Carballo, F.; Briones-Bitar, J.; Herrera-Borja, P.; Chávez-Moncayo, M.; Arévalo-Ochoa, J. Design of a technical-artisanal dike for surface water storage and artificial recharge of the Manglaralto coastal aquifer. Santa Elena parish, Ecuador. *Int. J. Sustain. Dev. Plan.* **2021**, *16*, 515–523. [\[CrossRef\]](#)
210. Cumbe-Vásquez, J.F. Gurumendi-Noriega, M.A. *Evaluación de Prefactibilidad de los Georecursos para el Desarrollo Sostenible en Manglaralto, Santa Elena–Ecuador*; ESPOL Polytechnic University: Guayaquil, Ecuador, 2021.