"A Journey Between Sky and Sea": Investigating Tourism Ecosystem in Madeira

Lucia Randò[1(✉)], Marianna Scavone[1], Simona Tarantino[1], Rachele Vanessa Gatto[2], and Francesco Scorza[2]

[1] DIUSS, University of Basilicata, Via Lanera, Matera, Italy
{aurora.dalto,lucia.rando,marianna.scavone,
simona.tarantino}@studenti.unibas.it
[2] School of Engineering, University of Basilicata, Viale dell'Ateneo Lucano, Potenza, Italy
{rachelevanessa.gatto,francesco.scorza}@unibas.it

Abstract. Sustainable development strategies at urban and regional levels encompass a multidisciplinary discourse integrating global perspectives with practical insights into sustainable urban planning, land use, transportation, and ecological design. Addressing the tensions between economic growth, social equity, and environmental preservation, current trends in policy recommendations draw from international institutions and academic research. Tourism emerges as a pivotal sector in urban sustainability discourse, shaping policy and design across multiple scales and stakeholders. This paper presents a case study applying the STESY model to Madeira Island, Portugal, a region witnessing substantial growth in its tourism industry. With nature-based tourism as its focus, the study employs open data and cluster analysis to identify local tourism Destination Areas, guided by a strategic framework developed through collaborative efforts with architectural students from the University of Basilicata. Focusing on tourism as a critical component of territorial planning, the paper advocates for a decision support system aligned with the New Urban Agenda, emphasizing context-based design and sustainable development principles. The methodology outlines the STESY model application, culminating in a proposed development strategy titled "A Journey Between Sky and Sea" aimed at enhancing Madeira's tourism ecosystem while preserving its local identity and sustainability. Discussions and conclusions highlight research insights, limitations, and future directions for sustainable tourism development.

Keywords: New Urban Agenda · Sustainable development · Sustainable tourism ecosystem · STESY

1 Introduction

Sustainable development strategies for urban and regional level are an umbrella concept linking together relevant debate from an interdisciplinary perspective. From the global perspective [1–3] to the operational level of key essays discussing various aspects of

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sustainable urban planning, land use, transportation, and ecological design [4]. Challenges and opportunities of sustainable urban development generally are positioned in the conflicts between economic growth, social equity, and environmental preservation in urban planning [5].

Current trends, more than standard rules, in policy recommendations are at the basis of key international institutional references [6, 7] and academic applications [8–11].

Tourism is a key sector for current debate in urban sustainability [12–16] and it represents and horizontal domain of policy making and design implementation in a multiscale [17, 18] and multistakeholder perspective [19].

In this case study we refer to an application of the STESY model in a specific case study: the Madeira island in Portugal. Madeira is a Portuguese region identifying an archipelago located in the North Atlantic Ocean. Portugal's tourism industry has experienced significant growth in recent years, establishing the country as a premier global destination. In 2023, Portugal welcomed 18.2 million international visitors, marking a 19% increase from 2022 and an 11% rise compared to 2019. Madeira's tourism sector has demonstrated remarkable growth in recent years, solidifying its status as a mayor destination. In 2023, the region welcomed approximately 1.53 million international tourists, making it the fourth most visited area in Portugal. The upward trend continued into 2024, with Madeira achieving record-breaking figures. The island received over two million visitors, marking a significant milestone in its tourism industry. Due to the "nature based" tourism specialization in Madeira, the management of current tourism trends represents a planning priority in the area in the perspective of sustainable and inclusive tourism development.

The objective of the application is to design a strategic framework for developing local tourism system on the ground of a robust analytical process oriented to identify local tourism Destination Areas according to STESY methodological framework. Open data and Cluster analysis are applied in order to combine interpretative approach to quantitative design approach during studio lab developed with architectural university students at University of Basilicata.

Tourism as a territorial planning component represents the disciplinary position of this paper, we aim at provide qualified decision support system in defining and support policy making territorial development process referring to the New Urban Agenda as a toolkit for better decision and better "context based" design [20– 23].

The paper presents the research methodological framework and process. Then, it describes the case study area and the analytical approach based on STESY model. The proposed development strategy "a journey between sky and sea" integrates local characters and sustainable issues related to enhance tourism eco-system in Madeira. Discussions and conclusions section proposes main highlights of the research, limitations and future perspectives.

2 Background and Scope of the Research

The STESY model [23] serves as a conceptual framework for analyzing and organizing knowledge related to specialized tourism phenomena, with a particular focus on spatial and territorial aspects. This taxonomy provides a structured system for classifying and managing information, supporting the analytical process from the initial phase of territorial classification to the development of strategic decision-making frameworks. The hierarchical approach of the model enables the classification of specialized tourism into three distinct levels: Specialized Tourism Ecosystem, Specialized Tourism System, and Specialized Destination Area (DAj). The latter represents the primary unit of analysis for describing the territorial tourism supply. A DAj does not necessarily correspond to traditional administrative boundaries but is instead defined by the spatial and functional organization of the local tourism system. Consequently, a DAj may encompass multiple municipalities or, conversely, multiple DAj may exist within a single municipal boundary. The conceptualization of DAj is formalized as follows:

$$\mathbf{DA_j} = \mathbf{f}\left(\mathbf{a_j}, \mathbf{s_j}, \mathbf{R}\right)$$

where:

- a*j* (Attractors) refers to physical points of interest (POIs), including officially recognized national and international tourist attractions (e.g., UNESCO sites, certified historic villages, Blue Flag locations, etc.).
- s*j* (Services) includes facilities within the tourism supply chain, such as accommodations and restaurants, each defined by specific locations and attributes.
- r (Reachability) represents the accessibility of the destination, encompassing the infrastructural and organizational system that allows visitors to reach the area via different modes of transportation (e.g., train stations, bus terminals, parking facilities).

A key aspect of the STESY model is the concept of tourism specialization (j), which categorizes a destination based on its predominant tourism type (e.g., cultural, gastronomic, nature-based tourism). This approach enables a detailed understanding of the relationships between functional sub-regions within a territory, facilitating the formulation of data-driven tourism development strategies. By applying this methodology to selected case studies, it is possible to construct a territorial network, enhancing the comprehension of spatial interconnections within the tourism system.

The research approach is based on the following phases (Fig. 1):

1. Analysis: Case study description through main tourism statistics, policies and analytics.
2. Application of STESY model: spatial data selection and classification, stakeholder identification, DA identification and benchmarking
3. Design: objectives identification, territorial scenario and design solutions, NUA compliance assessment.

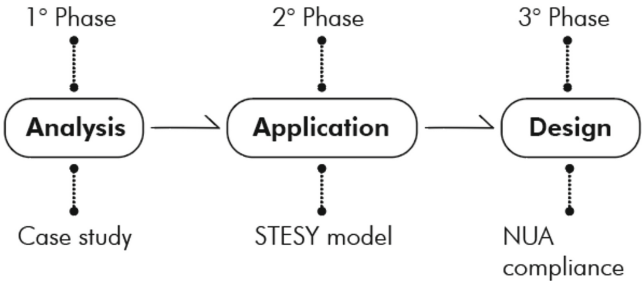

Fig. 1. Description of the methodological framework.

3 Case Study Analysis: Madeira Island

Madeira's tourism industry is deeply related with its unique natural and cultural identity. The capital, Funchal, plays a central role in attracting visitors through its blend of colonial heritage, botanical gardens, and vibrant cultural scene. Additionally, rural areas, with their traditional *"levadas"* (irrigation channels) and terraced vineyards, contribute to a diversified tourism offering that balances coastal leisure tourism with inland ecotourism experiences. Tourism policies in Madeira are shaped by a multi-level governance system involving regional and national authorities. The autonomous government implements strategic policies aimed at balancing economic growth with sustainability, focusing on infrastructure improvements, environmental conservation, and the diversification of tourism products[24]. The regional tourism plan aligns with European Union directives on sustainable tourism, emphasizing low-impact tourism models and the promotion of cultural heritage. Investment in connectivity, including airport expansion and port upgrades, further supports the sector's growth. Moreover, the region's branding strategy positions Madeira as a high-quality destination, leveraging digital marketing and partnerships with international travel platforms to enhance its global visibility. Statistical data from the Madeira Regional Institute of Statistics reveal significant trends in the island's tourism performance. Air and sea connectivity play a vital role in visitor inflows, with 67.5 million arrivals by air and 1.93 million by sea recorded in 2024 (https://app.powerbi.com/- 18 March 2025). Overnight stays data indicate a resilient tourism sector, with a sharp decline in 2020 due to the COVID-19 pandemic, followed by a steady recovery reaching pre-pandemic levels by 2022. The average length of stay has remained relatively stable over time, suggesting a well-established tourism model that caters to both short-term and extended visits. These data-driven insights support strategic planning, enabling policymakers to tailor tourism strategies that enhance visitor experiences while ensuring long-term sustainability [25–27].

3.1 Application of STESY Model: Reinforcing "Nature Based" Tourism Infrastructure Connecting the Coastal Area to the Inland Regions

The analysis of the territorial system and tourism offer of the Autonomous Region of Madeira was conducted by dividing the elements into three main categories according to STESY model: Attractors, Services, Reachability.

These elements total 2,603. The attractors are further categorized into cultural and natural. Cultural attractors include museums, traditional houses, and churches, while natural attractors consist mainly of theme parks, gardens, and viewpoints, with the latter being the most prevalent.

Services encompass infopoints, campsites, picnic areas, hotels, hostels, and various accommodation and catering facilities. Regarding accessibility, the analysis includes parking areas, the port, and airports - Madeira has two airports, one in Santa Cruz and another in Porto Santo.

The tourism offer is further enriched by 24 hiking trails aimed at enhancing the region's appeal. These routes are a key attraction for outdoor tourism. The capital, Funchal, stands out for its high concentration of cultural attractions.

From the stakeholder analysis, it was possible to identify the main actors involved in tourism management and their relationships. The sector's governance is divided between public and private entities:

- Natural and cultural attractions are mainly managed by the public sector.
- Reachability is managed by both public and private entities.
- Services are overseen by both sectors.

Building on the tourism supply map (Fig. 2), a further analysis was conducted using GeoDa software [28] to identify clusters of elements based on their proximity within the overall system [29]. This process highlighted eight clusters, each named after the main reference city in its respective area.

The analysis of aggregated data revealed an uneven distribution of accommodation facilities and services across the areas, while viewpoints are more evenly spread. Additionally, the number of hiking trails within the tourist destination was found to be significantly lower. Their current location is not strategically aligned with enhancing the natural heritage, as, unlike viewpoints, which are evenly distributed, the trails are concentrated inland. This results in a noticeable disparity between hiking routes and viewpoints.

In the previous figure the eight Destination Areas are identified and described in terms of at-tractors, services and reachability facilities. For each DA an in-depth analysis was conducted in order to compare the local hiking routes classifying per difficulty level, extensions and morphological features [30–33].

3.2 The Design Proposal: "a Journey Between Sky and Sea"

A key aspect of the project (Fig. 3) is the enhancement of accessibility to the natural capital intended as a tourism specialization in Madeira and safety in terms to deliver an "accessible for all" network of official hiking routes connecting coastal area with inland natural sites. Such features have been identified as critical factors for fostering tourism development in the region. Therefore, the proposal includes the creation of additional hiking trails while simultaneously considering the development of eco-sustainable diffuse housing on Porto Santo Island, which currently lacks such facilities, as well as on Madeira Island.

The project references the New Urban Agenda (NUA), a framework promoting inclusive, accessible, and socially responsible cities [34].

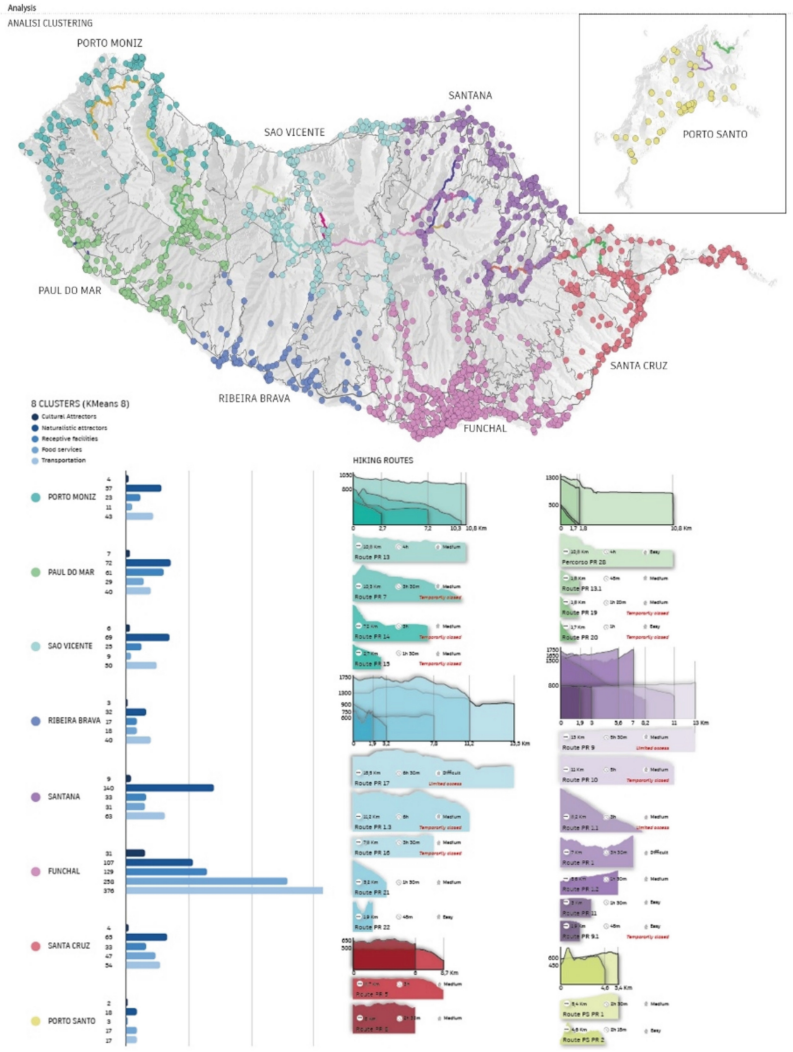

Fig. 2. Study area with Destination areas identification

The project includes the creation of 10 new hiking trails, totaling 180 km. Each trail follows a structured design model, incorporating hiking facilities.

The primary objective of the project is to enhance tourism quality, increase safety, and strengthen the local tourism system, addressing current weaknesses.

One significant finding from the analysis is that many existing hiking trails are either closed or fail to connect the coastal urban areas with the inland regions [35]. To bridge this gap, the project proposes a network of routes that originate from the coast and extend inland, fostering a more integrated and efficient tourism system.

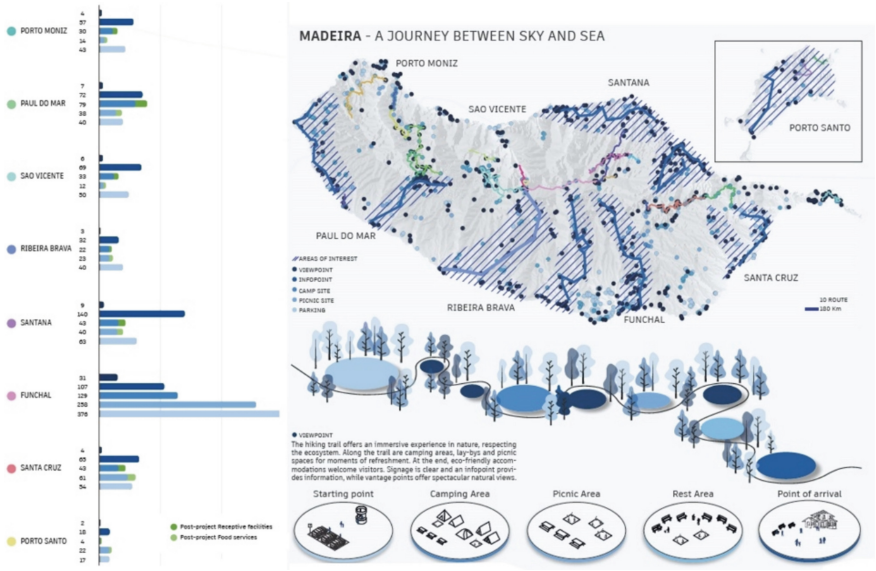

Fig. 3. Design: a journey between sky and sea.

As main general components of a hiking routes were identified in "Starting point" (gates) of the route, "camping areas", "picnic areas" and "rest area". Such elements promote a standardized approach for the design of each single routes promoting also an improvement in each destination area increasing services and reachability equipment[36].

4 Discussion E Conclusions

This research discussed a procedural approach based on the STESY model to develop a territorial sustainable tourism development strategy for Madeira (PT) with a particular focus on sustainability and inclusivity. In order to support evidence-based decision-making, by applying the STESY model, we have identified key tourism Destination Areas (DAj) and analyzed their components: Attractors, Services, and Reachability. Our findings underscore the need for a balanced tourism strategy that integrates natural and cultural heritage with sustainable infrastructure improvements, addressing to nature trails network as potential solutions to reinforce Madeira tourism supply system [37–39].

The proposed development strategy, "A Journey Between Sky and Sea," aligns with the New Urban Agenda by enhancing accessibility, fostering environmental conservation and promoting responsible tourism practices. The implementation of a new hiking trails network equipped with eco-sustainable accommodations aims to create a more structured and resilient tourism system that benefits both visitors and local communities. It represents a strategy to overcome the under-exploitation of local characterized natural POIs providing a more balanced tourism supply chain between coastal areas and inland mountainous sites.

While our study provides valuable insights into Madeira's tourism landscape, it also highlights certain limitations. Limitations derive from data source (mainly based on open data [40] - Open Street Map - implemented in the STESY model) and the need to involve local operators and stakeholders in the design procedures in order to enhance the local validations of the proposal.

This study was conducted on the basis of a University Class Studio conducted with Architectural students at the Basilicata University. Therefore, the character of the application is an academic application more than a real case study test. It reinforces a teaching objective oriented to test downscaling of the New Urban Agenda Principles on different topics and thematic area [41–45].

Future research should explore advanced spatial analysis techniques and participatory approaches to refine the STESY model [46–49] implementation placing results in the framework of real decisions making processes for tourism policymaking in Madeira [50–54]. Enhancing tourism governance, by continuing to integrate sustainability principles into urban and regional tourism planning[55], Madeira can further solidify its position as a leading destination while preserving its unique cultural and natural assets.

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