

Coastal erosion and tourism: Perceptions and impacts in an iconic Chilean destination

Erosión costera y turismo: Percepciones e impactos en un destino icónico de Chile

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ABSTRACT

Coastal erosion poses an increasing threat to the sustainability of tourism in vulnerable destinations. This study analyzes the perceptions of tourists and tourism enterprises regarding the impacts of this phenomenon in La Serena, Chile, a flagship destination along the Pacific coast. A mixed-methods approach with concurrent triangulation was employed, combining surveys with 176 tourists and 22 tourism businesses, complemented by semi-structured interviews with experts. Quantitative analysis (χ^2 , Cramer's V, Mann-Whitney, and Kruskal-Wallis tests) revealed low levels of erosion knowledge among visitors (65.4% with limited or no understanding). However, residents of the Coquimbo Region exhibited significantly higher knowledge levels compared to non-residents ($H(1) = 4.23$, $p = 0.040$), with a small but detectable effect size ($r = 0.18$). Erosion was perceived as a critical issue, with statistically significant differences between groups ($U = 2741$, $p = 0.001$; $r = 0.42$): tourism businesses expressed greater concern, highlighting that total sand loss could compromise infrastructure and economic viability. Qualitative analysis identified environmental, economic, and governance-related factors that exacerbate these impacts. The study concludes by emphasizing the need to develop integrated coastal zone management strategies and adaptive public policy frameworks to address increasing vulnerabilities in coastal settings.

Keywords: Coastal erosion, tourism sustainability, tourist perception, mixed methods, Chile.

RESUMEN

La erosión costera representa una amenaza creciente para la sostenibilidad del turismo en destinos vulnerables. Este estudio analiza las percepciones de turistas y empresas turísticas sobre los impactos de este fenómeno en La Serena, Chile, un destino emblemático del litoral pacífico. Se empleó un diseño mixto con triangulación concurrente, a partir de encuestas aplicadas a 176 turistas y 22 empresas turísticas, complementadas con entrevistas semiestructuradas a expertos. El análisis cuantitativo (χ^2 , V de Cramer, Mann-Whitney y Kruskal-Wallis) evidenció bajos niveles de conocimiento sobre la erosión entre visitantes (65,4% con escasa o nula comprensión). No obstante, quienes residían en la Región de Coquimbo presentaron niveles significativamente más altos de conocimiento que los no residentes ($H(1) = 4,23$, $p = 0,040$), con un efecto pequeño pero detectable ($r = 0,18$). La erosión fue percibida como un problema crítico, con diferencias significativas intergrupales ($U = 2741$, $p = 0,001$; $r = 0,42$): las empresas mostraron mayor preocupación, advirtiendo que la pérdida total de arena comprometería la infraestructura y la viabilidad económica. El análisis cualitativo identificó factores ambientales, económicos y de gobernanza que intensifican los impactos. Se concluye sobre la necesidad de desarrollar estrategias integradas de gestión costera y formulación de políticas públicas adaptativas.

Palabras clave: Erosión costera, sostenibilidad del turismo, percepción turística, métodos mixtos, Chile.

INTRODUCTION

Coastal zones serve as dynamic interfaces between terrestrial and marine systems, widely recognized for their ecological importance and key contributions to economic development. This is especially evident in the context of the expanding tourism sector and the broader framework of the blue economy, which emphasizes the sustainable use of marine and coastal resources to foster economic growth while preserving environmental integrity (Kabil et al., 2021; Schlacher et al., 2008). Featuring sandy beaches and scenic seascapes, these areas attract millions of visitors annually, generating substantial revenue for local and national economies (Shasha et al., 2023). Nevertheless, the intensifying threat of coastal erosion—driven by climate change and human-induced pressures—presents a pressing challenge to the long-term viability of tourism-dependent coastal destinations (Vousdoukas et al., 2020).

Coastal erosion—a geomorphological process driven by natural forces such as wave action, tidal dynamics, and extreme weather events—has become an increasingly urgent issue for coastal tourism, a sector of substantial economic relevance for many regions worldwide. This phenomenon is further exacerbated by anthropogenic pressures, including unregulated urban expansion, sediment extraction, and the degradation of coastal ecosystems, collectively threatening both the integrity of natural habitats and the viability of tourism infrastructure that underpins sun-and-beach economies (Martínez et al., 2018; Mentaschi et al., 2018). Shoreline retreat is now a growing global concern, with beach loss documented across diverse geographies (Toledo et al., 2024). Projections indicate that, without effective policy and management interventions, nearly 50% of the world's sandy beaches may disappear by 2100 as a result of sea-level rise and accelerated coastal processes (Vousdoukas et al., 2020). This alarming scenario highlights the critical need for an interdisciplinary approach to coastal erosion—one that integrates sustainable tourism planning with adaptive and mitigation strategies to enhance the resilience of coastal destinations (Paula et al., 2021).

Chile, with over 6,400 kilometers of coastline, faces notable challenges from coastal erosion,

particularly in tourism-reliant areas. Recent studies estimate that approximately 80% of the Chilean coast experiences erosion rates exceeding 0.2 m/year, with some beaches retreating by more than 1.5 m/year—classified as high erosion—posing a major threat to key tourism destinations (Isla & Cortizo, 2023; Martínez et al., 2022). The degradation of these coastal ecosystems not only undermines their intrinsic natural beauty and recreational value but also generates cascading effects on local economies that are highly dependent on tourism revenue. Previous research has consistently shown that beach environmental quality is a decisive factor in destination choice, with visitors increasingly sensitive to environmental degradation and the loss of natural attractions (Contreras et al., 2022; Smith et al., 2023). Moreover, coastal erosion directly threatens tourism infrastructure—including hotels, restaurants, and recreational areas—potentially resulting in substantial economic losses and reduced competitiveness of affected destinations (Alexandrakis et al., 2015; Garzo et al., 2023).

This issue is particularly acute in La Serena, one of Chile's most emblematic sun-and-beach tourism destinations, where coastal erosion has become a visible and intensifying threat (Martínez et al., 2022; Winckler et al., 2023). Winckler et al. (2019) documented an erosion rate of -0.30 m/year at La Serena Beach between 1978 and 2017, classifying it as a degraded area (-0.2 to -1.5 m/year). As an urban beach, its vulnerability to erosion is amplified, heightening the risks to tourism infrastructure and associated economic activities. This scenario is particularly concerning given that tourism contributes 3.3% to Chile's national GDP and 7% to national employment (Chanquey et al., 2021). Beyond direct economic impacts, erosion in La Serena also threatens to undermine the region's rich cultural heritage and local traditions intrinsically linked to the sea, such as artisanal fishing and coastal festivals, thereby weakening the unique identity of these communities (Cooper & McKenna, 2008; UNESCO, 2016).

This study addresses a critical gap in the literature by examining the perceptions of both tourists and tourism service providers in La Serena regarding the causes, impacts, and potential mitigation strategies for coastal erosion. Understanding the concerns, beliefs, and attitudes of these key

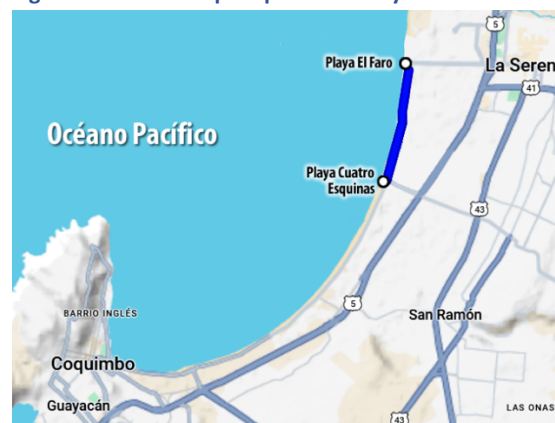
stakeholders is essential for designing coastal management strategies that are environmentally sustainable, socially acceptable, and economically viable, and aligned with the needs and expectations of local communities and visitors. La Serena's iconic Avenida del Mar—the city's main coastal frontage (Araya-Pizarro & Álvarez, 2020) — serves as a representative case study in the context of accelerating erosion processes that visibly threaten the destination's tourism appeal and long-term economic viability.

The objective of this study is to analyze the perceptions of tourists and tourism service providers regarding the impact of coastal erosion on tourism activities in La Serena. The findings aim to inform the development of integrated coastal management strategies and the advancement of sustainable tourism practices. By bridging scientific evidence with the perspectives of key stakeholders, this research contributes to the literature on the interface between coastal erosion and tourism, offering actionable insights for evidence-based policymaking. Ultimately, the study supports efforts to enhance the resilience of coastal communities and ensure the long-term sustainability of both coastal ecosystems and the local economies that depend on them.

METHODOLOGY

This study employed a mixed-methods approach with a concurrent triangulation design and a cross-sectional scope, aimed at comprehensively analyzing the impact of coastal erosion on tourism along Avenida del Mar in La Serena, Coquimbo Region, Chile. The integration of quantitative and qualitative data collection and analysis was strategically designed to describe and quantify tourist perceptions, attitudes, and behaviors, as well as to rigorously assess the effects of coastal erosion on tourism services within the study area. The research focused on the coastal strip extending from El Faro to Cuatro Esquinas, a zone recognized as emblematic for sun-and-beach tourism in Chile (Figure 1).

Figure 1. Coastal strip map of the study area



Source: Adapted from Google Maps (December 10, 2024).

Quantitative phase: Tourist and business surveys

The target population consisted of two distinct groups: tourists visiting Avenida del Mar and tourism service providers (including accommodation and gastronomic establishments) within the study area. For tourists, an infinite population was assumed (exceeding 100,000 annual visitors), while for service providers, 26 establishments were identified. The sample size for tourists was calculated to be 176 individuals, based on a 95% confidence level, a 7.4% margin of error, and a 50% population heterogeneity. For service providers, the sample size was determined to be 22 establishments, calculated with a 95% confidence level, an 8.4% margin of error, and a 50% heterogeneity.

Non-probability convenience sampling was employed, selecting participants who were easily accessible and willing to participate. This method was deemed appropriate given the dynamic context of the study, enabling efficient data collection within a high-tourist-traffic environment. While acknowledging the limitations of convenience sampling in terms of generalizability, the pragmatic advantages for data collection in situ within a tourism setting were prioritized.

Data collection was conducted using structured surveys, validated through expert review, and administered between January and April 2024. Tourist surveys were administered both in-person along the coastal strip and virtually via a self-administered questionnaire on Google Forms to

maximize reach and response rates. Surveys for service providers were administered in-person at their respective establishments. Questionnaires incorporated multiple-choice, categorical, and ordinal scale questions, meticulously designed to measure perceptions, satisfaction levels, and the perceived impact of coastal erosion on tourism activities. For tourists, the instrument explored visit frequency, perceptions of beach condition, and the influence of erosion on future travel decisions. For service providers, the survey assessed the impact on business operations and implemented mitigation measures.

Quantitative data were analyzed using descriptive statistics to summarize the sample characteristics and distribution of perceptions. Association tests (Chi-squared) were employed to examine relationships between categorical variables, and Cramer's V was calculated to assess the effect size of statistically significant associations, providing a measure of practical significance beyond p-values. Additionally, a t-test was applied to evaluate the differences in perceptions of coastal erosion impact between tourists and tourism service providers, highlighting discrepancies between the two groups.

To examine group differences in ordinal variables, non-parametric tests were employed: the Mann–Whitney U test and the Kruskal–Wallis H test, the latter followed by Dunn's post hoc comparisons with Bonferroni adjustment. Results include the H statistic, p-values, and three effect size measures appropriate for ordinal data: epsilon squared (ϵ^2), eta squared (η^2), and rank-biserial correlation (rrb).

Statistical analyses were conducted using IBM SPSS Statistics (version 24) and JASP (version 0.19.3.0), both running on Windows platforms.

The study ensured the confidentiality and anonymity of all participants. Informed consent was obtained from all respondents, who received clear explanations regarding the study's objectives and the intended use of the collected data.

Qualitative phase: Expert and authority interviews

The qualitative phase involved semi-structured interviews with four key informants, selected

through purposive sampling to capture diverse expert perspectives on coastal erosion and its implications for tourism in La Serena, Chile. The interviewees included: (1) a Coastal Environmental Consultant specializing in biodiversity, wetlands, and erosion dynamics; (2) the Director of Tourism Development at the National Tourism Service (SERNATUR) in La Serena, responsible for regional tourism planning and governance; (3) a Climate Change Projections Specialist with extensive experience in coastal impact assessment; and (4) the Municipal Delegate for Avenida del Mar, responsible for local coastal management and community coordination. This selection ensured a comprehensive representation of technical, institutional, and territorial perspectives.

Interviews were conducted using thematic guides with open-ended questions, addressing five core areas: (1) expert views on the causes and dynamics of coastal erosion in La Serena; (2) observed effects on the tourism sector and local economy; (3) perceived effectiveness of current management strategies; (4) projected scenarios and long-term implications; and (5) recommended measures for mitigation and resilience. This design allowed for the collection of both factual information and in-depth reflections, experiences, and proposals from stakeholders.

All interviews were audio- and video-recorded, and transcribed verbatim to ensure accuracy in analysis. Data were processed through open coding and thematic analysis, supported by Atlas.ti software for systematic organization and categorization. Initial codes derived from the transcripts were later grouped into thematic clusters such as "drivers of coastal erosion," "impacts on tourism" and "proposed solutions". This rigorous and iterative approach ensured transparency and depth in interpreting the qualitative evidence.

Mixed-methods integration

The concurrent triangulation design enabled the integration of quantitative and qualitative findings, enriching the overall analysis. Quantitative results from tourist and business surveys regarding erosion perceptions and impacts were contextualized and enriched by qualitative insights from expert interviews. This methodological synergy provided a more holistic and nuanced

understanding of the research problem, strengthening the validity and depth of the study's conclusions.

RESULTS

Tourist profile and perceived satisfaction

Surveys of 176 tourists in La Serena, Chile, revealed a predominantly female (53.4%) and young adult demographic, with 40.3% aged 18-25 years and 29% aged 26-35 years, indicating the destination's strong appeal among younger segments (Table 1).

**Table 1. Tourist profile and perceived satisfaction
(n = 176)**

Variable	Segment	%
Gender	Male	43.2
	Female	53.4
	Other	3.4
Age	18-25 years	40.3
	26-35 years	29.0
	36-50 years	18.2
	61 years or older	12.5
Zone of residence	Region of Coquimbo	65.3
	Other Region of Chile	33.0
	Other country	1.7
Trip purpose	Tourism/Leisure	60.8
	Business/Work	5.7
	Visiting family	18.8
	Special events	5.1
	Others	9.7
Visit frequency	Annually	21.6
	Semiannually	22.2
	Monthly	36.4
	Weekly	12.5
	Daily	4.0
	Never before	3.4
Services used	Accommodation only	2.8
	Food services only	26.7
	Recreational activities only	17.6
	Two of the above services	35.8
	All of the above services	9.1
	None of the above services	8.0
Satisfaction level	Very low	3.4
	Low	5.7
	Moderate	39.8
	High	38.6
	Very high	12.5

Source: Author's own survey data.

Domestic tourism prevailed, with 98.3% of respondents residing in Chile and 65.3% specifically from the Coquimbo Region, highlighting the primarily local and national character of tourism in the area. Leisure and tourism were the main purposes of travel (60.8%), followed by visiting family (18.8%) and attending special events (5.1%), reinforcing La Serena's role as a recreational destination.

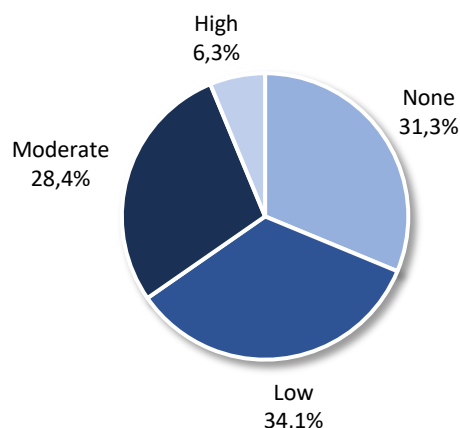
Visit frequency was relatively high: 36.4% reported visiting monthly and 22.2% twice a year. Only 3.4% were first-time visitors, suggesting a high level of visitor loyalty. Gastronomic services emerged as the most utilized, with 26.7% using only food-related services and 35.8% combining two or more service types, underscoring the centrality of gastronomy in the tourist experience.

Satisfaction levels were predominantly moderate (39.8%) or high (38.6%), while extreme ratings were less frequent ("very high": 12.5%; negative: 9.1%), suggesting an overall acceptable level of perceived satisfaction. Further analysis revealed significant variation by place of residence ($\chi^2 = 26.02$, $p < 0.001$; Cramer's $V = 0.385$): 72.3% of non-local visitors reported satisfaction, compared to only 58.1% of local residents. This perceptual gap suggests that geographic origin—possibly through differing expectations or familiarity with the destination—may influence the evaluation of the tourist experience.

Coastal erosion and tourist perception

The analysis of tourist perceptions regarding coastal erosion and its impact on tourism reveals clear and concerning patterns affecting both current experiences and future travel intentions (Figure 2).

Figure 2. Familiarity with the term "Erosion" (n = 176)



Source: Author's own survey data.

Preliminary results show a notable lack of familiarity with the term coastal erosion. Specifically, 31.3% of tourists reported no knowledge of the concept, and 34.1% only a very limited understanding. Meanwhile, 28.4% had a moderate level of knowledge, and just 6.3% demonstrated a comprehensive understanding. This knowledge gap highlights the pressing need for targeted public education and awareness campaigns.

The Kruskal–Wallis test indicated statistically significant differences in erosion knowledge by place of residence ($H(1) = 4.23$, $p = 0.040$, $\epsilon^2 = 0.024$, $\eta^2 = 0.019$), pointing to a small yet detectable effect. Post hoc Dunn's tests with Bonferroni correction revealed that residents of the Coquimbo Region had significantly higher knowledge ranks ($W_i = 93.98$) than non-residents ($W_j = 78.17$; $z = 2.06$, $p = 0.040$; $rrb = 0.18$), suggesting that local exposure may enhance familiarity with the phenomenon.

With regard to perceptions of erosion in the beach area, 89.8% of respondents "agreed" or "strongly agreed" that erosion negatively affects the

destination. This perception was reinforced by direct observations: 84.7% noted visible changes to the beach in recent years, indicating that erosion impacts are widely perceived by visitors.

Coastal erosion's impact on tourist experience was notable. 47.7% of tourists reported erosion moderately or significantly affected their experience; 26.1% remained neutral, suggesting potential future impact; and only 26.1% perceived no negative effect, indicating coastal erosion is a relevant factor for nearly half of visitors.

Concerning destination switching due to erosion, 48.9% of tourists would not change destinations; 27.8% were neutral; and 23.3% considered switching, suggesting erosion, while recognized, is not yet a decisive destination choice factor for most, though this could shift with intensified erosion.

Persistence in future beach visits, even under worsening erosion conditions, was affirmed by 44.3% of tourists. However, 29.5% stated they would not return, and 26.1% were uncertain, reflecting a divide between loyal and potentially deterred visitors.

Intentions to continue visiting if the beach lost all sand were markedly lower: over 50% said they would not return under such conditions, and only 34.1% expressed willingness to do so. This underscores the sandy beach's essential role as a tourism resource. Complete sand loss would likely result in severe consequences for tourism and the local economy.

Regarding future impact perceptions, a vast majority (90.3%) agreed or strongly agreed that continued erosion would damage tourism services. Moreover, 63.6% believed that beachfront construction—particularly hotels and restaurants—contributes to coastal erosion, signaling growing public awareness of anthropogenic causes.

Table 2. Tourist perception of coastal erosion and its impact on tourism (%), n=176

Question	Level of agreement				
	SD	D	N	A	SA
P1. I believe that the phenomenon of coastal erosion affects the resort	1	1	9	24	66
P2. I have noticed the effects of coastal erosion in recent years at the resort.	1	3	12	38	47
P3. I have experienced some impact on my tourism experience due to coastal erosion.	12	14	26	27	21
P4. I have considered changing my tourist destination due to the effects of coastal erosion.	31	18	28	15	8
P5. If the situation remains the same, I will continue visiting this beach in the coming years.	11	19	26	25	19
P6. If the beach loses all its sandy area, I will still visit it.	32	20	13	16	18
P7. If coastal erosion continues, I believe these tourist services will be negatively impacted.	5	1	4	21	69
P8. The construction of accommodations and dining establishments near the beach increases coastal erosion.	8	6	23	19	44
P9. I believe that coastal erosion is an issue that should be addressed more thoroughly.	2	1	6	15	77

Source: Author's own survey data.

Note: SD= Strongly disagree, D = Disagree, N = Neutral, A = Agree, SA = Strongly agree.

Furthermore, 91.5% of tourists expressed the belief that erosion should be addressed more proactively, indicating strong visitor demand for concrete mitigation measures. A summary of these findings is presented in Table 2.

In conclusion, the results demonstrate coastal erosion is visible and concerning for most tourists, significantly impacting their experience and future decisions. While many do not yet consider switching destinations, beach loss as a tourism resource could drastically alter this trend.

Chi-Square tests and Cramer's V effect sizes revealed statistically significant effects in two key statements related to tourist visit frequency. A moderate association was observed between tourists' willingness to revisit the beach and their erosion perception ($V = 0.276$, $p = 0.001$), suggesting those more aware of erosion are less likely to return if it worsens. Another moderate relationship was observed between the belief that beachfront construction contributes to erosion and visit frequency ($V = 0.202$, $p = 0.027$), reflecting growing recognition of human-induced coastal impacts. These results highlight coastal erosion not only as an environmental concern but also as a critical factor in tourism sustainability—especially considering potential intensification in the future (Table 3).

Additionally, while not reaching full statistical significance ($p = 0.069$), a weak trend was observed in tourists' perception of erosion impacting their tourism experience ($V = 0.174$), suggesting erosion is already negatively affecting satisfaction for a proportion of visitors. These findings reinforce the need to address erosion as critical for tourism

sustainability, particularly given potential future intensification.

Statistically significant associations ($p < 0.05$) were also observed between tourist satisfaction levels and erosion-related perceptions, with Cramer's V values ranging from 0.20 to 0.24, indicating small to moderate effect sizes (Table 4). A nuanced pattern emerged: tourists who were "very satisfied" reported higher recognition of erosion (86.4% for P1; 72.7% for P2) compared to less satisfied groups.

A marked dissociation was observed between problem perception and behavioral intention. While 50% of the "very satisfied" tourists reported that erosion had impacted their experience (P3), only 22.7% would consider changing destinations (P4). This apparent contradiction suggests a loyalty effect or risk tolerance among the most satisfied visitors.

Table 3. Tourist perception of coastal erosion and its impact on tourism according to visit frequency (%)

Question	Frequent visitor (n=93)			Non-frequent visitor (n=83)			Association test		
	Disagree	Neutral	Agree	Disagree	Neutral	Agree	Chi-Square	p-value	Cramer'sV
P1	2	9	89	0	10	90	1.843	0.398	0.102
P2	4	13	83	2	11	87	0.697	0.706	0.063
P3	22	23	56	31	30	39	5.341	0.069*	0.174
P4	52	27	22	46	29	25	0.641	0.726	0.060
P5	18	27	55	42	25	33	13.438	0.001***	0.276
P6	46	14	40	60	12	28	3.628	0.163	0.144
P7	6	2	91	5	6	89	1.885	0.390	0.103
P8	8	22	71	20	24	55	7.193	0.027**	0.202
P9	2	4	94	2	8	89	1.304	0.521	0.086

Source: Author's own survey data.

Note: Frequent visitor (At least once a month). Non-frequent visitor (Less than once a month). Significance level: * p < 10%, ** p < 5%, *** p < 1%.

Table 4. Association between perceptions of coastal erosion and level of tourist satisfaction (n=176)

Perception variable	χ^2 (p-value)	Cramer's V	Significant pattern observed in the "Strongly agree" option
P1. Beach area affected	30.59 (0.015) *	0.208	86.4% of "Very satisfied" v/s 100% of "Very dissatisfied"
P2. Noticed recent effects	33.26 (0.007) **	0.217	72.7% of "Very satisfied" v/s 37.1% of "Moderately satisfied"
P3. Impact on experience	28.33 (0.029) *	0.201	50% of "Very satisfied" v/s 11.4% of "Moderately satisfied"
P4. Would change destination	40.85 (0.001) **	0.241	22.7% of "Very satisfied" v/s 2.9% of "Moderately satisfied"
P5. Would continue visiting	31.61 (0.011) *	0.212	50% of "Very satisfied" v/s 10% of "Dissatisfied"
P6. Would visit even without sand	32.40 (0.009) **	0.215	36.4% of "Very satisfied" v/s 10% of "Dissatisfied"
P7. Need for management response	31.71 (0.011) *	0.212	100% of "Very satisfied" v/s 68.6% of "Moderately satisfied"

Source: Author's own survey data.

Note: Non-significant variables (P7, P8) were omitted. The effect size (Cramer's V) ranged from 0.20 to 0.24, indicating a small to moderate association. Percentages reflect the proportion within each satisfaction category that selected 'Strongly agree' for each variable. Significance level: * p < 5%; ** p < 1%.

Regarding destination resilience, data showed that 36.4% of the "very satisfied" group would continue visiting the beach even in the absence of sand (P6), a significantly higher percentage than the 10% among dissatisfied tourists. This finding suggests that satisfaction may act as a moderating factor in the willingness to accept physical transformations of the coastal environment.

Although significant, these associations explained relatively little variance ($V^2 \leq 0.058$), implying that other unmeasured factors are likely influencing behavior. Overall, the findings underscore the importance of integrating both satisfaction and risk perception into the sustainable management of erosion-prone coastal destinations.

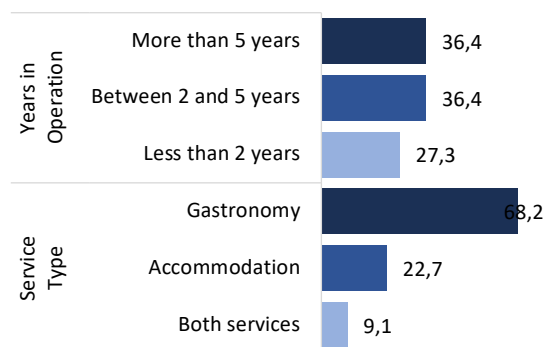
Perceptions of coastal erosion among tourism service providers

Survey data reveal widespread and concerning perceptions among tourism service providers

regarding the operational, infrastructural, and economic implications of coastal erosion in La Serena, Chile.

Among the surveyed businesses, 68.2% operated exclusively in gastronomy, 22.7% in accommodation, and 9.1% offered combined services. Business longevity varied: 27.3% had been operating for less than two years, 36.4% between two and five years, and 36.4% for more than five years. This distribution reflects a dynamic and constantly evolving sector, where the proportion of recently established businesses highlights both the area's tourism appeal and the increased vulnerability of newer ventures to coastal risks (Figure 3).

Figure 3. Composition of tourism services (%), n = 22



Source: Author's own survey data.

Table 5 presents a detailed characterization of stakeholders' perceptions. While 90.9% acknowledged the presence of visible coastal changes in recent years, 77.3% tended to downplay the severity of the phenomenon, expressing some degree of disagreement with its classification as a critical issue. This divergence suggests that, although environmental changes are widely recognized, their operational implications have not

yet been fully assimilated by local businesses, which may hinder the implementation of effective adaptive measures at the local level.

Economic vulnerability is a central concern: 95.5% of respondents indicated that beach disappearance would have substantial economic repercussions for their services. Additionally, 81.8% reported that continued erosion poses a serious threat to their infrastructure, reflecting broader concerns about the sector's long-term viability.

Perceptions of governmental response were predominantly negative. A total of 54.5% "disagreed" or "strongly disagreed" that sufficient action was being taken by local authorities. In contrast, only 4.5% "strongly agreed" with this statement. Despite this, 54.5% "agreed" or "strongly agreed" that they would be willing to participate in coastal protection initiatives. This suggests untapped potential for collaborative public-private approaches to coastal risk management.

Table 5. Perception of tourist services regarding coastal erosion and its impact on tourism (%), n=22

Question	Level of agreement				
	SD	D	N	A	SA
I have observed noticeable changes in the beaches of the area due to coastal erosion in recent years.	5	0	5	55	36
The issue of coastal erosion in the beach resort is critical.	32	45	23	0	0
I have experienced a decline in the number of customers due to coastal erosion.	55	9	5	18	14
I believe that the potential disappearance of the beaches due to coastal erosion would significantly affect my service economically.	5	0	0	36	59
I consider that the infrastructure of my business could be seriously threatened if coastal erosion continues to advance.	9	0	9	14	68
I believe that local authorities are taking sufficient measures to address the problem of coastal erosion and its impact on tourism.	45	9	41	0	5
I would be willing to cooperate with authorities in initiatives to protect coastal tourism from coastal erosion.	5	0	41	23	32
The influx of tourists is essential for the operation and viability of the tourism service.	0	0	23	13	64
I am concerned about the future of my business due to coastal erosion.	5	0	36	36	23

Source: Author's own survey data.

Note: Sd = Strongly disagree, D = Disagree, N = Neutral, A = Agree, SA = Strongly agree.

Moreover, 77.3% of respondents identified tourist inflows as critical for their businesses' functioning and sustainability, while 59.1% expressed concern about the future viability of their operations due to erosion-related impacts. These results highlight the dual environmental and economic threat coastal erosion poses to tourism-dependent local economies.

Statistical analysis supports these concerns. Chi-square tests and Cramer's V identified a statistically significant and strong association between service type and the perception that business infrastructure is seriously threatened by ongoing erosion ($V = 0.72$, $p < 0.001$). This finding implies that vulnerability to erosion varies significantly across tourism sub-sectors, a key insight for targeted resilience planning.

Additionally, Mann–Whitney U test revealed significant differences between the perceptions of service providers and tourists regarding the consequences of beach loss ($U = 2,741$, $p = 0.001$). The effect size, measured via rank-biserial correlation ($r = 0.42$), indicates a moderate yet meaningful divergence. Specifically, service providers are more likely than tourists to recognize the structural risks and economic implications of erosion. In contrast, visitors tend to minimize its impact on their experience and willingness to return.

In conclusion, the findings clearly demonstrate that coastal erosion is perceived by tourism service providers as a pressing operational and economic challenge. The results underscore the need for proactive coastal protection and adaptation strategies. Given the sector's dependence on beach integrity and the identified dissatisfaction with current government efforts, an integrated, multi-stakeholder approach—combining infrastructure investment, environmental restoration, and stakeholder collaboration—is essential to safeguard tourism sustainability in erosion-prone destinations.

Expert and authority perspectives

A thematic analysis of expert interviews yielded valuable insights into the multidimensional dynamics of coastal erosion and its repercussions for tourism in La Serena (Figure 4). Experts highlighted that erosion results from the interplay of natural processes and human-induced pressures. On the natural side, rising sea levels and increased wave energy were consistently cited as major contributors. However, anthropogenic drivers—particularly the construction of upstream dams such as the Puclaro Reservoir—were identified as significant disruptors of sediment transport to the coastal zone, thereby exacerbating beach erosion. Furthermore, the proliferation of unregulated coastal urban development was recognized as an amplifying factor, accelerating shoreline retreat and undermining both ecosystem integrity and the resilience of tourism infrastructure.

Expert testimonies aligned with the survey findings, reinforcing the tourism sector's high vulnerability to coastal erosion. The degradation of

coastal landscapes was noted to reduce the aesthetic and recreational appeal of the destination, with direct economic repercussions such as lower tourist arrivals, declining business revenues, and reduced investment in tourism infrastructure. These impacts were framed not only as environmental concerns but as significant threats to local economic sustainability.

In response, experts advocated for the urgent implementation of integrated coastal management (ICM) strategies. They recommended a dual approach combining hard engineering measures—such as seawalls, groynes, and breakwaters—with soft solutions including dune restoration, beach nourishment, and coastal reforestation. Enhanced environmental monitoring and the adoption of adaptive planning mechanisms were also emphasized, allowing for policy adjustments in response to evolving climatic and geomorphological conditions. Strong collaboration between public institutions and the private sector was considered essential to ensure the long-term effectiveness and sustainability of these interventions.

Public education and awareness campaigns emerged as another central theme. Experts underscored the importance of targeted communication strategies aimed at both residents and visitors, designed to improve understanding of the causes and consequences of coastal erosion. These initiatives are intended to foster a culture of shared responsibility and to encourage the sustainable use and conservation of coastal resources. Increased awareness was viewed as a foundational element in building social and institutional resilience to environmental risks.

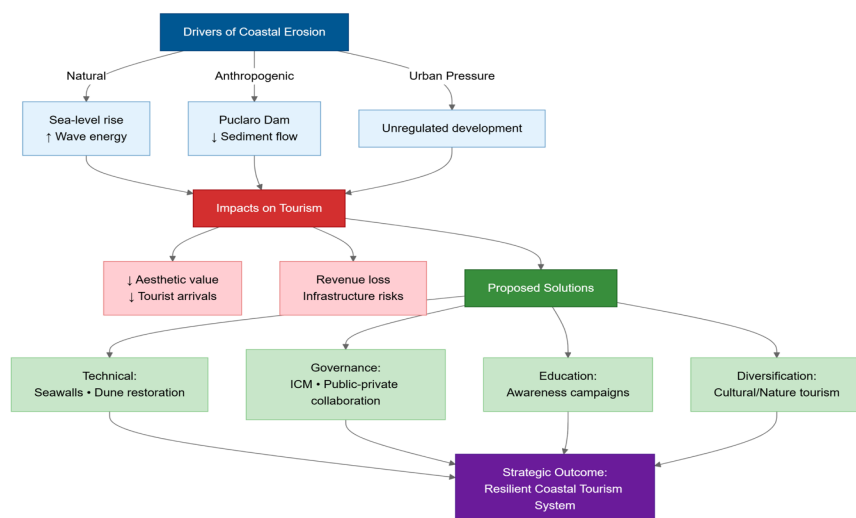
Finally, experts recommended diversifying La Serena's tourism offer to reduce its dependence on sun-and-beach products. They suggested promoting cultural heritage, nature-based tourism, and adventure tourism as viable alternatives to attract a broader visitor base and to enhance sectoral resilience. In parallel, the development of adaptive tourism infrastructure—such as modular, mobile, or relocatable facilities—was proposed to mitigate exposure to coastal hazards.

In sum, expert perspectives reinforce the need for a proactive, integrative strategy to address coastal

erosion in La Serena. A combination of technical, educational, and economic diversification measures is proposed as a feasible pathway to

mitigate current and future erosion impacts, ensuring the long-term sustainability of the region's tourism sector.

Figure 4. Coastal erosion threats and solutions for La Serena's tourism: Expert insights



Source: Author's own survey data.

DISCUSSION

The findings of this study provide robust evidence of the multifaceted impact of coastal erosion on the tourism sector along the El Faro–Cuatro Esquinas coastal strip in La Serena. The convergence of quantitative and qualitative data offers a comprehensive understanding of the phenomenon, shedding light not only on tangible economic risks but also on evolving perceptions among tourists and business stakeholders. These insights contribute meaningfully to the growing body of literature on coastal vulnerability by presenting a detailed account of how environmental degradation interacts with tourism dynamics in a socioeconomically sensitive context.

Quantitative results indicate a widespread awareness of coastal erosion among tourists. Although current erosion levels have not yet significantly altered visitation patterns, a hypothetical scenario involving total beach loss elicited a marked decline in tourists' intention to return. This finding underscores the pivotal role of beach attractiveness in destination appeal and aligns with previous research demonstrating the strong correlation between beach quality and

tourist satisfaction in coastal regions (Arias et al., 2019; López-Contreras et al., 2022).

In parallel, a considerable proportion of visitors reported a diminished tourism experience due to visible erosion impacts. This is reinforced by the high levels of concern expressed by tourism business operators, particularly those with longer tenure in the sector. Their perception of erosion as a “serious” and escalating threat reflects growing uncertainty regarding business continuity, mirroring concerns raised in other erosion-affected coastal destinations (Contreras et al., 2022; Winckler et al., 2019, 2023).

Qualitative insights derived from expert interviews corroborate these findings and further illuminate the systemic nature of coastal erosion in La Serena. Experts emphasized the interplay of natural and anthropogenic drivers, particularly sediment supply reduction linked to dam construction (e.g., the Puclaro Reservoir), unregulated coastal development, and the compounded effects of global climate change—such as accelerated sea-level rise and increased storm frequency (Contreras et al., 2022; Schlacher et al., 2008; Warrick et al., 2019). These factors collectively

disrupt sediment dynamics and undermine coastal ecosystem resilience (Augusto et al., 2023; Celata & Gioia, 2024; Wang et al., 2023).

In response to these complex challenges, experts advocated for an integrated coastal management (ICM) framework as a strategic pathway forward. This entails harmonizing conservation objectives with development imperatives through ecosystem-based adaptation strategies, including dune restoration, beach nourishment, and sustainable tourism practices that minimize ecological disruption (Mustapha & Awang, 2018; Sulistyadi et al., 2024). Public education and awareness initiatives, targeting both residents and visitors, were also identified as critical to fostering shared responsibility and long-term resilience (Luttenberger & Mandić, 2022). Furthermore, the participation of experienced tourism stakeholders is essential to ensure that proposed strategies are contextually grounded and socially viable.

Despite offering valuable empirical insights, this study is subject to several limitations that should be acknowledged. First, the cross-sectional research design captures perceptions and reported impacts at a single point in time, constraining the capacity to identify temporal dynamics or to infer causality with confidence. Observed relationships should therefore be interpreted cautiously, particularly considering potential seasonal and interannual variability.

Second, the focus on a single coastal strip in La Serena restricts the generalizability of findings. Although the identified trends may be relevant to similar settings facing erosion-related challenges, context-specific social, institutional, and geomorphological factors may yield different outcomes elsewhere. Broader comparative studies would enhance the external validity of these results.

To deepen understanding, future research should adopt longitudinal designs capable of tracking shifts in perceptions and business impacts over time. Comparative analyses across destinations with varying levels of erosion exposure and governance responses could yield broader insights into adaptation pathways and sectoral resilience. Moreover, further investigation is needed into the performance and scalability of specific erosion

mitigation strategies, including both hard infrastructure and nature-based solutions. Evaluating their environmental effectiveness and economic cost-benefit ratios would support more informed decision-making. Finally, exploring the economic feasibility of diversifying tourism offerings—such as cultural, ecological, and adventure tourism—could inform strategic planning to reduce reliance on erosion-sensitive beach tourism and build a more resilient tourism economy.

Collectively, the study underscores the urgent need for proactive, integrated responses to coastal erosion in La Serena, combining scientific knowledge, stakeholder engagement, and strategic diversification to safeguard the long-term sustainability of its coastal zone and tourism sector.

CONCLUSION

This study provides empirical evidence on perceptions of the impacts of coastal erosion on the tourism sector in La Serena, Chile. The findings underscore the importance of adopting proactive and integrated coastal management approaches to mitigate the effects of erosion and to ensure the long-term sustainability of tourism-dependent coastal destinations. The analysis reveals that coastal erosion not only affects the physical environment but also alters stakeholder perceptions of tourism performance, particularly in gastronomy and accommodation services. Several strategic recommendations emerge from this research:

- **Invest in coastal protection infrastructure:** It is essential to prioritize and implement coastal protection measures such as beach nourishment and dune restoration. These interventions can help stabilize the shoreline, maintain beach attractiveness, and safeguard key tourism assets.
- **Enhance public awareness and education:** Public engagement through targeted awareness campaigns can foster a better understanding of coastal erosion, its drivers, and the need for sustainable behaviors among both residents and visitors.

- **Diversify tourism diversification:** To reduce dependence on beach-related tourism, destinations should diversify their offerings by promoting cultural, ecological, and adventure-based experiences. This strategy enhances resilience and broadens the appeal of coastal destinations.
- **Strengthen multi-stakeholder collaboration:** Effective coastal management requires participatory frameworks involving government agencies, private sector actors, academic institutions, and local communities. Collaborative governance can ensure context-sensitive and inclusive responses to coastal risks.
- **Implement adaptive planning and management:** Flexible and adaptive planning frameworks are needed to accommodate dynamic coastal processes. These should include continuous monitoring, scenario analysis, and participatory decision-making to adjust strategies over time in response to evolving erosion trends and climate change impacts.

Ultimately, addressing coastal erosion constitutes not only an environmental priority but also an economic imperative for regions heavily reliant on tourism. Through the implementation of anticipatory and sustainable coastal management strategies, destinations like La Serena can enhance their adaptive capacity, protect critical tourism resources, and secure the long-term viability of their coastal economies in the face of growing environmental pressures.

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53

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