Symbiotic Territories: Application of the STESY Framework for Rebalancing Tourism Flows Between Granada and Sierra Nevada

Martina Caterina Addabbo[1(✉)], Sonia Legrottaglie[1], Dalila Sigrisi[1], Rachele Vanessa Gatto[2], and Francesco Scorza[2]

[1] DIUSS, University of Basilicata, Via Lanera, Matera, Italy
{martina.addabbo,sonia.legrottaglie,
dalila.sigrisi}@studenti.unibas.it
[2] DIING, University of Basilicata, Viale dell'Ateneo Lucano, Potenza, Italy
{rachelevanessa.gatto,francesco.scorza}@unibas.it

Abstract. Granada and Sierra Nevada constitute a highly sensitive tourism system characterized by the spatial coexistence of two differentiated tourism environments: an urban heritage destination and a mountain tourism area. Within this configuration, Granada concentrates cultural tourism flows within its historic core, producing localized pressure on urban services, housing dynamics, and public space. Conversely, Sierra Nevada is characterized by a strongly seasonal tourism regime, marked by a pronounced concentration of demand during the winter period. In this context, the present study applies the STESY framework to support the spatial interpretation and strategic assessment of the territorial system. The methodological approach integrates territorial analysis and the application of composite indicators, including the Attraction Potential Index (API), the Balanced Tourism Supply Index (BTSI), and the Diversity Reachability Index (DRI), in order to examine the distribution of tourism functions, territorial performance, and spatial complementarities across the study area.

The results reveal differentiated territorial configurations and uneven patterns of tourism specialization, reflecting the coexistence of heterogeneous functional structures and distinct pressure regimes. On this basis, the study outlines a planning strategy structured around thematic hubs, sustainable mobility interventions, and a digital incentive system aimed at improving stay distribution, supporting a more balanced use of territorial resources, and enhancing the overall performance of the Granada–Sierra Nevada tourism system.

Overall, the proposed framework contributes to the advancement of policy-oriented and transferable approaches for the spatial planning of tourism in complex urban–mountain destinations.

Keywords: Sustainable tourism planning · spatial analysis · cluster analysis

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1 Introduction

Sustainable tourism becomes more and more a core argument in territorial development debate defining local multi-stakeholders' perspectives and global framework for innovation and better management of such complex phenomena [1, 2]. Today tourism is recognized as a dominant driver of economic growth in coastal and heritage destinations, yet its rapid expansion has also generated critical spatial and temporal imbalances [3]. In the perspective of the authors, tourism opens to relevant debate in urban and regional planning research as the decision making process connected with tourism management represent a comprehensive framework in which sustainable urban regeneration and transformation, landscape protection actions, economic development issues interacts generating an effective environment to apply sustainable urban development principles, methods and agendas for short term and strategic territorial design [4–8]. Those applications are also oriented to improve the competences of students in academic curricula dealing with territorial design professionals, and this paper comes as a result of a studio in architectural classes following the research tradition [9–14] of sustainable urban planning and design at UNIBAS [15–18].

Tourism as a spatial phenomenon is a multidisciplinary domain where spatial dimension represents a robust analytical dimension for managing information and designs, applying collaborative approach for strategic planning [19–25].

This issue becomes especially relevant in territorial contexts characterized by marked internal differentiation, where multiple tourism environments coexist within the same regional system while expressing distinct functional profiles, temporal rhythms, and development patterns. In such configurations, tourism demand often tends to concentrate within a limited number of highly attractive nodes, while surrounding areas may remain comparatively less activated despite the presence of significant territorial resources and latent tourism potential. These dynamics may contribute to uneven spatial development, localized pressure on specific areas, and limited redistribution of tourism-related opportunities across the wider territory [26].

Granada and Sierra Nevada provide a relevant case study within this perspective. The system combines one of the most significant historic urban destinations in southern Spain with a major mountain tourism area associated with winter sports and high-value natural landscapes [27]. Within this territorial configuration, Granada concentrates cultural tourism flows within its historic urban fabric, whereas Sierra Nevada is characterized by a strongly seasonal tourism regime. The coexistence of these differentiated tourism environments gives rise to a complex territorial structure, shaped by heterogeneous forms of tourism use, distinct spatial pressures, and uneven functional organization [28].

This paper aims to develop a spatially informed planning framework capable of supporting the transition from a short-duration, high-pressure tourism model toward a more balanced system based on extended stays and territorial redistribution. The study proposes an integrated methodological approach combining spatial analysis, cluster-based interpretation, and policy-oriented design strategies in compliance with NUA principles. The contribution lies in bridging analytical diagnosis and operational planning within a coherent framework transferable to similar tourism destinations.

2 Study Area

The study area is located in the province of Granada, in the Andalusian region of southern Spain, and includes the urban system of Granada together with the mountain environment of Sierra Nevada. The territory is characterized by an exceptional morphological and functional duality, where in a relatively limited spatial extent it is possible to move from the dense and historically stratified urban core of Granada to the high-altitude natural landscapes of one of the most important mountain systems of the Iberian Peninsula.

The territorial reading highlights the coexistence of two highly differentiated tourism models. This polarization is also reflected in the temporal structure of tourism demand and in the differentiated pressure patterns affecting the two components of the system. As shown by the monthly distribution of tourist arrivals (Fig. 1) and overnight stays (Fig. 2), Granada maintains a relatively stable tourism profile throughout the year, with moderate seasonal variation and consistently high accommodation demand across multiple months. This condition is associated with an intense and continuous use of the urban tourism system, which in recent years has been increasingly exposed to overtourism-related dynamics. In particular, the concentration of more than 2.6 million annual visitors, the progressive expansion of short-term rental accommodation, and the prevalence of short-stay visitation patterns have contributed to increasing pressure on housing availability, urban services, public space, and the socio-spatial balance of the historic fabric, particularly in the Albaicín area. By contrast, Sierra Nevada exhibits a markedly concentrated temporal pattern, with tourist flows and overnight stays strongly clustered in the winter season and sharply reduced during the rest of the year. This seasonal concentration intensifies the use of mountain infrastructure and accessibility systems during peak months, producing localized congestion and significant management pressures. Overall, these dynamics highlight the coexistence of two distinct tourism regimes within the same territorial system: a more continuous and diversified urban demand in Granada, and a highly seasonal mountain demand in Sierra Nevada, characterized by a limited temporal utilization of tourism infrastructure and services.



Fig. 1. Comparative Tourist Arrivals in Granada and Sierra Nevada. Source: Personal elaboration of data from Instituto Nacional de Estadistica.

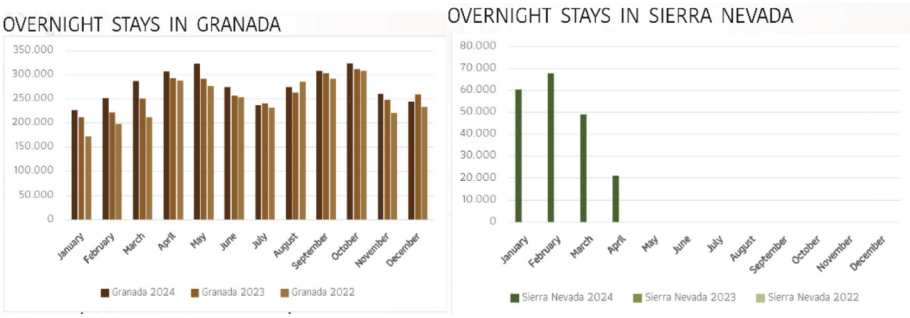

Fig. 2. Comparative Overnight stays in Granada and Sierra Nevada. Source: Personal elaboration of data from Instituto Nacional de Estadistica.

3 Territorial Analysis

The approach adopted in this study is based on the STESY framework [29] conceived as an integrated analytical and interpretative tool for the identification of territorial imbalances and the support of evidence-based planning strategies.

The first phase consists of a contextual analysis of the study area, focusing on the identification and classification of key georeferenced components (PoIs) of the tourism system, including attractors, services, and reachability (Fig. 3).

Granada represents a consolidated cultural tourism destination whose identity is strongly rooted in its historic and architectural heritage. The urban structure is dominated by the monumental complex of the Alhambra and by the historical districts of Moorish origin, particularly Albaicín, both recognized as UNESCO heritage assets. These elements constitute the primary attractors of tourism demand and define the city as a destination with strong symbolic and experiential value.

In contrast, Sierra Nevada constitutes a valuable environmental system and an important node of winter tourism in the south of Spain. The region includes protected natural territories and contains one of the most popular ski resorts in the country, located in Pradollano and the nearby high-altitude structures. Regarding its relevance to tourism, the mountain complex is linked to winter sports, but it remains underutilized outside of winter.

The attraction dimension incorporates cultural, historical, scenic, and experiencial assets that add value to a tourist destination in terms of castles, towers, monu-ments, churches, museums, galleries of arts, theaters, artworks, ancient ruins, squares, quarters, villages, rivers, bridges, waterfalls, observation points, observatories, mountains, and hiking trails. Such factors embody the main spatial elements of tourism attractiveness and form the basis for distinct identity features of both urban and mountain territories.

The service dimension encompasses tourism-oriented infrastructure that enables accommodation and hospitality services, such as hotels, hostels, restaurants, camp-ing sites, mountain lodges, recreational areas for caravans, gift stores, markets, picnicking grounds, public lavatories, fountains, and maps of tourist routes. This category was used to assess the functional capacity of the territory to host and support tourism demand across different spatial contexts.

Finally, the reachability dimension refers to the accessibility structure of the tourism system and includes strategic transport and mobility infrastructures such as the airport, railway station, bus station, highways, and local bus connections. This component was considered in order to evaluate the degree of territorial accessibility and the potential connectivity between the main tourism environments.

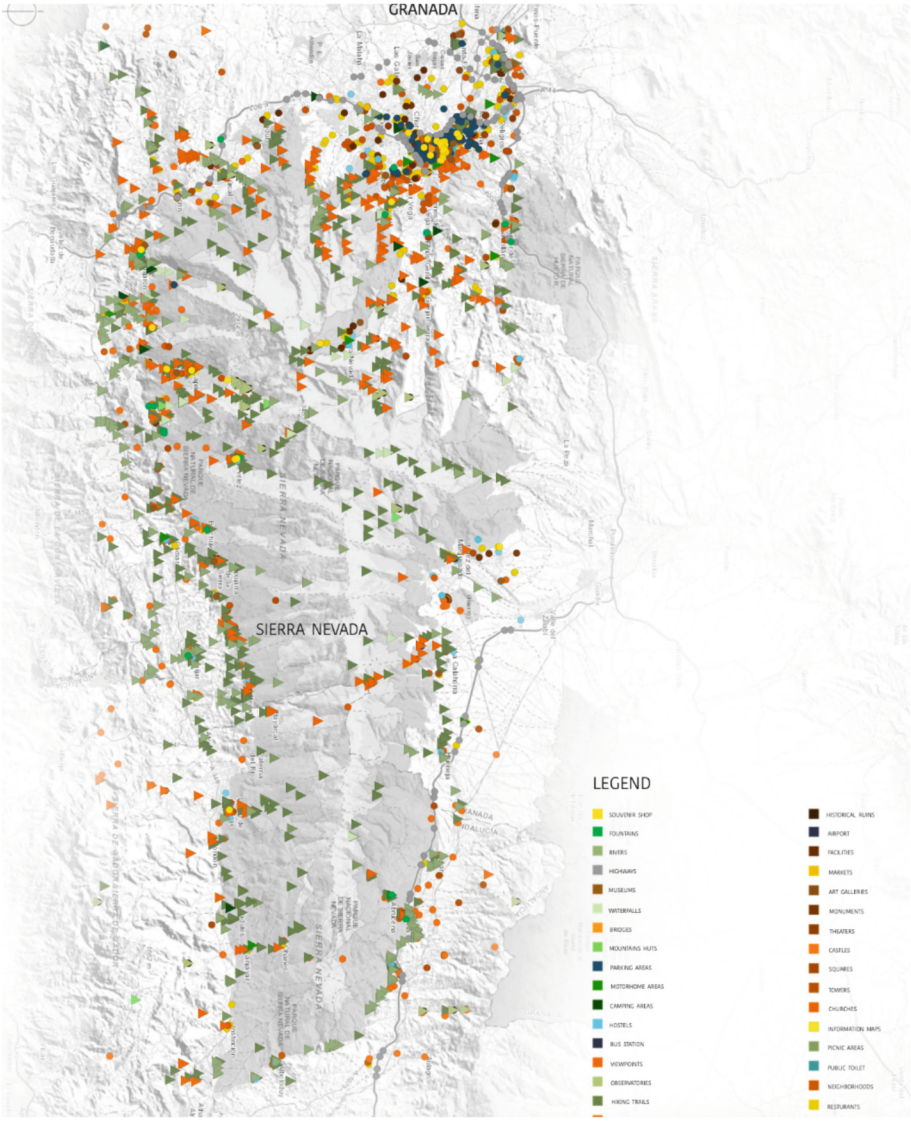

Fig. 3. Distribution of Attractors, services and reachability in Sierra Nevada e Granada

The second phase involves the spatial interpretation of these components through a cluster-based approach in order to identifying the Destination Areas of the tourism system in the case study. The territorial system is divided into homogeneous clusters using GeoDA software[30] aimed at identifying distinct spatial patterns. The optimal number of clusters is determined through the application of the Elbow Method[31], ensuring a balance between analytical detail and interpretative clarity (Fig. 4).

The three clusters therefore represent: (1) the urban Destination Area associated with Granada, (2) the transition Destination Area corresponding to the intermediate foothill belt, and (3) the mountain Destination Area centered on Sierra Nevada and the ski-related environment.

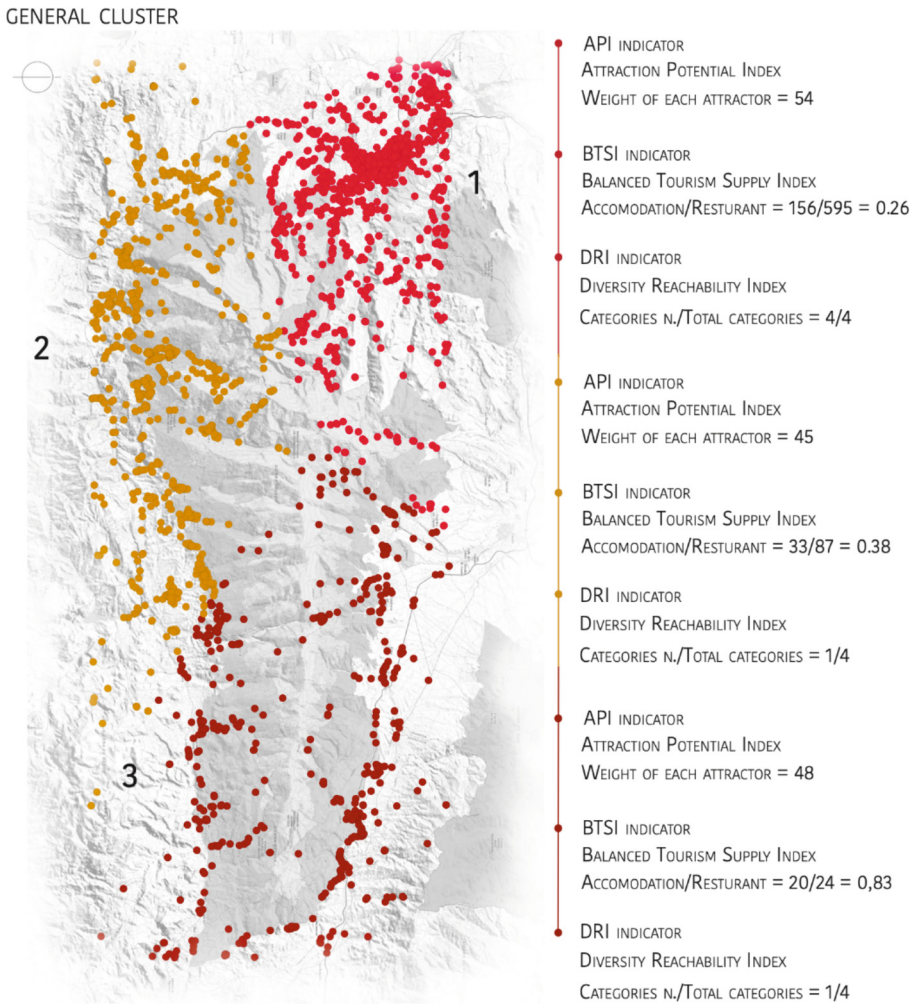

Fig. 4. Clusters identified of Attractors, services and reachability and Indicators.

To quantify the characteristics of each cluster, three indicators are employed (Fig. 4): The Balanced Tourism Supply Index (BTSI), The Attraction Potential Index (API) and the Diversity Reachability Index (DRI).

The API evaluates the territorial strength of the attractors present in each cluster. The results show a relatively high attraction potential across the entire system, with the urban detsination area reaching the highest value (54), followed by the mountain destination area (48) and the transition destination area (45). These values indicate that even the non-central areas possess a significant intrinsic tourism potential. However, the inability of these areas to attract proportionate tourism demand suggests that attraction alone is insufficient when not supported by a coherent system of services and mobility infrastructures.

The BTSI measures the balance between accommodation and food-related services, offering insight into the type of tourism structure that characterizes each destination area. The urban destination area presents the most critical condition, with a highly unbalanced ratio between accommodation and restaurants (156/595), corresponding to an index value of 0.26. This result indicates a tourism economy disproportionately oriented toward day-use consumption and short-duration visits. The transition Destination Area shows a slightly less critical but still unbalanced value (33/87; 0.38), while the mountain Destination Area presents the highest equilibrium (20/24; 0.83), suggesting a more stay-oriented tourism structure, although limited in scale and seasonal in operation.

The DRI assesses the diversity of service categories in relation to their effective accessibility. In this case, the urban Destination Area reaches a maximum value of 4/4, confirming the high diversity and availability of services within Granada. By contrast, both the transition and mountain Destination Areas record extremely low values (1/4), revealing a strong lack of diversification and complementary functions. In particular, the foothill area appears to operate merely as a transit corridor toward the mountain, while the high-altitude Destination Area remains functionally dependent on winter sports and unable to support alternative forms of tourism such as hiking, cycling, or night-based environmental experiences.

4 Discussion and Planning Strategy

The findings of the analysis support the development of a multi-scalar planning strategy aimed at transforming the existing tourism system. The downscaling of NUA [32, 33]compliance assessment supports the definition of spatial strategies designed to address both the physical disconnection between Granada and Sierra Nevada and the behavioral dynamics that currently reinforce tourism concentration and short stays. The overall strategy is coherent with the broader sustainability goals related to mobility transition, territorial resilience, environmental quality, and more inclusive and balanced urban-tourism relationships.

Instead of suggesting separate tourism infrastructures, the intervention is set up as a holistic transformation of territorial relations, to convert proximity into complementarity and tourism demand into value for territorial space.

The proposed approach is based on the combination of soft measures and hard interventions, designed to influence both visitor behavior and spatial organization.

The first group of interventions focuses on infrastructural strengthening and deseasonalization (Fig. 5). In order to address the lack of service diversity and the rigid seasonality of the mountain destination area, the strategy proposes the implementation of specialized high-altitude hubs. These include a hiking hub designed to operate from spring to autumn and equipped with basic but strategic facilities such as lockers, water refill stations, and light food services; an astronomical hub aimed at extending the temporal use of the mountain environment into evening and nighttime hours; and a ski hub conceived as a retrofitting intervention for rationalizing winter tourism infrastructure and reducing dysfunctional car-based occupation of public space.

The second group of interventions addresses alternative mobility and the valorization of marginal areas, particularly the transition Destination Area, which currently functions as an infrastructural void (Fig. 5). In order to transform this area from a mere transit corridor into a place of pause and activation, the project introduces a cycling hub equipped with self-service repair facilities and e-bike charging stations, capable of supporting soft mobility and intercepting visitors before they reach the upper mountain system. This is complemented by the introduction of a cultural hub and a dedicated shuttle service linking the city with foothill stations, with the dual objective of reducing private car dependence and redistributing tourist attention across intermediate territorial nodes.

The third component of the strategy concerns territorial marketing and systemic integration through the implementation of a digital incentive infrastructure. Coherently with the Copenhagen precedent, the project introduces the app-based system “Tapas Currency”, conceived as a gamified territorial reward mechanism. Through this tool, tourists accumulate points by walking or cycling across the various hubs and routes, and can subsequently redeem them within Granada’s food and hospitality system. In this way, the project establishes a circular relationship between outdoor tourism and the urban economy, encouraging visitors to remain in the city after mountain-based experiences and thereby increasing the probability of overnight stays and more distributed expenditure patterns.

The expected impacts of the proposed scenario are significant. The DRI values of the transition and mountain clusters are projected to improve through the introduction of new functions and services, while the average length of stay is expected to increase from the current short-stay pattern toward a more stable overnight-oriented tourism structure. At the same time, the reorganization of access and the introduction of collective mobility systems are expected to reduce private traffic toward Sierra Nevada, especially during winter peaks, contributing to lower congestion and reduced environmental pressure. The strategy therefore supports a transition from a polarized and extractive tourism model toward a more diversified, resilient, and territorially integrated ecosystem.

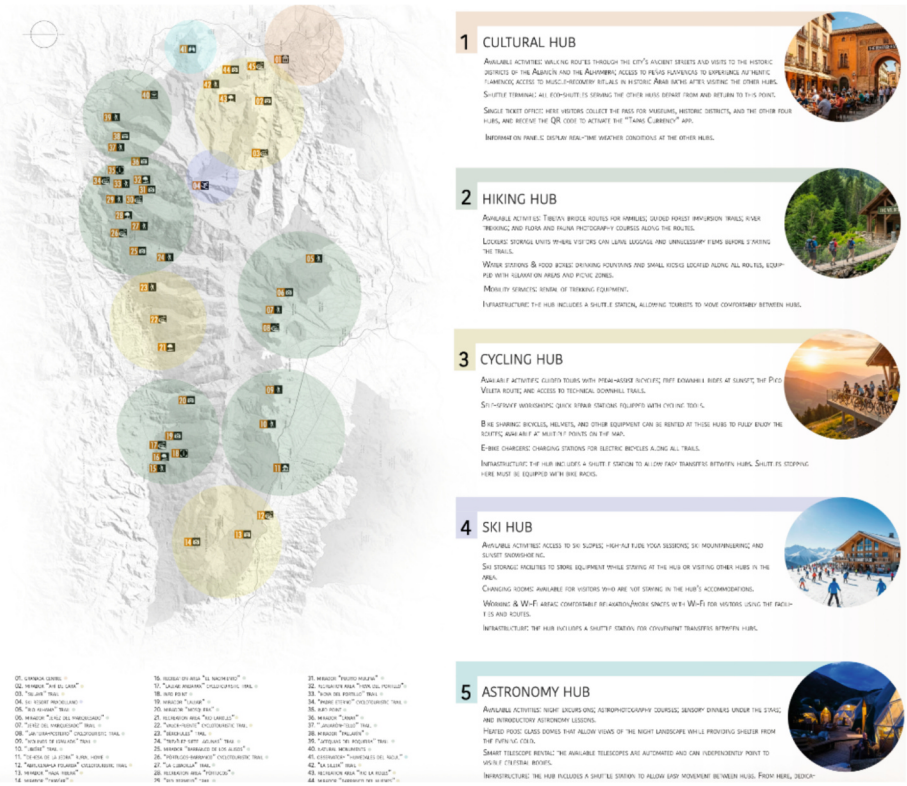

Fig. 5. Frist two group of Interventions.

5 Conclusions

This study has developed a spatially informed planning framework for addressing tourism imbalances in a complex urban–mountain destination, using Granada and Sierra Nevada as a representative case. The integration of territorial analysis, cluster-based interpretation, and composite indicators has enabled the identification of structural mismatches between tourism potential and actual demand distribution[34–41].

The proposed strategy demonstrates how the combination of soft and hard measures can support the transition from a fragmented, high-pressure, and seasonally polarized tourism model toward a more balanced system based on territorial complementarity, extended stays, and distributed value creation. By strengthening the role of currently marginal areas and improving the integration between mobility, services, and attractors, the framework contributes to the development of a more resilient tourism ecosystem.

The approach is designed to be replicable and adaptable to other destinations facing similar challenges, offering a practical contribution to the field of sustainable tourism planning and territorial governance.

The whole application is structured on the STESY framework [29, 42, 43]: a robust spatial analytical framework driving from the early stages the strategic design in sustainable tourism for a specific destination area. The framework had been applied in a number

of local studies selected among major destinations (i.e. EU Capitals, UNESCO Sites, Environmental global attractors etc.) [44, 45], minor inland tourism areas (i.e. Vulture, Pollino national Park) [46, 47] and niche tourism sites (i.e. Islands) [48–50].

In this paper the main limitation comes from the lack of discussion with local stakeholders. In facts the research was fully development on desk and remotely. It is also relevant to point out how the STESY method effectively supported the process providing a guide to students to start with effective local analysis, to perform meaningful spatial interpretation of a complex phenomenon, to identify design options/solution for a strategic proposal compliant with NUA international principles.

The indicator dashboard included in the STESY platform allows to compare this application with other case study in a significant and effective way, supporting the decision making process in identifying intervention priority to better plan tourism sector locally benefitting of multi scale assessment options and accountability management of global objective for sustainable and climate responsive design [51–53].

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