From Linear Accessibility to Distributed Territorial Activation: A STESY-Based Approach for the Lofoten Islands

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Abstract. The Lofoten Islands, Norway, represent a fragile Arctic tourism destination characterized by exceptional environmental attractiveness, strong cultural identity, and limited infrastructural capacity. The main challenge of the archipelago is the spatial fragmentation and uneven accessibility of its territorial components. Tourism demand is primarily structured along a linear infrastructural corridor defined by the main road, resulting in localized pressure phenomena and the underutilization of peripheral areas with high latent potential. This study applies the STESY framework in order to support the transition from a linear and infrastructure-dependent tourism model toward a more integrated and spatially distributed territorial system. The methodology combines territorial analysis, spatial mapping of attractors, services, and reachability, cluster-based classification, and the interpretation of composite indicators, including the Balanced Tourism Supply Index (BTSI), Attraction Potential Index (API), and Diversity Reachability Index (DRI). The results reveal a structural mismatch between attraction potential and effective accessibility, highlighting the coexistence of highly attractive but weakly connected clusters and more accessible but functionally saturated nodes. Based on these findings, the study proposes a multi-scalar strategy focused on multimodal accessibility, slow tourism infrastructures, and the activation of marginal territories. The proposed framework contributes to the development of policy-oriented approaches for sustainable tourism planning in fragile, low-density, and environmentally sensitive destinations.

Keywords: Sustainable tourism planning · spatial analysis · cluster analysis

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

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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].

It is possible that not all tourism pressure influenced all tourism locations the same way. Many sensitive locations experience pressure from tourism demand that is spatially focused and uneven [26].

For example, Areas with tourism pressure that has low connectivity and tourism offerings are not faced with other tourism location challenges, such as congestion, overtourism, and other tourism supply shortfalls [27].

A better understanding of demand concentration and offer supply tourism networks is needed to address the challenges faced by the spaced out weakly connected tourism locations. [28].

In emerging tourism destinations, such as the Lofoten islands in Northern Norway, the location is characterized by high scenic beauty. However, because of poor connectivity and weak infrastructure, demand is concentrated in specific tourism destinations which creates uneven distribution of tourism and stifles the development of the tourism potential in the less visited periphery.

The archipelago combines extraordinary landscape values, globally recognizable environmental identity, strong maritime heritage, and a deeply rooted fishing culture. Yet, the territorial organization of tourism is strongly conditioned by the morphology of the islands and by the dependence on a limited infrastructural backbone, primarily structured along the E10 road corridor.

The adoption of monitoring-oriented approaches remains relevant in order to detect temporary concentration patterns, support adaptive management over time, and inform strategic actions aimed at improving the visitor experience while better orienting the experience of territorial opportunities.

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

This research will be undertaken within the Lofoten archipelago region located within Northern Norway and above the Arctic circle. The group of islands constitutes an exceptionally unique island system covering an area of about 1,200 square kilometers, whose uniqueness is brought out by the striking interplay of sea and mountains where reliefs, fjords, narrow coastal plains, and exposed Atlantic coasts create a unique land morphology. Such an environment contributes greatly to the distinctive landscape of the archipelago and increases its international appeal to tourists. In addition, there are several unique natural occurrences in the region like the Northern lights in the winter months and the Midnight sun during the summer that add to the appeal of this destination.

The territorial identity of the Lofoten Islands has also been influenced by an important historical interaction between settlement, seafaring economic activity, and fishing. The history of human settlements in the islands goes back to prehistoric times, while the evolution of more organized territoriality was especially significant during the Viking Age and in the context of the cod fishing economy. This historical evolution resulted in the creation of a unique cultural landscape where production, settlement, and adaptation to the environment are strongly linked together. The rorbuer, traditional fishermen's cabins located on the coast, can be seen as some of the most representative elements of this cultural landscape.

The administrative structure of the islands consists of six municipalities, namely Vågan, Vestvågøy, Flakstad, Moskenes, Værøy, and Røst. These municipalities have very distinctive demographic and functional features. Vestvågøy and Vågan serve as the principal demographic centers of this archipelago, whereas the rest of the municipali-ties demonstrate low demographic density, growing marginalization, and poor infrastructural facilities. From the perspective of tourism, such demographic polarization within the archipelago has significant implications.

The evolution of tourism flows in the Lofoten Islands in relation to the broader regional context of Nordland and the national tourism system of Norway, focusing on the comparison between 2019 and 2023 (Fig. 1).

The data suggest a clear strengthening of the archipelago's role within both the regional and national tourism context. While the seasonal structure remains largely unchanged, with tourism demand concentrated during the summer months, the comparison between the two years highlights an overall increase in visitor volumes and a greater visibility of the Lofoten Islands within the tourism geography of Northern Norway.

In both years, tourism flows show a pronounced seasonal pattern, with a gradual increase from winter to summer followed by a decline during the autumn months. However, the 2023 data indicate a more consolidated tourism dynamic compared to the pre-pandemic baseline of 2019, confirming the growing attractiveness of the archipelago.

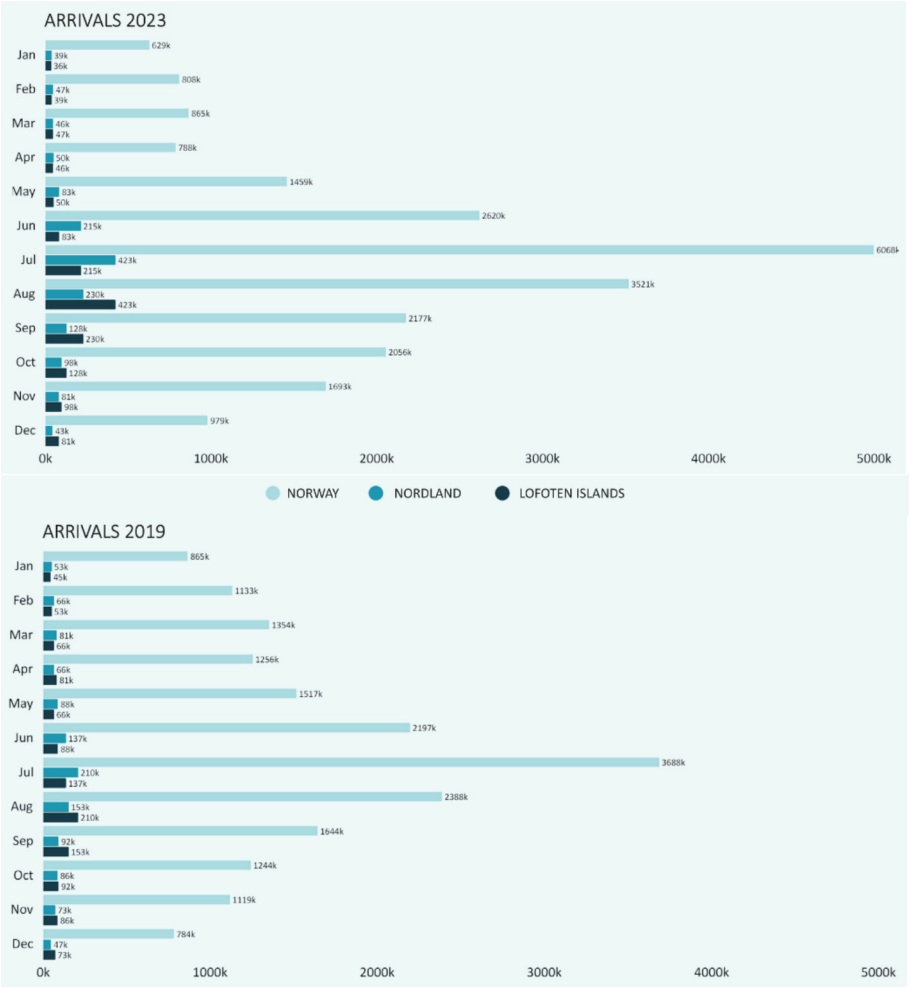

Fig. 1. Comparative overview of tourism dynamics in Norway, Norland and Lofoten Islands

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. 2). Attractors are categorized according to their cultural, historical, environmental, and landscape characteristics. The analysis reveals a territorial structure in which the environmental dimension clearly dominates the tourism ecosystem. A very large number of attractors are associated with outdoor and nature-based experiences, including trekking routes, viewpoints, cycling

itineraries, and panoramic landscapes. Alongside this environmental structure, the cultural dimension is articulated through museums, Viking-related heritage, fishing culture, churches, galleries, festivals, and traditional settlement patterns, all of which contribute to the narrative and symbolic depth of the tourism experience. Services are analyzed in relation to accommodation, food provision, logistics, and support functions for visitors. The results show a diversified but territorially uneven hospitality system, with a strong presence of motels, hotels, cafés, restaurants, parking areas, camping facilities, and a more limited provision of complementary services such as e-bike rental and visitor-oriented infrastructures. Reachability is evaluated through the presence and integration of transport infrastructures, including airports, ferry terminals, and bus stations. The analysis highlights the strategic importance of the maritime system and the E10 corridor as the main territorial backbone of the archipelago.

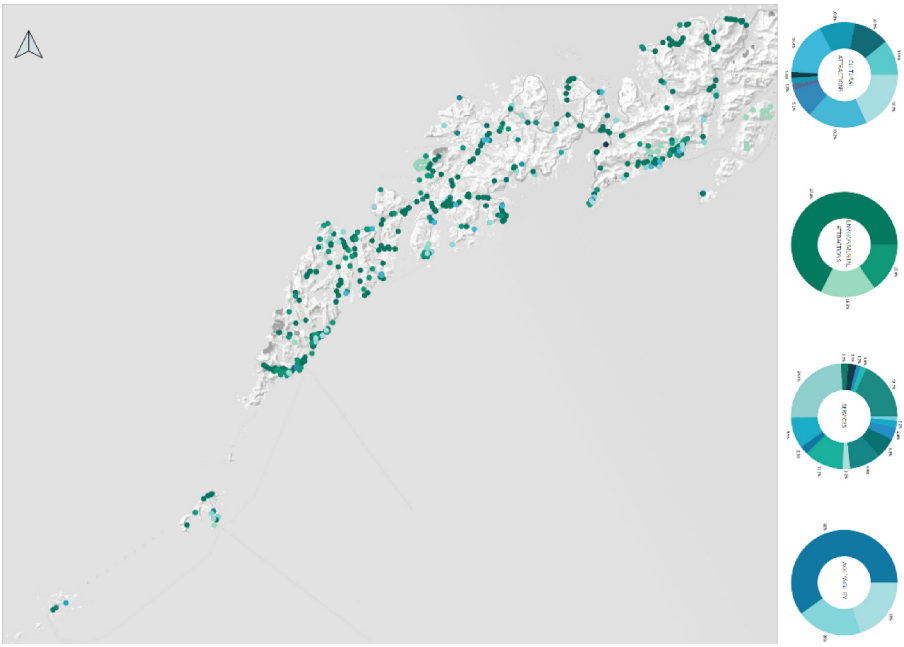

Fig. 2. Distribution of Attractors, services and reachability in Lofoten Islands.

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. 3).

The analysis identifies four clusters**,** corresponding to four Destination Areas characterized by different degrees of maturity, accessibility, tourism specialization, and infrastructural support.

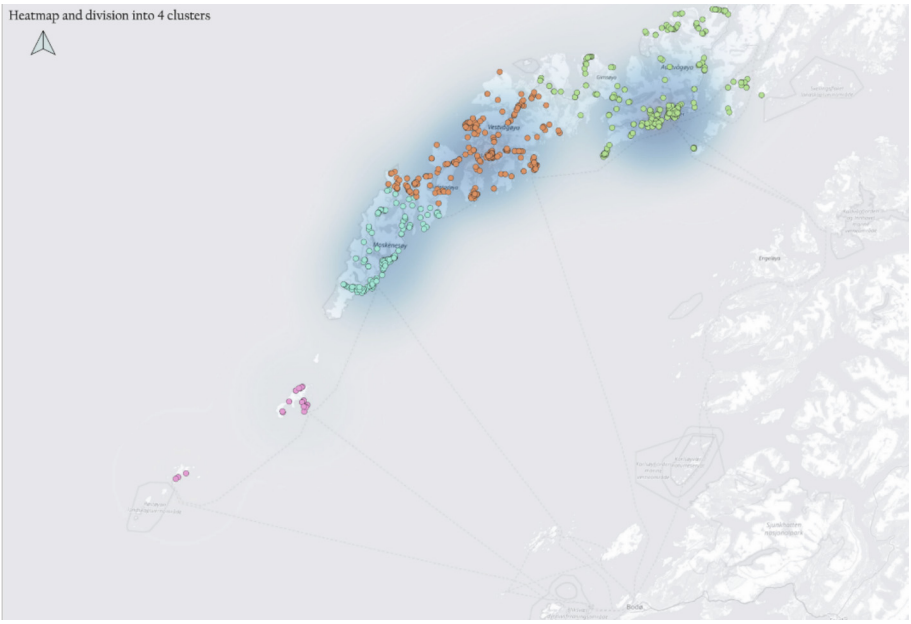

Fig. 3. Clusters of Attractors, services and reachability.

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

The Balanced Tourism Supply Index (BTSI) is used to evaluate the balance between the tourism accommodation system and the broader territorial support structure. The results reveal that the archipelago is generally configured for forms of extended stay rather than purely transient tourism, but internal differences between clusters remain significant. The first Destination Area shows a relatively balanced and consolidated structure, confirming its role as the principal support node of the system. The second cluster exhibits the lowest BTSI value, suggesting a more open and less saturated territorial condition, potentially suitable for quality-oriented development. The third Destination Area, by contrast, records the highest BTSI value, indicating a strong concentration of accommodation functions and a localized condition of structural pressure. The fourth cluster, although more peripheral and sparse, also presents a relatively high BTSI, revealing that tourism density can become significant even in marginal areas when infrastructural support is weak.

The Diversity Reachability Index (DRI) measures the capacity of each cluster to connect its different resources, identities, and functions through the accessibility system. This indicator reveals one of the most relevant criticalities of the Lofoten tourism system. The first Destination Area records a modest value, while the second cluster achieves the highest DRI, suggesting a stronger capacity for integrating different components of the territorial experience. However, both the third and fourth Destination Areas record a value equal to zero, indicating a condition of functional isolation and

poor systemic accessibility. This result is particularly important because it demonstrates that high tourism value and attraction potential are not necessarily supported by adequate reachability.

The Attraction Potential Index (API) evaluates the density and quality of attractors within each cluster. The first Destination Area records the highest API value, confirming its role as the principal generator of territorial image and tourism demand within the archipelago. The second cluster maintains a significant but more balanced attraction potential, indicating a more gradual and integrated form of territorial value. The third cluster also records a high API, but in this case the strong attractiveness appears to be in tension with environmental fragility and infrastructural limitations. The fourth Destination Area, although characterized by the lowest API, still presents a relevant identity value linked to marginality, remoteness, and selective experiential potential (Fig. 4).

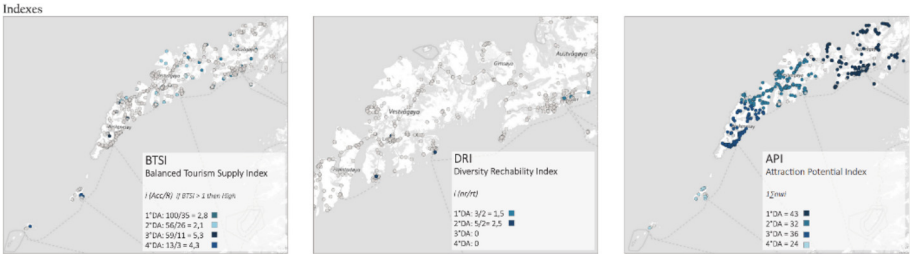

Fig. 4. Indicators applied to each Cluster (Destination Area).

The two identified clusters show the systemic versatility of the first and the potential landscape resilience of the second. The third shows the most critical situation, as tourism potential and attraction intensity are poorly supported infrastructurally and systemically. The fourth shows the most fragile and peripherally isolated conditions, needing soft systems to activate tourism density, but to enable selected system structures. The findings point to the necessity of planning for systems not aimed at minimizing tourism, but at integrating the system and improving distributed accessibility.

4 Discussion and Planning Strategy

The findings of the analysis support the development of a multi-scalar planning strategy aimed at strengthening territorial integration and enabling a more distributed and resilient tourism system. In this case, the objective is not to reduce tourism pressure in absolute terms, but to reconfigure the spatial logic of access and experience, improving the relationship between tourism demand, mobility systems, and territorial structure. The downscaling of New Urban Agenda (NUA) principles supports the definition of spatial strategies capable of addressing the structural weaknesses of the archipelago while preserving its environmental and cultural identity [32, 33].

The strategic proposal is developed under the project vision “Between Sky and Ocean”, conceived as a territorial framework for redefining the relationship between infrastructure, landscape, and tourism experience in the Lofoten Islands. In this perspective, reachability becomes not only a technical issue, but also a planning tool for territorial diversification and resilience.

The proposed planning strategy is structured around two main directions (Fig. 5).

The first concerns the strengthening of Destination Area 3, which currently functions as the terminal and most fragile segment of the E10 axis. The strategy proposes the introduction of an integrated public transport system capable of ensuring more continuous and distributed accessibility beyond the end of the primary road corridor. This intervention aims to reduce the dependency on private vehicles, improve the continuity of movement between settlements, and support both visitors and local communities through a more efficient and coherent territorial mobility structure.

This intervention is reinforced through the design of a Cultural and Environmental Route connecting Hamnøy and Å. The route is conceived as a slow tourism infrastructure integrating cultural heritage, landscape experience, and environmental accessibility. It links the traditional fishing villages, the rorbuer landscape, the cod-related heritage system, and the trekking infrastructure through a sequence of strategically located nodes. These nodes include arrival and departure hubs, scenic viewpoints, regulated camping points, visitor services, and environmental interpretation devices. The objective is to transform movement itself into a structured tourism experience while reducing the concentration of use on a few isolated hotspots.

The second strategic direction concerns the reconnection of Destination Area 4, the most peripheral and infrastructurally isolated component of the archipelago. In this case, the main issue is the territorial marginality and lack of accessibility. To address this condition, the strategy introduces a new system of maritime connections aimed at extending the infrastructural logic of the archipelago beyond the limits of the road network. A strategic ferry line from Svolvær is proposed to reconnect marginal settlements and integrate them more effectively into the broader territorial system. This intervention is further strengthened by the proposal of additional maritime links toward Bodø, allowing the peripheral islands to gain a more direct relationship with the regional accessibility network.

The proposal for Destination Area 4 is based on the selective enhancement of identity, accessibility, and experiential quality.

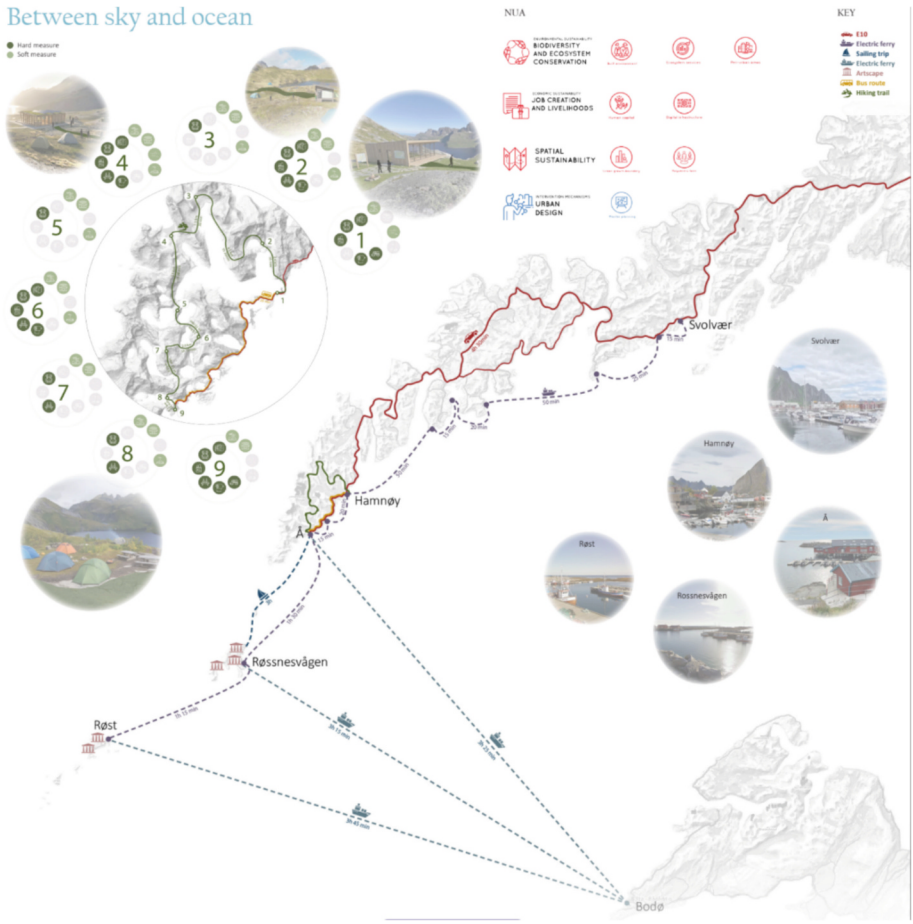

Fig. 5. Plan of interventions

5 Conclusions

Looking at regions differently, using clusters and blended measures revealed distinct patterns across the islands, showing that tourist activity depends less on attractions alone and more on how well transport, amenities, and local layouts connect. What stands out is how boosting various travel modes, building low-speed tourism facilities, while gently linking outer areas helps shift away from rigid, road-heavy tourism toward a looser yet unified land use setup. Instead of just spreading visitors around, the idea works by strengthening the islands' ability to manage visits through tighter area links, sturdier access routes, and matching visitor needs more closely with local character. The whole application is structured on the STESY framework [29, 34, 35]: 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.) [36, 37], minor inland tourism areas (i.e. Vulture, Pollino national Park) [38, 39] and niche tourism sites (i.e. Islands) [40–42].

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 [43–50].

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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