

SUPPLEMENTARY MATERIALS

Article

Geo-environmental assessment of tourist development and its impact on sustainability.

Supplementary Materials:

Table S1 lists the experts who carried out the environmental evaluation of geosites. In addition, there is a brief description of each evaluator and a web address to their academic profile.

Table S1. Experts involved in the cause-effect geo-environmental assessment matrix.

N.-	Evaluator	Academic profile	Link
1	Paúl Carrión Mero	Paúl Carrión-Mero is Director of the Center for Research and Projects Applied to Earth Sciences (CIPAT) of ESPOL and has more than 120 publications, 8 of them editions and book authorship, as well as more than 30 research projects and around 5 dozen service/consulting projects. He received his PhD in Mining Engineering, specialty in Hydrogeology and Environment from the Polytechnic University of Madrid, Spain. He teaches postgraduate courses in Ecuador, Guatemala, and Honduras. Additionally, he is Principal Professor of ESPOL for more than 23 years.	https://orcid.org/0000-0002-9747-7547
2	Fernando Morante Carballo	Fernando Morante-Carballo is research coordinator of the Center for Research and Projects Applied to Earth Sciences (CIPAT) of ESPOL and professor in the Faculty of Natural Sciences and Mathematics. Has more than 60 publications, 4 of them editions and book authorship, as well as more than 20 research projects and around 2 dozen service/consulting projects. He received his PhD in Geology Engineering, specialty in Mining, Environment and Natural Zeolites from the Polytechnic University of Madrid, Spain. He is Principal Professor of ESPOL for more than 15 years.	https://orcid.org/0000-0003-0374-0306
3	Gricelda Herrera Franco	Gricelda Herrera-Franco is a teacher and research of the Faculty of Engineering Sciences of the Universidad de la Península de Santa Elena (UPSE), she has a doctorate in Geographical Engineering from the Universidad Politécnica de Madrid. She works on natural resources, geoparks and sustainable development projects. It is part of the CYTED International Water Sowing and Harvesting Network.	https://orcid.org/0000-0001-9558-6099
4	Bethy Merchán Sanmartín	Bethy Merchán-Sanmartín is a researcher at the Center for Research and Projects Applied to Earth Sciences (CIPAT – ESPOL). She obtained her degree in civil engineering at ESPOL University and completed her master's degree at the Ecole Nationale du Genie de l'Eau et de l'Environnement de Strasbourg -ENGINES- France, in the field of water and sanitation. She worked in different public and private institutions such as INTERAGUA, MIDUVI, and SENAGUA. Her lines of research are sustainability, circular economy, liquid, and solid waste, wastewater treatment, activated sludge, environment, geotourism, monitoring, management, and	https://orcid.org/0000-0001-5103-0355

		renewable energy. She has been a full-time professor at ESPOL for six years.	
5	Lady Soto Navarrete	Lady Soto – Navarrete, is an M.Sc in Social Sciences with a mention in Socio-environmental studies and belongs to the Marine and Coastal Tourism Research Group at ESPOL University and is completing her doctoral studies in Tourism and Leisure, in the line of research Tourism, local development, and sustainability at the Rovira i Virgili University. Is currently working on issues related to the sustainable development of tourism.	https://orcid.org/0000-0002-4761-4531
6	Fred Taranto Moreira	Fred Taranto-Moreira is an Environmental Management Engineer and junior researcher at the Quevedo State Technical University. He works on issues of conservation and environmental care related to sustainable development and bibliometric research.	https://scipfiles.com/profile/2756293
7	Boris Apolo Masache	Geological Engineer graduated from the ESPOL Polytechnic University. He is a technical assistant and researcher at the ESPOL Water and Sanitation Center (CADS). He has participated in two projects related to water resources and has experience in research in geosciences issues related to geoheritage and bibliometrics.	https://orcid.org/0000-0002-1767-3987

Table S2 shows the evaluation aspects identified in the field by the evaluators. In this table is each aspect with its brief description for a better understanding of the evaluation:

Table S2. Description of the aspects identified in situ.

N.-	Aspects	Description	References
1	Gas emission perception	Gas emissions cause environmental problems such as the alteration of the carbon cycle, through the emissions of carbon dioxide (CO ₂) and methane (CH ₄), in addition to the modification of the nitrogen, phosphorus and sulfur cycle, negatively impacting the land cover modification, climate change and human health.	[115,116]
2	Soil quality perception	Soil is a vital natural resource that performs environmental, economic and social functions. It is directly related to food security, health and economic and social sustainability. The main threats to the soil may be erosion, decreased organic matter content and bio-diversity, pollution, compaction and landslides.	[117,118]
3	Electricity consumption	The increase in the consumption of electrical energy affects the environment, accelerating the emission of greenhouse gases because, in Ecuador, its origin is not entirely renewable.	[119]
4	Bad odours perception	Bad odours affect health and, in the same way, general well-being, due to the discomfort they generate, both inside the place and in external areas.	[118]
5	Noise and vibration perception	Different studies have determined that noise and vibrations are detrimental to cardiovascular function in people exposed to high levels.	[120,121]
6	Generation or presence of wastewater	Wastewater contains many pollutants, such as biochemical oxygen demand and high nitrogen and phosphorus concentrations. Also, numerous varieties of bacteria and viruses are pathogenic to humans.	[122]
7	Fauna	Wildlife is a fundamental component of biodiversity and ecosystems. It constitutes an important factor in its ecological function and cultural significance for human societies, improving	[123,124]

		natural settings, ecotourism activities and disease control with a positive impact on public health.	
8	Flora	The presence of flora in any region of the world is key to the hydrological cycle in aspects such as water storage and release during evapotranspiration, radiation balance and wind dynamics. All of these elements contribute to the climate of a region.	[125]
9	Construction for geosite adjustments	They are strategies aimed at conserving and maintaining an environment, promoting education in Earth Sciences and promoting sustainable economic development at the local level.	[126]
10	Reforestation	It is an important initiative in areas with low vegetation, especially in urban areas. Is a natural tool that helps to improve the daily life of the city through the mitigation of climate change, carbon capture and as potential tourist attractions in geosites.	[127,128]
11	Organic waste generation	The presence of organic waste in certain areas generates bacteria and microorganisms that pollute the soil, water and air, affecting the ecosystem.	[118,129]
12	Inorganic waste generation	The accumulation of inorganic residues produces microbiological contamination, which causes potential risks to public health.	[130]
13	Hazardous waste generation	Hazardous waste can be any substance with hazardous properties such as toxicity, flammability, reactivity, and corrosivity. Therefore, it is causing a risk to humans and the environment.	[131]
14	Loss of vegetation cover	It affects the productivity of ecosystems through loss of habitat, biomass and carbon storage, increasing the temperature of the earth's surface and global warming.	[132,133]
15	Industrial activity	Due to intense energy consumption, industrial activities are the main contributor to greenhouse gas emissions.	[134]
16	Commercial activities	Commercial activities are successful public spaces for the city, increasing tourism and economic investment, contributing to citizens' health and quality of life.	[135]
17	Employment generation	The generation of employment in tourist sites can be beneficial due to its economic development and sustainability in the site, city or region.	[136]
18	Service generation	Promotes marketing to generate economic benefits through its enhancement as a tourist attraction. It encourages visitors to conserve and preserve these areas and similar urban or rural spaces.	[137]
19	Visual or landscape aspect	The landscape is a visual factor that is important in assessing and conditioning the basic infrastructures for the enjoyment of the destinations, establishing tourist routes to allow the contemplation of the environment from a strategic point of view.	[138]
20	Social recreation	It implies an exclusive and small number of activities that must be carried out for the good use of free time, presented in a pleasant and fun way, stimulating the visit of tourists.	[139]
21	Tourist capacity	It determines the optimal number of people for the use of the resource or service, maintaining the equilibrium condition of the natural system, without any changes in its initial characteristics.	[140]
22	Tourist safety	The importance of the experience, dedication and capacity of the staff provide security that helps tourists to make connections with the environment through tourism.	[141]

23	Symbol or figure cultural	They are tangible or intangible tourist attractions or tourist resources that motivate the temporary displacement of travelers. They can be archaeological sites, pre-Hispanic art, colonial art and traditions.	[142]
24	Presence of vehicles (transport or machinery)	The presence of vehicles has become a major source of air pollution in the world. Vehicles are the main contributors emitting more than 90% of NO _x and particulate matter, as well as 80% of carbohydrates.	[143]

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