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TOURISM AND SUSTAINABILITY: ASSESSING ENVIRONMENTAL IMPACTS IN A RESORT IN SANTANDER, COLOMBIA

Nelson Andrey Navas Gallo¹, Carlos Alberto Amaya Corredor, Natalia Alexandra Bohorquez Toledo^{1*}, Nataly Celis Esteban¹, Jhon Erick Zambrano Tarazona¹, Macarena Esteban-Ibáñez², Eli Rafael Perez Ruiz³

¹Unidades Tecnológicas de Santander Colombia, Faculty of Natural Sciences and Engineering

²Universidad Pablo Olavide Sevilla España, Department of Education and Social Psychology

³Universidad Autónoma de Ciudad de Juárez México, Department of Environmental Engineering

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Corresponding Author: Natalia Alexandra Bohorquez Toledo

ABSTRACT

Tourism is an economic activity that presents development opportunities but also causes significant negative environmental impacts on regional ecosystems. This research aimed to evaluate the environmental consequences of tourist activities at a recreational spa-type site. The study established the environmental baseline by using secondary information, characterizing the water source, calculating quality indices, and analyzing community perceptions. It was determined that water was the most impacted environmental resource due to activities like tourist transportation, camping, and bonfires. Water quality analysis in the study area revealed high turbidity from suspended solids and the notable presence of coliform bacteria. The Water Quality Risk Index (WQRIH) indicated that the water did not meet human consumption standards set by current regulations. Additionally, the ratio between Biochemical Oxygen Demand (BOD5) and Chemical Oxygen Demand (COD) suggested that the water had low biodegradability. Tourism-related activities showed the greatest interaction with the natural environment and were identified as the primary drivers of environmental impacts. This study highlights the need for better management strategies to mitigate the negative effects of tourism on the ecosystem, particularly water quality.

KEYWORDS: Anthropic activity, Environmental education, Water resources, Sustainable tourism.

1. INTRODUCTION

Tourism is one of the most dynamic and rapidly growing industries worldwide, generating significant economic benefits and contributing 10% to global Gross Domestic Product (GDP) and generating approximately 319 million jobs in 2018, representing 10% of total jobs internationally [1]. However, increasing pressure on natural resources and biodiversity due to the expansion of tourism activities has led to a more critical approach to the associated environmental impacts [2]; Several studies indicate that tourist activities can cause alterations in ecosystems, affecting both flora and fauna, and contributing to the degradation of natural landscapes [3].

At the national level, Colombia has seen an increase in tourism activity, with a 24% growth in domestic tourism in 2023, compared to 2022, according to the Ministry of Commerce, Industry and Tourism; this growth highlights the importance of the country as an attractive destination, not only for its cultural and natural diversity, but also for the growing demand for tourist experiences [4]. However, this boom poses serious challenges in terms of sustainability, especially in the management of water resources, where it is estimated that 57.7% of water sources in Colombia do not present significant risks, while 22.4% represent a medium risk and 30% face critical quality problems [5].

In the municipality in question, recreational spa tourism has gained a prominent role [6]; However, this place, known for its impressive natural beauty and tourism potential, faces significant challenges in terms of environmental management, coupled with the increasing arrival of tourists that exerts considerable pressure on local ecosystems, altering the natural balance and harming the quality of life of communities [7]. This research presents the evaluation of environmental impacts derived from the tourist activity in the recreational spa site of the Rancho Grande area, Santander; through the Conesa method [8], This study identifies changes in the ecosystem based on the biotic, abiotic and socioeconomic conditions of the area. In addition, the water source of the Cascajales River, linked to the resort, is characterized by measuring physicochemical and microbiological parameters. This information is essential for establishing the Water Quality Risk Index for Human Consumption (WQRIH) and the respective Biodegradability Index.

2. METODOLOGY

In the present research, a descriptive and exploratory method was addressed for the

structuring of fundamental aspects of sets of phenomena or populations, as mentioned by [9]. The evaluation of the impacts attributed to anthropic activities, considered the use of primary sources of information, obtained during field visits and the application of the perception survey; and secondary sources from official sources such as government entities and educational institutions. The area of influence corresponded to the Rancho Grande village, municipality of El Carmen del Chucurí in the Department of Santander [6].

2.1. Characterization of the water source

The in situ flow data of the Cascajales River are shown in Table 1. Additionally, the cross-sectional area of analysis is reflected in Figure 1.

Table 1. Field flow measurement data and monitored parameters.

FLOW MEASUREMENT				
	East	North	Flow (m ³ /s)	Method used
Point	4939895,5	2300420,8	1,44	Float
MONITORED PARAMETERS				
Evaluated parameter	Method			Units
pH	SM 4500 H+ B			pH units
Dissolved Oxygen	ASTM D888-18, Method C			mg/L
BOD ₅	SM 5210 B			mg O ₂ /L
COD	SM 5220 C			mg O ₂ /L
Total Dissolved Solids	SM 2540 C			mg/L
Turbidity	SM 2130 B			NTU
Reactive Phosphorus	SM 4500 P E			mg P - PO ₄ /L
Nitrates	J.Roeder adsorption spectrometry			mg P - NO ₃ /L

Figure 1. Study area



2.2. Environmental assessment

The activities likely to generate environmental impact, ASPI, identified were:

- Cocoa crops
- Restaurant operations
- Camping activities

Picnic activities
Hiking
Bonfires
Tourist transportation
Infrastructure adaptation
Recreational fishing
Commercial activities
Bovine production
Poultry production
Fish farming

The category of environmental impacts taken into account is presented in Table 2.

Table 2. Category of environmental impacts.

Value	Calification	Meaning	Nomenclature
$0 \leq 25$	Low	The impact is considered to be of low magnitude.	
$26 \leq 50$	Moderate	The occurrence of the impact does not cause serious damage to the environment. There are no protective measures.	
$51 \leq 75$	Severe	The impact requires the recovery of the previous environmental conditions so that it does not become irreversible.	
$+75$	Critical	The impact is considered irreversible. There is no possibility of recovering the factors that have been damaged.	
When a positive rating is given, it is considered a zero impact.			

3. RESULTS AND DISCUSSION

From the analyses carried out by the laboratory, the water quality values presented in Table 3 were obtained:

Table 3. Parameters regarding Resolution 2115 of 2007.

Parameter	Units	Value	Standard	Compliance
pH	pH units	8,44	6,5 – 9,0	Compliant
Turbidity	NTU	9,60	2	Not Compliant
Reactive Phosphorus	mg P – PO ₄ /L	<0,03	0,5	Compliant
Nitrates	mg P – NO ₃ N/L	<0,10	10	Compliant
Total coliforms	NMP / 100 mL	1100	Ausencia	Not Compliant

Each of the parameters met the maximum permissible values except for the parameter of turbidity and total coliforms. A turbidity value of 9.6 NTU was recorded, exceeding the maximum permitted limit of 2 NTU according to Resolution 2115 of 2007; this indicates that the turbidity is high, which affects ecosystem functions and water quality. In addition, coliforms were found in the water

source, making it undrinkable for humans as it can cause stomach problems, vomiting and illness [10]. Although there is no specific value to compare, Resolution 2115 of 2007 mentions that there must be a total absence of this and a value of 1100 NMP / 100 mL was obtained [5].

4. CALCULATION OF WQRI AND BIODEGRADABILITY INDEX

For the calculation of the WQRI, the risk scores for each of the parameters evaluated were taken into account and were established in accordance with current legal regulations [10], The numerical value was subsequently obtained from what is presented in Table 4.

Table 4. Risk indices by parameter contemplated in the WQRI.

Evaluated parameter	Value	Regulations	WQRI Score
pH	8,44	6,5 – 9,0	1,5
Turbidity	9,60	2	15
Reactive Phosphorus	<0,03	0,5	1
Nitrates	<0,10	10	1
Total coliforms	1100	Absence	15
SUMMARY 33,5			

Applying the WQRI calculation formula, a value of 89.55 was obtained, classifying the water as “unviable from a sanitary point of view”, that is, it is not suitable for human consumption due to high levels of contamination. In accordance with Resolution 2115 of 2007, it is important that various competent authorities, such as the Ministry of Health, the Ministry of Environment and local surveillance and control entities, implement actions and representatives that mitigate this problem and protect public health [10].

Regarding the biodegradability index, the BOD5 and COD parameters were compared, from which a value of 0.12 was obtained. It was determined that the water had very low biodegradability, which means that the contaminants it contains are not degraded quickly or effectively by microorganisms. This occurs mainly because the BOD is much lower than the COD, which causes resistance to biodegradability [11].

4.1. Environmental assessment

The Environmental Factors with Susceptibility to Environmental Impacts were related to the ASPI according to the Arboleda methodology (2008) and are presented in Table 5.

Table 5. Characterization of environmental factors.

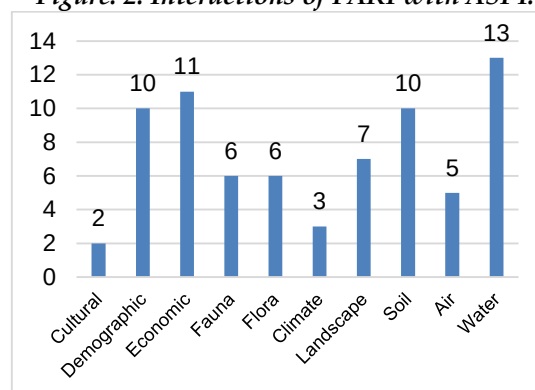
ASPI	Abiotic			Biotic			Socioeconomic		
	A	B	S	F	Fl	C	E	S	C
Cocoa crops	X		X	X		X	X	X	
Restaurant operations	X			X			X	X	
Camping activities	X		X	X		X	X	X	
Picnic activities	X		X				X	X	
Hiking	X		X			X	X	X	X
Bonfires	X	X	X		X	X	X		X
Tourist transportation	X	X	X		X			X	X
Infrastructure adaptation	X		X	X		X	X	X	X
Recreational fishing	X			X			X	X	
Trade activities	X						X	X	
Bovine production	X	X	X	X		X	X	X	
Poultry production	X	X	X	X				X	X
Fish farming	X			X				X	X
TOTAL									

The activities that had the most interactions with the above factors were cocoa cultivation and tourism. Within tourism, activities such as camping, hiking, bonfires and the transport of tourists were included. The owners or developers of tourism were also responsible for preparing the necessary infrastructure. All these activities were grouped under the same economic base of tourism and were carried out extensively in the area, which generated pressure on the ecosystem.

In the second stage, a traditional economy was observed based on large-scale cocoa cultivation and

the use of land for raising animals, such as cattle, poultry and fish production. These practices use conventional methods, such as pesticides, fungicides and artificial fertilizers and intensive grazing systems that cause changes in the use of land and other natural resources [13].

The interactions disaggregated by environmental factor are shown in Figure. 2.

Figure. 2. Interactions of FARI with ASPI.

4.2. Quantifying the magnitude of the identified impacts

Table 6 presents the evaluation of each of the impacts and their rating with respect to the Simplified Conesa method.

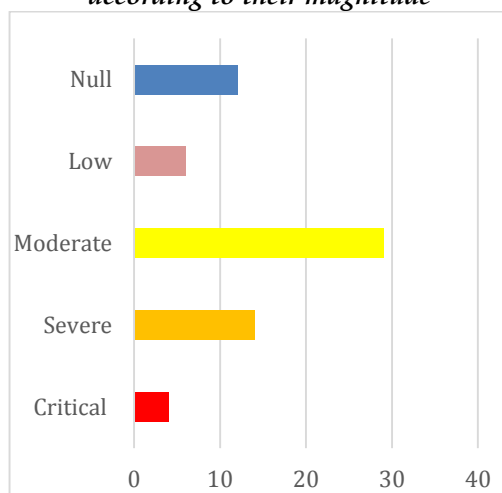
Table 6. Quantifying environmental impacts.

Impactos	CONESA METHODOLOGY												
	C	IN	EX	MO	PE	RV	SI	AC	EF	PR	RC	CA	I
Impact on the physicochemical characteristics of the soil	-	4	2	4	4	2	2	4	4	4	4	44	Moderate
Impact on the characteristics of the soil itself	-	8	2	4	4	2	2	4	4	4	4	56	Severe
Impact on water quality	-	8	4	8	2	2	4	4	4	4	4	64	Severe
Impact on air quality	-	2	2	4	2	2	2	4	4	4	2	34	Moderate
Impact on soil layers	-	4	2	4	4	2	2	4	4	4	4	44	Moderate
Impact on leachates in water bodies	-	8	8	8	2	4	4	4	4	4	4	74	Severe
Visual impact	-	2	2	2	2	2	1	4	4	4	2	31	Moderate
Alteration of vegetation cover	-	2	2	2	2	2	2	4	4	4	2	32	Moderate
Alteration of fauna communities	-	2	4	2	2	2	2	4	1	2	4	33	Moderate
Alteration of the behaviour patterns of fauna	-	2	4	2	2	2	2	4	4	2	4	36	Moderate
Alteration of natural processes	-	2	4	2	2	2	4	4	4	4	2	38	Moderate
Changes in the physicochemical properties of water	-	8	8	8	2	2	4	4	4	4	4	72	Severe
Increased concentrations of chemicals in the soil	-	8	2	4	4	2	2	4	4	4	4	56	Severe
Increased vector-borne diseases	-	4	4	2	2	2	2	4	4	2	4	42	Moderate
Increased soil compaction	-	8	2	4	4	2	2	4	4	4	4	56	Severe
Increased concentration of adverse substances	-	8	2	4	4	2	2	4	4	4	4	56	Severe
Increased concentration of greenhouse gases	-	2	4	2	4	4	2	4	1	4	4	39	Moderate
Increased erosion processes	-	8	2	4	4	2	4	4	4	4	8	62	Severe
Increased eutrophication processes	-	2	2	2	2	2	2	4	4	4	2	32	Moderate
Increased solid waste present in the soil	-	4	2	8	4	2	2	4	4	4	4	48	Moderate
Increased sediments in the water	-	4	4	8	2	2	2	4	4	4	4	50	Severe
Change in the structure of the landscape	-	2	4	2	2	2	4	4	4	4	2	38	Moderate
Change in local temperature	-	2	2	2	4	4	2	4	4	4	4	38	Moderate
Change in food chains	-	2	8	4	4	2	4	4	4	4	4	52	Severe
Change in the microclimate	-	4	2	2	4	4	4	4	4	4	4	46	Moderate
Change in architectural aesthetics	-	4	2	2	2	2	2	4	1	2	4	35	Moderate
Change in landscape structure	-	4	2	1	2	2	2	4	1	2	4	34	Moderate
Change in microbiological characteristics of water	-	12	8	8	4	2	4	4	4	4	4	86	Critical

Changes in chemical characteristics of water	-	8	8	8	4	2	4	4	4	4	4	74	Severe
Water pollution	-	8	12	8	4	2	4	4	4	4	4	82	Critical
Air pollution	-	4	2	4	4	4	2	4	4	4	4	46	Moderate
Soil pollution	-	4	2	2	2	4	2	4	4	4	4	42	Moderate
Displacement of native species	-	2	4	4	4	2	4	4	4	4	4	44	Moderate
Displacement of fauna species	-	2	4	4	4	2	4	4	4	4	4	44	Moderate
Deterioration of natural heritage	-	2	8	4	4	2	4	4	4	4	4	52	Severe
Deterioration in health	-	2	2	2	4	2	2	4	4	4	4	36	Moderate
Decrease in plant biomass	-	2	4	4	4	2	4	4	4	4	4	44	Moderate
Decrease in water supply for human consumption	-	8	12	8	4	2	4	4	4	4	4	82	Critical
Generation of particulate matter	-	4	2	4	4	4	2	4	4	4	4	46	Moderate
Generation of offensive odors	-	4	2	4	4	4	2	4	4	4	4	46	Moderate
Increase in deforested areas	-	2	4	4	4	2	4	4	4	4	4	44	Moderate
Increase in the occurrence of fires	-	4	8	2	4	2	4	4	4	4	4	56	Severe
Loss of flora species	-	2	1	1	2	1	2	1	1	1	2	19	Low
Loss of biodiversity	-	2	2	1	4	1	2	1	1	1	2	23	Low
Loss of water quality	-	8	8	8	4	4	4	4	4	4	4	76	Critical
Loss of soil quality	-	4	2	2	2	2	2	4	4	4	4	40	Moderate
Loss of soil fertility	-	4	2	2	2	2	2	4	4	4	4	40	Moderate
Loss of the natural vocation of the resource	-	8	2	4	4	4	2	4	4	4	4	58	Severe
Loss of landscape	-	2	2	1	4	1	2	1	1	1	2	23	Low
Reduction of productive capacity	-	4	2	2	2	2	2	4	4	4	4	40	Moderate
Risk of accidents	-	2	1	8	1	1	1	1	1	1	2	24	Low
Occupational risk due to diseases	-	2	1	8	1	1	1	1	1	1	2	24	Low
Vulnerability	-	4	1	1	1	1	1	1	1	1	2	23	Low
Increased economic income	+											0	Null
Increased local economic stimulus	+											0	Null
Increased local cultural pride	+											0	Null
Increased social fabric	+											0	Null
Increased quality of life	+											0	Null
Change in the perception of nature	+											0	Null
Change in employment dynamics	+											0	Null
Strengthening tourism	+											0	Null
Job creation	+											0	Null
Increase in local tourism	+											0	Null
Revaluation of natural spaces	+											0	Null
Revaluation of natural appreciation	+											0	Null

Specifically, 4 impacts were found in the critical category, 14 in severe, 29 in moderate, 6 in low and 12 in null; giving a visualization of the present impact in the study area as a result of the activities and categorized impacts. This can be seen in Figure 3.

Figure 3. Classification of environmental impacts according to their magnitude



The most affected resource was water, as it showed the highest levels of impact, with many of these classified as critical or severe. This means that water has the highest degree of degradation due to its constant deterioration. Traditional practices or unregulated tourism continually expose the ecosystem, which has led to the results of the environmental assessment. Impacts classified as severe indicate a state of alert regarding the damage caused [7].

Moderate impacts may require management and mitigation measures, but do not pose a risk to the viability of the ecosystem or public health if they are controlled in advance [8]. Low category impacts, although they do not cause immediate damage to the ecosystem, are important to take into account when planning strategies to manage the different resources within the latter; impacts on the demographic factor and also on flora, fauna and landscape resources were included. Finally, null impacts were those that had the capacity to provide a service focused on

improving the quality of life of the population or the ecosystem [14].

5. CONCLUSIONS

In conclusion, the municipality of El Carmen del Chucurí is characterized by its remarkable environmental diversity, which gives it great potential for sustainable development. Thus, the municipality has the capacity to integrate economic development with environmental protection, consolidating itself as a model of sustainability in the Santander region.

Analysis of water quality in the study area revealed high levels of turbidity, attributable to

suspended solids, and the significant presence of coliforms, which indicated possible fecal contamination, according to Santisteban (2017) [15]; According to these data, the water was classified as unfit for human consumption by the IRCA. In addition, the data obtained suggested that the water had a low biodegradability index.

Activities related to tourism had the highest number of interactions with the natural environment, being the main generators of impacts. These activities have directly affected the Cascajales River and the adjacent sector of Rancho Grande. It was concluded that these recreational activities, when not managed sustainably, have generated harmful effects on the natural environment and its water resources.

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