

Environmental Impact Assessment of Tourism in Mompox, Colombia: Promoting Sustainable Tourism within the Framework of the SDGs

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Tourism in the municipality of Mompox-Bolívar is one of the most recognized activities, it occurs in high seasons, such as Easter and during the jazz festival, but it also attracts hundreds of visitors for its striking architecture of colonial houses, its renowned filigree and the tours organized along the Magdalena River. Mompox is known as well as for each of its streets which have been trapped in time and are full of stories and culture. This municipality declared as historical and cultural heritage receives hundreds of tourists every year, the considerable number of visitors is on the increase and is evident, but the absence of a notable sustainable and environmentally friendly tourism generates a big problem, due to the high number of disturbances that are generated in the different components such as; social, biotic and abiotic. This disturbance is essentially caused by the presence of liquid and solid waste. For this project, a descriptive methodology was applied, with descriptive, qualitative and quantitative study approaches, where an environmental baseline was used, followed by an identification and evaluation of impacts, as well as the implementation of sustainable strategies to give a more sustainable management to the various tourist activities, also seeking compliance with the SDGs (Sustainable Development Goals) such as: clean water and sanitation, life of terrestrial ecosystems and responsible production and consumption in order to have a stable and responsible harmony between the environment and the municipality of Mompox Colombia.

1. Introduction

Colombia is a country with great tourist and commercial potential. This is due to its geography, followed by its wonderful biodiversity, its dazzling landscapes and excellent hospitality, this great South American country has transformed itself into one of the most chosen destinations, where its ecotourism is developed by the Ministry of Environment and Sustainable Development and the Ministry of Commerce (Zapata, 2022).

According to the Office of Economic Studies of the Ministry of Commerce, Industry and Tourism, a study on tourism is presented by identifying that this is one of the sectors that boosts the Colombian economy, highlighting the fact that Colombia received 5,869,869 visitors by the end of 2023. Taking into account that it exceeded the goal which had been stipulated and projected by the Government. The change had been stipulated within the 2022-2026 Sectoral Tourism Plan "Tourism in Harmony with Life", to be of 5.2 million non-resident visitors (Prada, 2021).

There is currently a great abundance of studies about tourism, its benefits and economic and social contribution. But there is also information on the type of environmental consequences that arise from tourism. Starting with the generation of negative impacts such as the alteration of landscapes, the high level of production of solid and liquid waste such as wastewater, the increase in water and energy consumption, the degradation and deterioration of the soil. In Colombia there is the sustainable practice of tourism, but at a local level it is not so relevant. The absence of responsible and sustainable tourism, which is derived from providing and imparting environmental education to visitors in order to protect all components, both biotic and abiotic, can generate negative effects on the environmental aspect in each area where there is a significant presence of tourists who lack information on the importance of having a good environmental education and disposition (Sánchez, 2017).

Mompox, a municipality in the department of Bolívar, surrounded by one of the branches of the Magdalena River located in the north of Colombia, 5 hours away from Cartagena de Indias, is a destination that has a significant historical, natural and cultural wealth, in addition to having an impressive architectural and unique cultural beauty. There is no doubt that it is a must-see place for visitors who wish to know and explore this historic district and cultural heritage, with wide biodiversity and impressive landscapes of Colombia (Buitrago, 2019).

This work provides a significant contribution since it precisely compiles information about the current state of the flora and fauna present in the area, as well as the circumstances of the water source where domestic wastewater from the urban area of the municipality of Mompox is discharged, as well as the impacts caused by various tourism activities (Victoria, 2022).

2. Methodology

The environmental baseline was carried out through bibliographic information from primary, secondary and tertiary sources (Romero, 2019), to provide accurate data on the current state and situation of the municipality of Mompox, focused mainly on the biotic, abiotic and socioeconomic components. The understanding and diagnosis of the various variables allows generating a vision of the environmental consequences and an acceptable estimate of these (Trespacios, 2021).

Through an investigation through questionnaires related to environmental education and the problems related to the generation of impacts due to the presence of visitors to the municipality, both the resident population and tourists. In order to understand how informed they are regarding the applied topics. People between 18 years old and 70 years old were investigated. The sample size is 256 people with a confidence level of 95% and a margin of error of 8%. The percentage of women surveyed is 43.9%, while the percentage of men surveyed is 55.7%. Monitoring was carried out in the discharge to know the concentrations of the wastewater through the measurement of the parameters: COD, BOD, Suspended Solids, Sedimentable Solids, pH, Oils and Greases. The results were compared with Colombian regulations (Minambiente, 2015).

Taking as reference the main activities in the municipality of Mompox, the environmental impact evaluation matrix was developed using the Conesa method for the assessment of impacts, which were compared with table 1. The Conesa method relates the activities to the components. To determine the value of the evaluation, numerical values were assigned to: nature (NA), intensity (IN), moment (MO), reversibility (RV), synergy (SI) accumulation (AC), effect (EF), probability (PR), recoverability (R), extension (EX), persistence (PE) and importance (I). Each tourist activity was evaluated with each of the environmental components to identify the impacts, which were called interactions. In this way, it was possible to identify the number of alterations associated with each tourist activity developed in the municipality of Mompox.

Table 1. Impact identification range

Category	Identification
Compatible	Less than 25
Moderate	Between 25 and 50
Severe	Between 50 and 75
Critical	Over 75
Null	Zero Impacts

(Minvivienda, 2007).

3. Results and Discussion

3.1 Social Media

A questionnaire surveyed tourists and residents about the importance of more sustainable tourism activities in Mompox-Bolívar. It reflects a strong consensus in favor of promoting sustainable tourism activities in Mompox, with 54.47% of respondents expressing their full agreement, especially in the 25-40 age group with 27.20%. The higher standard deviation in this group (11.01%) suggests a greater variability of opinions, which could indicate a greater ecological awareness or a perception of the urgency to act to protect the environment in this age group.

An additional 36.4% agree, with significant representation across all age ranges, but led by those aged 25-40 (17.24%). This suggests that there is a general recognition of the importance of reducing the environmental impact of tourism. The lowest standard deviation in the 40-70 age group (3.45%) indicates more agreement among them on the need to promote sustainable tourism activities, reflecting a more homogeneous stance compared to the other age groups.

Only a small percentage disagree (3.07%) or strongly disagree (3.07%), with the lowest representation in the 18-25 age group for both categories, which could reflect a trend towards a more proactive stance on environmental conservation among younger people.

3.2 Characterization

The flow measurement activity in the discharge was carried out through composite sampling, which consisted of taking the sample for 12 hours. (Ideam, 2021). The flow was captured punctually; the value of the flow is reflected in Table 2.

Table 2. Field data of the discharge flow.

Sampling point	Method	Flow rate (L/s)
Dumping	Volumetric	1,26

3.2.1 Comparison of parameters obtained from dumping with Resolution 0631 of 2015

The following table presents is the analysis of the monitoring carried out on the main discharge point of domestic wastewater in Mompox, which was carried out during a period of high tourist influx; showing the values obtained by the analysis of the residual sample and its comparison with the Colombian regulations in Table 3 with its indication of whether it complies or does not comply with the permissible standards.

Table 3. Comparison between the pouring point and Resolution.

Parameters	Dumping	Units	Resolution 0631 of 2015	Complies
Settleable solids	ml/L	0,1	5	yes
Total suspended solids	mg/L	40,5	90,0	yes
BOD ₅	mg/LO ₂	123	90,0	No
COD	mg/LO ₂	211	180,0	No
Fats and oils	mg/L	24	20,0	No
Total coliforms	UFC/100 ml	92000000		N/A

The parameters analyzed were: Total solids, Settleable solids, fats and oils, BOD₅, COD, and Total coliforms. These were compared with Resolution 0631 of 2015. The parameters that did not comply with this regulation were BOD₅, COD, fats and oils, exceeding the permissible limits established by the Resolution as evidenced in table 3. The other parameters are within the ranges permissible by the regulations.

It is important to highlight that Mompox ranked first in Colombia's Regional Tourism Competitiveness Index in 2024. This study was carried out during a tourist season, allowing the performance of the domestic wastewater discharge system to be evaluated under conditions of high visitor influx. Considering that all Colombian municipalities with sewerage systems must comply with the maximum permissible limits, the results obtained are relevant to verify regulatory compliance in this context. However, due to resource limitations, monitoring was carried out exclusively during this time.

3.3 Identification and evaluation of environmental impacts

Through diagnoses carried out on the activities and work carried out in the municipality. The activities carried out in the Mompox District by tourists that generated impacts in the study area were evaluated and identified, which are: Operation of hotels, operation of restaurants, cheese production, production of corn chicha, candy production, filigree making, wine production, walking tours, visit to monuments, navigation along the Magdalena River, Autorickshaw tour activity.

Cheese production and road construction are the activities with the most interaction in biotic, abiotic and social factors, presenting significant alterations in the study area (Marquez, 2018). Activities such as walking tours and visits to monuments are those that present the least alterations, and those that present the greatest interactions are: the operation of hotels, restaurants and boat tours on the Magdalena River, as shown in Figure 1.

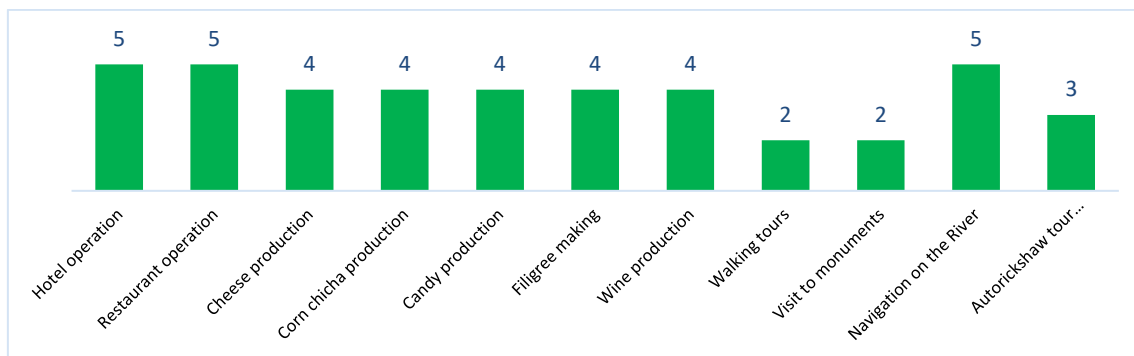


Figure 1. Interactions between activities and environmental factors

After identifying the environmental changes resulting from the aforementioned tourism activities, the environmental impact assessment was carried out using the Simplified Conesa method (Carvajal, 2021). Each impact was rated using numerical scales, which allowed calculating its magnitude and assigning a score to each of them, as shown in Table 4.

Table 4. Evaluation of environmental impacts.

NAT	IN	EX	MO	PE	RV	SI	AC	EF	PR	MC	IMP	IMPACT	
N	8,00	4,00	4,00	2,00	2,00	1,00	1,00	4,00	2,00	2,00	50,00	Severe	Changes in water dynamics
N	12,00	8,00	4,00	4,00	4,00	4,00	4,00	4,00	4,00	4,00	84,00	Critical	Changes in water quality
N	4,00	4,00	4,00	4,00	2,00	4,00	4,00	4,00	2,00	2,00	46,00	Moderate	Depletion of Water Resources
N	2,00	1,00	2,00	1,00	1,00	2,00	1,00	4,00	2,00	2,00	23,00	Low	Generation of offensive odors
N	4,00	4,00	2,00	2,00	2,00	2,00	4,00	4,00	4,00	4,00	44,00	Moderate	Generation of particulate matter
N	8,00	2,00	2,00	2,00	2,00	4,00	4,00	4,00	2,00	4,00	52,00	Severe	Increase of solid waste in water
N	2,00	4,00	4,00	4,00	4,00	4,00	4,00	4,00	4,00	4,00	46,00	Moderate	Decrease in air quality
N	12,00	8,00	4,00	2,00	2,00	4,00	4,00	4,00	4,00	4,00	80,00	Critical	Solid waste generation
N	8,00	4,00	4,00	4,00	4,00	2,00	4,00	4,00	4,00	4,00	62,00	Severe	Soil pollution
N	2,00	2,00	2,00	2,00	2,00	2,00	1,00	1,00	2,00	2,00	24,00	Low	Loss of flora
N	1,00	2,00	1,00	2,00	2,00	2,00	1,00	4,00	1,00	4,00	24,00	Low	Biodiversity loss
N	1,00	2,00	1,00	1,00	2,00	2,00	4,00	4,00	1,00	4,00	26,00	Moderate	Wildlife displacement
N	4,00	4,00	4,00	4,00	4,00	2,00	4,00	4,00	4,00	4,00	50,00	Severe	Increased eutrophication
N	4,00	4,00	2,00	2,00	2,00	2,00	4,00	4,00	4,00	4,00	44,00	Moderate	Alteration in soil properties
N	4,00	4,00	2,00	2,00	2,00	2,00	4,00	4,00	4,00	4,00	44,00	Moderate	Soil erosion
N	4,00	4,00	2,00	4,00	4,00	2,00	4,00	4,00	4,00	4,00	48,00	Moderate	Emission of volatile organic compounds
N	12,00	4,00	4,00	4,00	4,00	4,00	4,00	4,00	4,00	8,00	80,00	Critical	Modification of water properties
N	2,00	2,00	2,00	2,00	2,00	2,00	1,00	1,00	2,00	2,00	24,00	Low	Formation of suspended particles
N	2,00	4,00	2,00	4,00	4,00	2,00	4,00	4,00	2,00	4,00	40,00	Moderate	Discomfort to the community
N	4,00	4,00	2,00	2,00	2,00	2,00	4,00	4,00	4,00	4,00	44,00	Moderate	Decrease in soil quality
N	1,00	1,00	1,00	1,00	1,00	1,00	1,00	4,00	4,00	4,00	22,00	Low	Increase in respiratory diseases
N	8,00	4,00	2,00	2,00	2,00	2,00	4,00	4,00	4,00	4,00	56,00	Severe	Soil compaction
N	4,00	4,00	4,00	2,00	2,00	4,00	4,00	4,00	2,00	4,00	46,00	Moderate	Decrease in landscape quality
N	4,00	4,00	4,00	4,00	2,00	4,00	4,00	4,00	4,00	4,00	50,00	Severe	Sedimentation in water
N	12,00	8,00	4,00	4,00	2,00	4,00	4,00	4,00	4,00	4,00	82,00	Critical	Increase in wastewater

Next, the type of interaction by impact is shown in Figure 2, with moderate, severe and critical impacts being the most representative.

Considering the importance of each impact, that is, its value, it is identified or highlighted whether it is null or positive, moderate, severe or critical. Pollution by solid waste and alteration to the water body are the most significant impacts within the study area and are related in that they originate mainly from tourist activities.

The waste that is discarded or thrown causes the deterioration of the soil and the poor sustainable consumption of water in hotels and restaurants, as well as in the residences in the urban area of the municipality, they are in favour of altering the water source by being discharged by dumping, thus affecting aquatic life. The presence of waste on the streets of the municipality after the influx of tourists, according to the Bioger cleaning company, is equal to 150 tons.

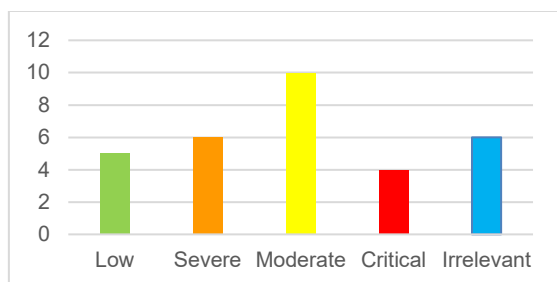


Figure 2. Classification of impacts

Regarding impact-generating activities, the modification of water properties and the increase in wastewater, with values of 80 and 82 respectively, are those that contribute the most to the critical category. These activities require special attention due to their potential to significantly alter aquatic ecosystems and the availability of water for human and agricultural use. The generation of solid waste and soil contamination, with values of 80 and 62, are the main contributors to severe impacts. These effects can lead to soil degradation and affect public health through contamination of crops and water sources.

Moderate impacts include soil compaction and sedimentation in water, with values of 56 and 50. These impacts, although not as severe as critical or severe, still require management to avoid long-term negative effects on soil structure. and bodies of water. Low impacts, such as the generation of offensive odours and an increase in respiratory illnesses, with values of 23 and 22, may not be as immediately destructive, but their constant presence can decrease the quality of life and well-being of the community.

4. Conclusions

The field study with inhabitants and visitors determines that the population that is most committed towards a sustainable environment are men between 28 and 35 years old because their knowledge is coming from the environmental education received by their children in schools. It should be noted that this study was carried out through the entire resident population and visitors. The use of the Statistical Package for the Social Sciences (SPSS) software stands out as a fundamental tool for the analysis of the collected data obtained in the aforementioned field study with the inhabitants through questionnaires. Using SPSS, the measures of dispersion and reliability of the results were calculated, which made it possible to measure the internal consistency of the responses.

The main environmental impacts are the improper consumption of water in hotels, restaurants and residential areas, as well as pollution from solid waste. This is due to the various activities carried out by visitors and their lack of knowledge and environmental education. Through the evaluation of environmental impacts, it is concluded that the most affected component is the soil resource due to various tourist activities that result in the generation of plastic waste and the deterioration of the soil due to the agglomeration of plastic in different areas of the municipality.

The study carried out on the water source with respect to the parameters established by Resolution 0631, for its physicochemical analysis of the parameters of BOD5, COD, fats and oils, in the discharge located in the sector called "Y" of the urban area of the municipality of Mompox, show a high degree of concentration, by not complying with the permissible limits established by the regulations. Demonstrating that it can have considerable consequences for the health of aquatic life, as well as water quality. This is consistent with the study carried out by (Jaimes, 2021), which highlights the importance of proper and adequate treatment before discharge into the

water source to avoid alterations or changes in the main water resource, air and health quality in the municipality where the study is carried out. The pollution of the most important river in Colombia has reduced fishing by 62%. Through the same study, it is shown that the tourist activities that most affect the environment of the municipality are mobile quad tours, boat rides along the Magdalena River, guided tours through the historic centers of the district, tasting of typical local food and crowding at high-profile events.

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