

Spatial Assessment for Sustainable Tourism Using Multicriteria Analysis in a Coastal Area of Ecuador

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Abstract

In Ecuadorian coastal communities, the interaction between tourism activities and ecosystems of high environmental value poses challenges for land-use planning. In this context, determining land suitability can help guide tourism development based on conservation and responsible resource-use criteria. This study aims to estimate the Geospatial Sustainable Tourism Suitability Index (IGATS) in Ecuadorian coastal communities by integrating multicriteria analysis techniques with geographic information systems (GIS) to identify priority areas and guide the planning of sustainable coastal destinations. The methodology was structured into five phases: (i) input spatial data; (ii) cartographic standardization; (iii) calculation of sub-indexes; (iv) multicriteria integration; and (v) IGATS classification and spatial analysis. The results showed that low and medium tourism suitability categories predominated in both provinces. In Manabí, the low and medium categories accounted for 49.83% and 41.37% of the analyzed provincial area, respectively, whereas in Santa Elena, they accounted for 65.76% and 25.72%, respectively. At the cantonal scale, the largest combined areas in the high and very high suitability categories were recorded in Chone, Santa Elena, Portoviejo, Manta, and Bolívar cantons. The proposed index is a potentially replicable tool for other coastal areas and may contribute to sustainable tourism planning, the prioritization of territorial interventions, and the integration of local development, environmental conservation, and responsible land management.

Keywords

Tourism potential, GIS-based multicriteria evaluation, Coastal territories, Sustainable destinations, Spatial planning

1. Introduction

Sustainable tourism has become established as a strategic approach that promotes economic development, environmental conservation, and social well-being across diverse rural areas [1]. This perspective is particularly relevant given that the travel and tourism sector accounts for approximately 10% of global gross domestic product (GDP) [2]. This highlights the sector's strategic role in the economic and territorial development of various destinations (e.g., France, Spain, Mexico, and Colombia). Furthermore, implementing sustainable tourism requires balancing the use of natural and cultural resources with the conservation of the ecosystems that support tourism activities [3]. Because these resources and ecosystems are spatially distributed, the sustainability of tourism destinations depends not only on the management of tourism activities but also on the territorial conditions that determine the suitability of the land for tourism use [4].

In this regard, land suitability refers to assessing the extent to which an area is suitable for specific activities based on its environmental attributes and constraints [5, 6, 7]. Its application is particu-

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larly relevant in coastal areas, where the coexistence of ecosystems of high environmental value and tourism activities poses challenges for land-use planning and sustainable management aimed at their conservation [8, 9].

Several studies have delineated areas suitable for ecological conservation, agricultural production, and urban development using multicriteria assessments designed to analyze land-use compatibility, optimize the spatial allocation of land uses, and reduce conflicts between development and conservation. In Inner Mongolia, China, [10] assessed land suitability for ecological conservation, agricultural production, and urban development. Their assessment enabled the ecological–agricultural scenario to be prioritized and 40.71% of the territory to be designated for protection. Other studies have proposed optimal areas for urban development based on ecological constraints, topographic factors, accessibility, and infrastructure [11]. Furthermore, several studies have compared land suitability with current land use to identify areas where existing land use does not align with the estimated suitability and to inform sustainable land-use planning decisions [12, 13].

The complexity of these assessments has prompted the incorporation of geospatial tools capable of integrating multiple spatial variables within a unified analytical framework. In this context, geographic information systems (GIS), the analytic hierarchy process (AHP), multicriteria evaluation (MCE), ordered weighted averaging (OWA), automated modeling approaches, and machine-learning techniques have been widely used to support more systematic weight assignment and improve the spatial delineation of suitable areas [14, 15, 16].

In Ecuador, geospatial tools and multicriteria analysis approaches have been widely used to support land assessment in various fields, including agricultural, urban, and tourism planning, as well as land-use planning. These studies primarily integrate biophysical, climatic, and topographic variables with land-cover and land-use data, such as slope, elevation, precipitation, geomorphology, and soil type. They also incorporate infrastructure, accessibility, and socioeconomic criteria, highlighting the potential of these methods to support land-use planning and management [17, 18, 19, 20]. Nevertheless, most applications have adopted sector-specific approaches focused on agricultural suitability, urban expansion, or land-use planning. Tourism-related applications have generally incorporated only a limited set of spatial variables.

Consequently, a methodological gap remains in the development of geospatial approaches that simultaneously integrate variables related to environmental conditions, topography, accessibility, tourism attractiveness, tourism services, and environmental sensitivity to assess land suitability for sustainable tourism in Ecuadorian coastal communities. Existing studies have focused primarily on agricultural, urban, and land-use planning applications, whereas tourism-related research has incorporated only selected territorial components. This limitation hinders the systematic identification of priority areas to guide land-use planning and the development of sustainable tourism destinations. Accordingly, the following research question is posed: Which areas of Ecuador's coastal provinces exhibit favorable territorial conditions for sustainable tourism development when environmental, topographic, accessibility, tourism attractiveness, tourism services, and environmental sensitivity variables are considered jointly? To address this question, this study aims to estimate the Geospatial Sustainable Tourism Suitability Index (IGATS) in Ecuadorian coastal communities by integrating multicriteria analysis techniques with geographic information systems (GIS) to identify priority areas and support the planning of sustainable coastal destinations.

2. Geographical and Tourism Context

Manabí and Santa Elena are located on Ecuador's central-western coast, an area shaped by Pacific Ocean dynamics and climate variability and characterized by coastal and marine ecosystems (Figure 1). In Manabí, climatic conditions range from dry subtropical to humid tropical [21]. The provincial economy is closely linked to the agricultural and livestock sector, which accounted for 13.20–14.80% of provincial gross value added between 2012 and 2022, alongside fishing, trade, services, and tourism [22]. In this province, beaches, cliffs, cultural attractions, and geoheritage resources have been recognized as assets

that could strengthen geotourism, provided that their development is integrated with geoconservation, geoeducation, and land management strategies [23].

Santa Elena has dry to arid climatic conditions [21] and an economy closely linked to beach tourism, fishing, hospitality, gastronomy, local trade, and communal culture. Its peninsular location, dry coastal climate, and connectivity via the Spondylus Route have supported the development of destinations centered on sun-and-beach tourism, marine wildlife viewing, cultural heritage, and geological resources [24]. Furthermore, the Santa Elena Peninsula Geopark Project has identified geosites and geo-resources with the potential to promote geotourism, environmental education, and community development [25]. Against this background, both provinces constitute strategic areas for applying geospatial tools to support the planning of sustainable coastal destinations.

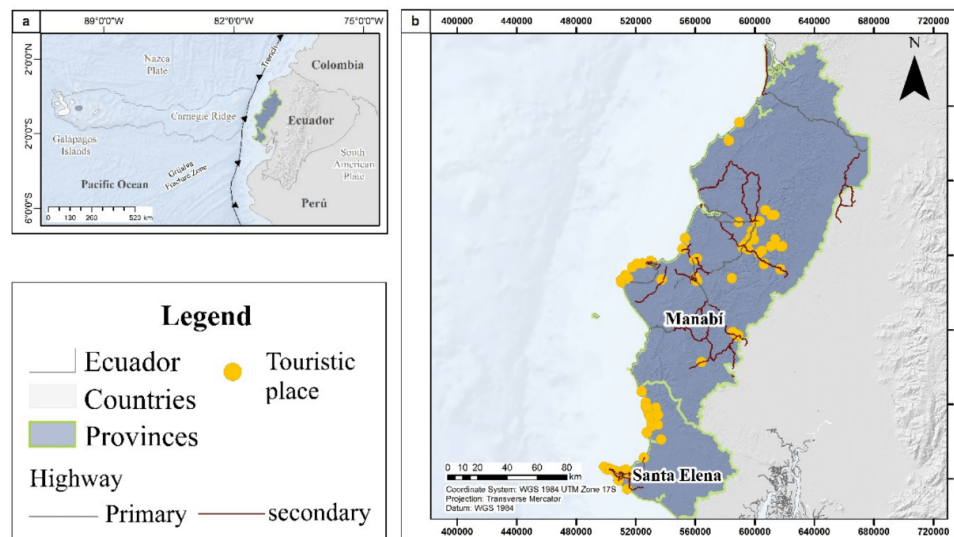


Figure 1: Location of the study area: (a) regional setting of Manabí and Santa Elena provinces on the central-western coast of Ecuador; and (b) detailed map of the study area showing provincial boundaries, the primary and secondary road network, and the spatial distribution of tourist attractions.

3. Materials and Methods

This study employed a geospatial approach based on geographic information system–based multicriteria decision analysis (GIS-MCDA), a well-established method for integrating heterogeneous spatial criteria into land assessment processes [26]. Building on this approach, the Geospatial Sustainable Tourism Suitability Index (IGATS) was developed as a methodological adaptation to assess suitability for sustainable tourism in the coastal provinces of Manabí and Santa Elena, Ecuador. This procedure integrated environmental, territorial, accessibility, and tourism-support variables and spatially delineated areas with different levels of suitability for sustainable tourism activities. Recent studies have applied similar GIS-MCDA approaches to assess land suitability and potential for tourism and ecotourism [27, 28, 29]. The methodological workflow comprised five phases, summarized in Figure 2: (i) input spatial data; (ii) cartographic standardization; (iii) calculation of sub-indexes; (iv) multicriteria integration; and (v) IGATS classification and spatial analysis.

3.1. Phase I: Input Spatial Data

During the first phase, spatial information was compiled from official institutions, geospatial databases, and open-access cartographic sources (Table 1). Specifically, data were obtained on tourist attractions, land cover and land use, the road network, population centers, and tourism services. These variables were selected based on their influence on tourism potential, spatial accessibility, the availability of

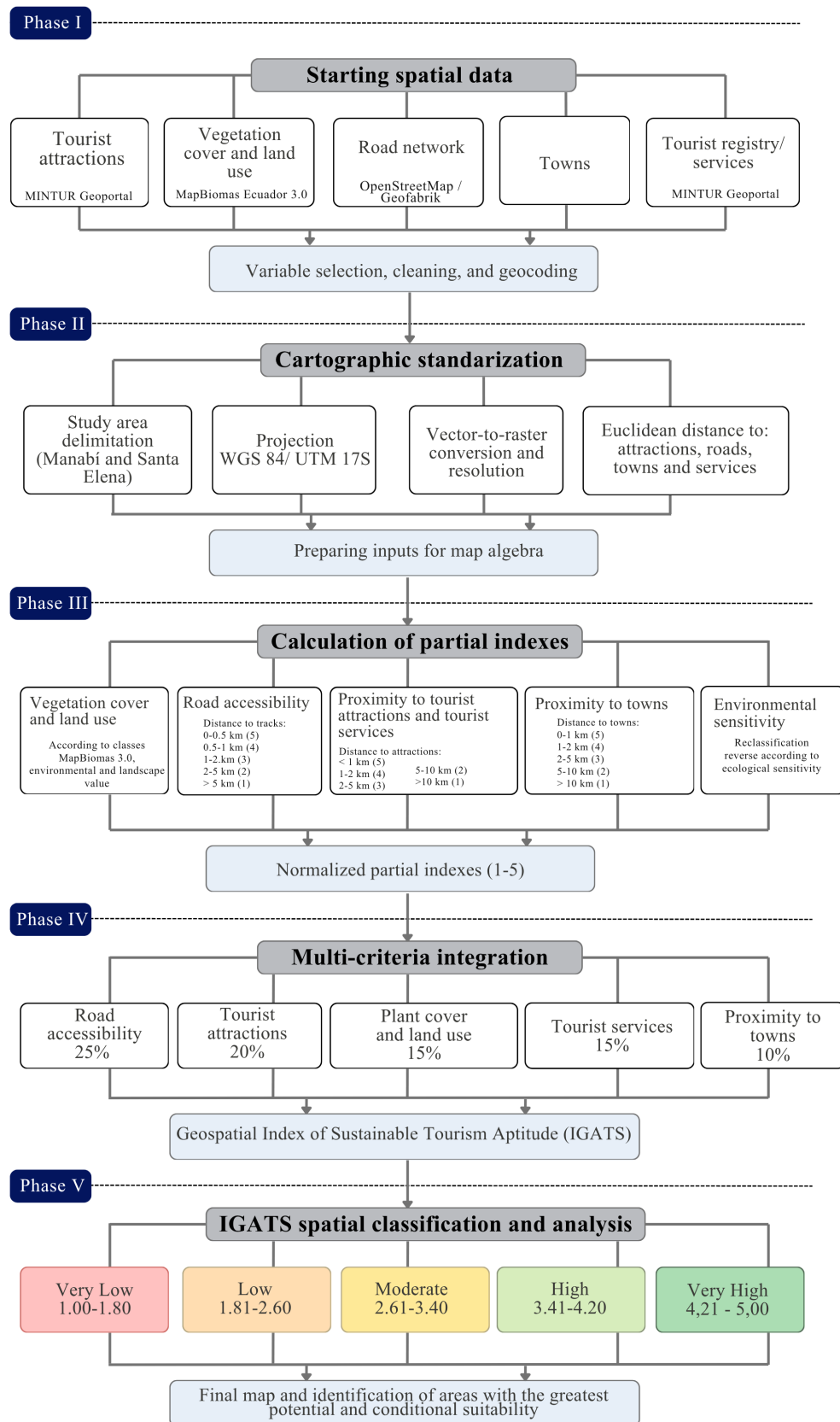


Figure 2: Methodological framework.

supporting infrastructure, and the environmental conditions of the study area. This variable-selection approach is commonly used in spatial models of tourism suitability [27, 28, 29]. Five geospatial inputs were used to construct the IGATS sub-indexes. Tourist-attraction data were obtained from the Tourist Attractions Geoportal of the Ecuadorian Ministry of Tourism and were used to represent the spatial distribution of natural and cultural tourism resources. Land-cover and land-use data for 2024 were obtained from MapBiomias Ecuador, Collection 3.0 (<https://ecuador.mapbiomas.org/>). Its classification system made it possible to distinguish natural, agricultural and livestock, urban, and other land types characterized by different levels of human intervention. Incorporating vegetation and landscape conditions into suitability models makes it possible to represent environmental attributes relevant to nature-based tourism activities [29].

Road-network data were obtained from OpenStreetMap through Geofabrik. Only primary, secondary, and tertiary roads were selected to represent effective spatial connectivity. Minor roads, trails, and internal access routes were excluded to avoid overestimating accessibility. Road connectivity is a relevant criterion in tourism suitability models because it influences access to tourism resources and destinations [30].

Population centers were incorporated as spatial proxies for supporting infrastructure and potential access to basic services. Their inclusion provided a spatial approximation of the relationship between areas with tourism potential and settlements where infrastructure and services relevant to tourism development are concentrated [27].

Tourism-service data were obtained from the National Tourism Registry of the Ecuadorian Ministry of Tourism. The database was cleaned to identify accommodation establishments, food and beverage establishments, and other services associated with tourism activities.

3.2. Phase II: Cartographic standardization

During this phase, the spatial layers were prepared to ensure their integration into the multicriteria model. First, all datasets were clipped to the provincial boundaries of Manabí and Santa Elena. The vector and raster layers were then reprojected into the WGS 84 / UTM Zone 17S coordinate reference system. All raster layers and outputs were standardized to a common spatial extent, cell size, and grid alignment. This process ensured the spatial compatibility required for the subsequent combination of criteria using map algebra.

Once the layers had been standardized, Euclidean distances were calculated from each cell in the study area to the nearest road, tourist attraction, population center, and tourism service establishment. This procedure transformed point and linear features into continuous raster distance surfaces, thereby representing spatial variations in accessibility and proximity [30].

The resulting surfaces represented proximity to infrastructure, tourism resources, and other features supporting tourism development. The use of distance as a criterion made it possible to analyze spatial variations in suitability according to the proximity to or distance from features considered relevant to tourism development [27, 31, 32].

3.3. Phase III: Calculation of the Sub-Indexes

During this phase, six sub-indexes were constructed: (i) land cover and land use, (ii) road accessibility, (iii) proximity to tourist attractions, (iv) proximity to tourism services, (v) proximity to population centers, and (vi) environmental sensitivity. Each variable was reclassified and standardized using a common five-class suitability scale: very low (1), low (2), medium (3), high (4), and very high (5). Transforming the criteria to a common scale enabled the comparison and integration of continuous and categorical variables originally expressed in different units, formats, and value ranges.

3.3.1. Land Cover and Land Use Indexes (CVUS)

The Land Cover and Land Use Index was calculated using the thematic classes from MapBiomias Ecuador, Collection 3.0. Each class was first evaluated according to its potential contribution to the development

of sustainable tourism activities. Forests and natural formations were assigned the maximum suitability score (5) [33]. Beaches, dunes, water bodies, and rock outcrops were classified as highly suitable (4); agricultural mosaics and non-vegetated natural areas as moderately suitable (3); intensive agricultural land uses, aquaculture, and urban infrastructure as having low suitability (2); and mining sites and other heavily modified anthropogenic areas as having very low suitability (1). The importance assigned to vegetation and natural landscapes is consistent with ecotourism suitability studies that consider land cover and naturalness to be relevant factors in determining the tourism potential of an area [28, 29, 30].

3.3.2. Road Accessibility Index (AV)

The Road Accessibility Index was calculated from the distance surfaces generated for the selected road network. An inverse relationship between distance and suitability was assumed, such that areas closer to the road network received higher suitability scores. This criterion was based on the importance of road connectivity in facilitating access to tourism destinations and resources, as widely incorporated into recent land-suitability models [27, 29, 30]. Distances were reclassified as follows: $\leq 0.5 \text{ km}$, very high suitability (5); $> 0.5 - 1 \text{ km}$, high suitability (4); $> 1 - 2 \text{ km}$, medium suitability (3); $> 2 - 5 \text{ km}$, low suitability (2); and $> 5 \text{ km}$, very low suitability (1).

3.3.3. Tourist Attraction Proximity Index (AT)

The Tourist Attraction Proximity Index was calculated based on the distance to the nearest natural or cultural tourist attraction. Proximity to tourist attractions was considered favorable because access to natural and cultural resources is a relevant component of spatial assessments of tourism potential [27]. Distances were reclassified as follows: $\leq 1 \text{ km}$, very high suitability (5); $> 1 \sim 2 \text{ km}$, high suitability (4); $> 2 \sim 5 \text{ km}$, medium suitability (3); $> 5 \sim 10 \text{ km}$, low suitability (2); and $> 10 \text{ km}$, very low suitability (1).

3.3.4. Tourism Service Proximity Index (ST)

The Tourism Service Proximity Index was estimated to use the same distance-analysis procedure. Higher suitability scores were assigned to areas located closer to accommodation establishments, food and beverage establishments, and other tourism services. This criterion incorporated existing visitor-support infrastructure and the capacity of the area to support tourism activities into the model. The availability and proximity of facilities and services have been incorporated into recent models as a relevant dimension for assessing tourism development potential [27].

3.3.5. Population Center Proximity Index (CP)

The Population Center Proximity Index was used to represent community support and potential access to basic services. Areas closer to settlements were considered comparatively more favorable because of their greater potential connectivity to infrastructure and services. Recent studies have incorporated distance to settlements as an ecotourism suitability criterion and have highlighted its relationship with infrastructure availability and access facilities [30]. Distances were reclassified as follows: $\leq 1 \text{ km}$, very high suitability (5); $> 1 \sim 2 \text{ km}$, high suitability (4); $> 2 \sim 5 \text{ km}$, medium suitability (3); $> 5 - 10 \text{ km}$, low suitability (2); and $> 10 \text{ km}$, very low suitability (1).

3.3.6. Environmental Sensitivity Index (SA)

Finally, the Environmental Sensitivity Index was derived from the land-cover and land-use classes and was inversely standardized in relation to suitability for intensive tourism uses. Mangroves, wetlands, and water bodies received the lowest suitability scores because of their high ecological fragility and the need to restrict intensive uses. Forests, open forests, non-forest natural formations, and beaches were classified as highly sensitive areas; rock outcrops and other non-vegetated natural areas as

having medium sensitivity; and productive or anthropogenic surfaces as having comparatively lower environmental sensitivity. Incorporating this index prevented environmentally sensitive areas from being classified as highly suitable solely because of favorable accessibility, proximity to tourist attractions, or availability of tourism services.

3.4. Phase IV: Multicriteria Integration

During this phase, the six standardized sub-indexes were integrated using a weighted-overlay procedure. This approach combined the standardized criteria according to their relative importance within the model. Weighted linear combinations and comparable aggregation procedures are commonly used in GIS-based tourism and ecotourism suitability models [26, 27, 28, 29].

The weights were established through a methodological adaptation informed by the literature and the contextual relevance of each criterion to the coastal provinces under study. Greater weights were assigned to road accessibility and proximity to tourist attractions because of their direct relationship with access to the area and the presence of resources that can attract visitors. Land cover and land use, tourism services, and environmental sensitivity received intermediate weights, whereas proximity to population centers was incorporated as a complementary criterion representing territorial support.

The final weights were 25% for road accessibility, 20% for proximity to tourist attractions, 15% for land cover and land use, 15% for proximity to tourism services, 15% for environmental sensitivity, and 10% for proximity to population centers. The IGATS was calculated using Equation (1):

$$IGATS = (AV * 0.25) + (AT * 0.20) + (CVUS * 0.15) + (ST * 0.15) + (SA * 0.15) + (CP * 0.10) \quad (1)$$

3.5. Phase V: IGATS Classification and Spatial Analysis

The values obtained through the weighted overlay were reclassified into five suitability categories: very low, low, medium, high, and very high. This five-level classification represented a progressive spatial gradient of suitability, following classification schemes previously used in geospatial assessments and recent tourism and ecotourism suitability models [29, 34, 35].

Because the six sub-indexes had previously been standardized on a scale from 1 to 5 and their weights summed to 1, the theoretical limits of this scale were retained when classifying the final index. Values from 1.00 to 1.80 were classified as having very low suitability; values greater than 1.80 and up to 2.60 as having low suitability; values greater than 2.60 and up to 3.40 as having medium suitability; values greater than 3.40 and up to 4.20 as having high suitability; and values greater than 4.20 and up to 5.00 as having very high suitability.

Finally, the IGATS map was analyzed to identify the spatial distribution of areas with the greatest potential for sustainable tourism development. Conditionally suitable areas were also identified, together with areas where tourism development would require improvements in accessibility and services or the implementation of specific environmental management measures. The resulting index therefore integrated territorial, environmental, and tourism-support conditions into a spatial representation designed to support sustainable tourism planning in the provinces of Manabí and Santa Elena.

4. Results

4.1. Partial Indexes

The partial indexes allowed the independent analysis of the spatial distribution of the criteria subsequently used to estimate the Geospatial Index of Sustainable Tourism Suitability (IGATS). At this stage, each map represents a specific factor associated with vegetation cover and land use, road accessibility, tourist attractions, tourism services, population centers, or environmental sensitivity (Figure 3).

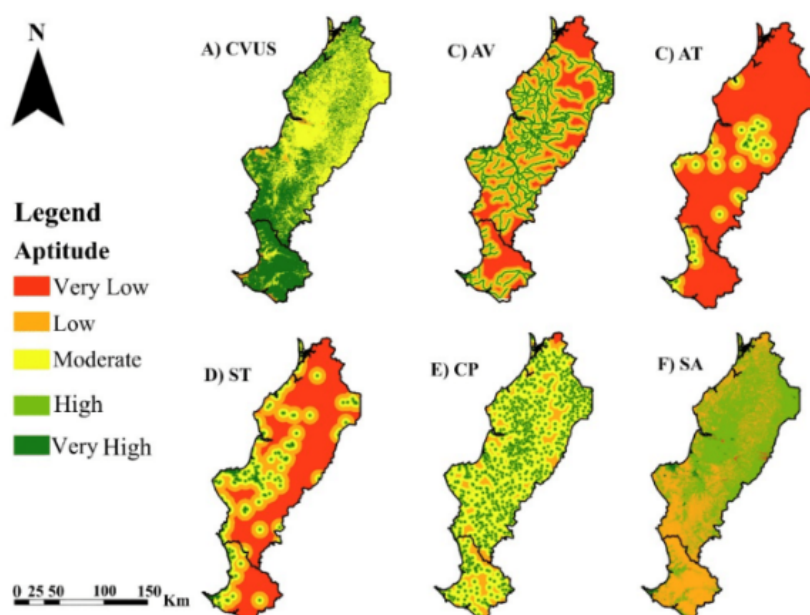


Figure 3: Spatial distribution of the partial indexes used to estimate the Geospatial Index of Sustainable Tourism Suitability (IGATS) in Manabí and Santa Elena, Ecuador: (a) vegetation cover and land-use index (CVUS); (b) road accessibility index (AV); (c) proximity to tourist attractions index (AT); (d) proximity to tourism services index (ST); (e) proximity to population centers index (CP); and (f) environmental sensitivity index (SA). The indexes were reclassified into five suitability categories: very low, low, moderate, high, and very high, represented by a color scale ranging from red for very low suitability to dark green for very high suitability.

The vegetation cover and land-use index (CVUS) showed a differentiated spatial distribution between the two provinces. In Manabí, the moderate-suitability category predominated, mainly associated with the extensive presence of agricultural areas, with a broader distribution toward the inland areas of the province. In contrast, Santa Elena was predominantly characterized by very high suitability, spatially associated with forests and natural formations, particularly in less urbanized areas and specific sectors of the province.

The road accessibility index (AV) exhibited high values around the main transportation corridors of Manabí and Santa Elena. In Manabí, this pattern was more spatially extensive, corresponding to the broader territorial coverage of the road network. In Santa Elena, high accessibility values were mainly concentrated along the main routes connecting population centers and coastal areas.

The proximity to tourist attractions index (AT) showed a localized spatial distribution around the inventoried natural and cultural attractions. In Manabí, the highest index values were observed mainly in coastal areas and at specific inland locations. In Santa Elena, the highest values were concentrated primarily around tourist attractions located along the coastal strip.

The proximity to tourism services index (ST) showed that tourism services in both Manabí and Santa Elena are mainly concentrated near the coastline and the principal urban centers. Consequently, areas located closer to these establishments exhibited the highest values within this partial index.

The proximity to population centers index (CP) showed a broad distribution of moderate and high values across both provinces. In Manabí, the more dispersed spatial distribution of settlements was reflected in a greater territorial extent of moderate and high index values. In Santa Elena, the highest values were concentrated around the main population centers and their surrounding areas.

The environmental sensitivity index (SA) differentiated areas according to their level of environmental sensitivity. In Manabí, higher sensitivity values were observed in areas associated with natural land cover, water bodies, and coastal ecosystems. In Santa Elena, higher sensitivity values were primarily associated with natural environments and environmentally sensitive coastal areas.

4.2. Multi-criteria integration

The final map of the Geospatial Index of Sustainable Tourism Suitability (IGATS) showed a heterogeneous spatial distribution across Manabí and Santa Elena (Figure 4; Table 1). The low, moderate, and high suitability categories accounted for the largest proportions of the study area, whereas areas classified as very highly suitable showed a more localized distribution, mainly in sectors close to tourist attractions.

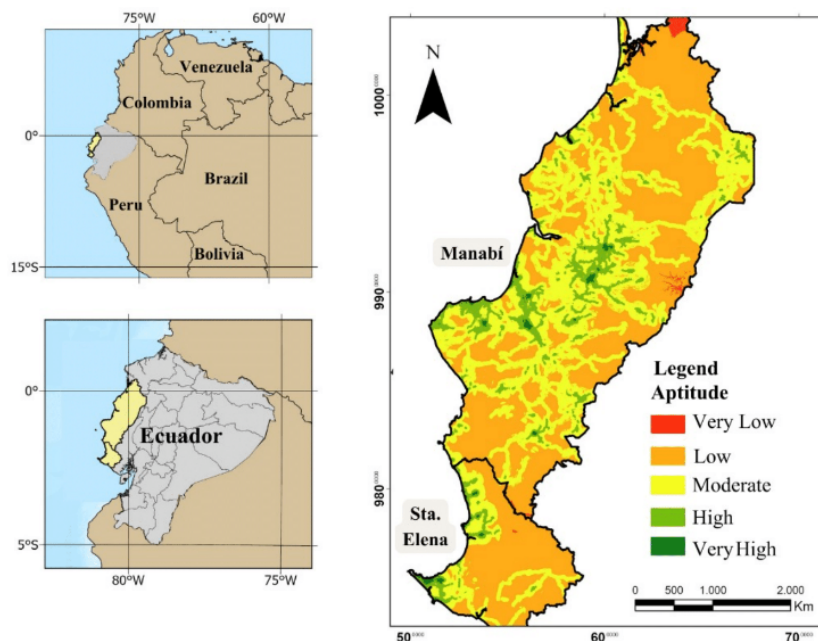


Figure 4: Spatial distribution of the Geospatial Index of Sustainable Tourism Suitability (IGATS) in Manabí and Santa Elena, Ecuador. The study area was classified into five suitability categories: very low, low, moderate, high, and very high.

In Manabí, the very low suitability category covered 160.42 km² (0.85% of the analyzed provincial area). The low suitability category accounted for the largest area, covering 9,432.06 km² (49.83%), followed by the moderate suitability category, which covered 7,831.85 km² (41.37%). The high and very high suitability categories covered 1,428.62 km² (7.55%) and 76.27 km² (0.4%), respectively.

Table 1

Distribution of area among IGATS suitability categories in Manabí and Santa Elena.

Province	Very low (km ²)	Low (km ²)	Moderate (km ²)	High (km ²)	Very high (km ²)	High + Very high (km ²)
Santa Elena	3,64	2.394,37	936,59	260,04	46,44	306,48
Manabí	160,42	9.432,06	7.831,85	1.428,62	76,27	1.504,89

Nota. Areas are expressed in km² and correspond to the five suitability categories obtained through the reclassification of the IGATS.

At the cantonal scale, the analysis focused on the combined area classified as high and very high suitability, as these categories represent the highest levels of suitability within the IGATS (Table 2). The largest areas were recorded in Chone (272.36 km²), Santa Elena (238.53 km²), Portoviejo (221.33 km²), Manta (135.23 km²), and Bolívar (109.44 km²). These cantons contain the largest areas classified as favorable within the model and represent priority territories for assessing tourism development strategies that are compatible with environmental conservation and sustainable land management.

Table 2

Cantons with the largest areas classified as high and very high IGATS suitability.

Canton	Very low (km ²)	Low (km ²)	Moderate (km ²)
Chone	258,82	13,54	272,36
Santa Elena	212,86	25,67	238,53
Portoviejo	200,59	20,74	221,33
Manta	129,09	6,14	135,23
Bolívar	95,67	13,78	109,44

Nota. The ranking was calculated based on the combined area classified as high and very high suitability.

5. Discussion

The Geospatial Sustainable Tourism Suitability Index (IGATS) identified spatial differences in tourism suitability across Manabí and Santa Elena. The results indicate that the spatial patterns of suitability reflect the combined influence of road accessibility, tourist attractions, tourism services, population centers, land cover, and environmental sensitivity. This finding is consistent with Ecuadorian studies emphasizing the importance of assessing coastal tourism in relation to infrastructure, environmental management, and the conservation of tourism resources [23, 36].

In Manabí, the low and medium suitability categories predominated, covering 9,432.06 km² and 7,831.85 km², respectively. Although the province has a large land area and diverse environmental and tourism conditions, the areas with the highest relative suitability were concentrated in specific locations. This result is consistent with [23], who reported that Manabí has favorable conditions for coastal geotourism because of its beaches, cliffs, cultural attractions, and geoheritage resources. However, they also emphasized the need to integrate tourism development with geoconservation and geoeducation strategies.

In Santa Elena, the low and medium suitability categories also predominated, covering 2,394.37 km² and 936.59 km², respectively. Although the province has a smaller area than Manabí, its high- and very-high-suitability areas were associated with locations where accessibility, tourism services, and proximity to tourism attractions converged. This interpretation is particularly relevant to the Santa Elena Peninsula Geopark Project. [25] reported that the project seeks to highlight the geological, mining, scenic, and cultural value of the territory as a basis for promoting geotourism, environmental education, and appreciation of its natural heritage. The authors also identified geosites and geo-resources with the potential to support community development through geotourism.

The cantonal analysis provided a more detailed identification of the areas with the largest extent in the high and very high IGATS categories. The largest combined areas were recorded in Chone, Santa Elena, Portoviejo, Manta, and Bolívar cantons. These cantons contain areas with favorable conditions according to the model and may therefore represent strategic locations for sustainable tourism planning, provided that land-use decisions incorporate conservation, environmental management, and local participation. This approach is consistent with recent Ecuadorian studies of geotourism routes, which emphasize that tourism planning should focus not only on identifying resources but also on conserving them through interpretive, educational, and land-management activities [37].

Similarly, studies conducted in Ethiopia, Sri Lanka, India, and Brazil have shown that models based on geographic information systems and multicriteria decision analysis (GIS-MCDA), the analytic hierarchy process (AHP), weighted linear combination, and fuzzy inference can identify areas with ecotourism potential and support land-use planning [28, 29, 34, 38]. These studies support the potential applicability of the IGATS as a decision-support tool for prioritizing areas, guiding tourism-planning strategies, and integrating tourism development with sustainability criteria.

Finally, although IGATS provides a useful spatial assessment, its results should be interpreted as

decision-support information rather than as a definitive zoning instrument for tourism development. The model depends on the quality and currency of the geospatial inputs and on the weights assigned to the criteria. Moreover, it does not directly incorporate socioeconomic variables, community perceptions, tourism carrying capacity, or field validation. Its practical application should therefore be complemented by local information and the participation of local stakeholders.

6. Conclusion

The spatial distribution of IGATS values indicates that sustainable tourism planning requires an integrated spatial perspective. Areas with higher relative suitability were not limited to locations near tourist attractions but also included areas where road connectivity, territorial support, and service availability converged. At the same time, incorporating environmental sensitivity helped prevent fragile ecosystems from being classified as favorable solely because of their scenic or tourism value. In this regard, the index can serve as a decision-support tool for guiding land management and prioritizing areas where tourism development could be planned in a manner compatible with environmental conservation.

Manabí had the largest absolute area in the high and very high suitability categories, totaling 1,504.89 km², equivalent to 7.95% of its analyzed area. In Santa Elena, these categories covered 306.48 km², corresponding to 8.42% of its analyzed area. Although Manabí had a larger absolute extent, Santa Elena had a slightly higher proportion of areas classified as having high or very high suitability. The cantons with the largest combined areas in these categories were Chone, Santa Elena, Portoviejo, Manta, and Bolívar. These cantons may represent priority areas for sustainable tourism initiatives if planning decisions account for environmental sensitivity, local management capacity, and compatibility with existing land uses.

The proposed methodology offers a potentially replicable framework for other coastal areas because it integrates available spatial information, standardized criteria, and GIS-based multicriteria analysis. Its application can support sustainable tourism planning, the prioritization of territorial interventions, and the integration of local development, environmental conservation, and responsible land management. Future development of the model should incorporate standardized field-survey forms and the participation of local stakeholders to strengthen its applicability to land-use planning and decision-making.

Declaration on Generative AI

During the preparation of this work, the authors used Grammarly to perform grammar and spelling checks. After using this tool/service, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the publication's content.

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