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Mapping landscape qualities across the inner Bradano valley by integrating GIS and RS applications to support sustainable tourism strategies

This contribution presents a methodological approach for mapping the landscape qualities of the inner Bradano Valley (southeastern Italy), by exploiting the potential of Geographic Information System (GIS) and Remote Sensing (RS) to support new territorial strategies centred on sustainable tourism. The research specifically focuses on the northern section of the Bradano Valley, on the border between Basilicata and Apulia, which is recognised as inner territory by the National Strategy for Inner Areas. This area is characterised by a complex hilly landscape, where natural components, historical urban settlements, and widespread built heritage mostly related to agricultural activities are interconnected through a system of historical infrastructure and a network of minor roads (the UNESCO via Appia Regina Viarum, the Tratturo regio Melfi-Castellaneta, the FAL railway Altamura-Potenza, and the abandoned railway Melfi-Gioia del Colle, the Bradanica road Mate-

ra-Foggia, the Cammino Materano routes), that offer valuable opportunities for promoting slow tourism and improving accessibility to these heritage-rich places. The landscape, which appears empty and uniform, becomes more appealing to visitors over the spring and summer seasons due to the colour contrasts and nuances of the croplands. These seasonal phenomena hold strong potential for tourism development in this area, especially when combined with the promotion of the rural heritage and cultural practices. The research shows how GIS-based mapping plays a key role in integrating both geospatial information in a static form, mostly related to natural and built heritage, and the dynamic mapping of seasonal landscape phenomena by RS applications of multispectral satellite imagery, supporting an interactive map-based device for promoting knowledge, fruition, and development of tourism strategies in inner areas.

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INTRODUCTION

This research shows how the mapping of spatial qualities of inner areas [1], especially related to the landscape, natural and built heritage, and historical infrastructures, which are relevant assets for establishing new sustainable development strategies, can take advantage of the integration between Geographic Information System (GIS) and Remote Sensing (RS) applications. One of the main challenges that inner areas are facing concerns the enhancement of the existing landscape and built heritage assets through sustainable tourism (Dipartimento per lo sviluppo e la coesione economica, 2013), which can contribute to revitalizing local development by stimulating the promotion of culture, even encouraging communities' creativity [2] (Cavuta et al., 2018). Specifically, slow tourism (Dickinson et al., 2011) strategies can be set for marginal territories (Pileri et al., 2018), primarily by taking into consideration the potentialities related to the high quality of open spaces characterizing these places, and the presence of existing infrastructure and the historical routes, which can improve the accessibility of the widespread natural and built heritage, but also taking into consideration that these territories are 'fragile' and that tourism can impact on that negatively, generating the extreme phenomenon of overtourism [3] (European Parliament, 2018).

By considering the case study of the northern section of the Bradano valley, on the border between Basilicata and Apulia regions (southeastern Italy), which is considered as 'peripheral area' by the National Strategy for Inner Areas (SNAI) [4] (fig.1), the research explores the complexity of this landscape, resulting by the interaction of natural and human factors, which is also strongly interlaced with the intangible dimension of local cultures and traditions, by activating a mapping process which integrates spatial information both in a static and dynamic form. The presence of minor built heritage related to agricultural and productive activities scattered across the territories, as well as the large portions of open spaces, are considered as relevant assets for reactivating inner territories (e.g., on-site experiencing of local productions that are related to specific aesthetic conditions of the landscape, which occur, for example, over the spring in arable lands), which require

firstly to be analysed, and then to be 'made visible' within a territorial strategy framework, by exploiting the potential of visual devices (e.g. maps). The SNAI selected some inner areas to prioritize dedicated development strategies aimed at realizing tourism-oriented projects, as those of 'Alto Bradano' and 'Alta Murgia', which overlap the study area. In this framework, the research is an attempt to introduce a mapping method by considering both the spatial and temporal dimensions of landscape, enabling, on the one hand, the multiscalar visualization of relevant landscape heritage assets, and other hand, building a web map-based device to foster users' interaction and the sharing of knowledge as a basis for establish sustainable development strategies.
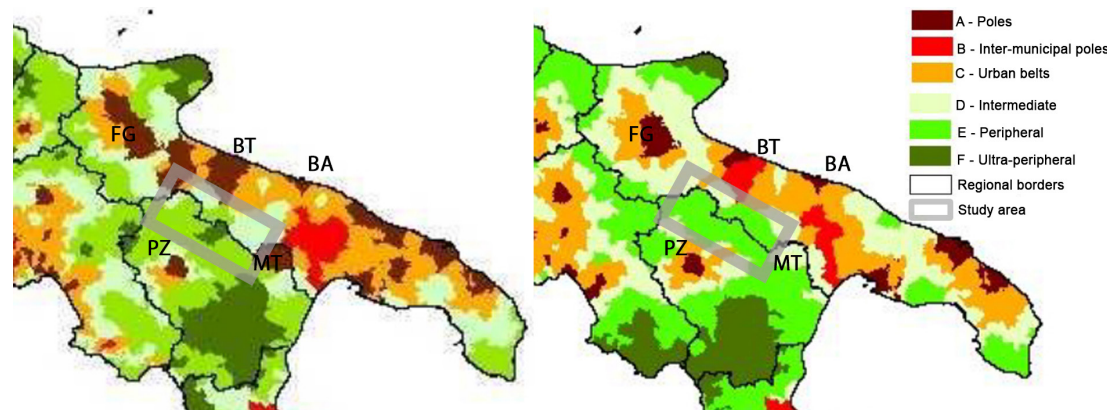
STUDY AREA: THE INNER AREAS OF BRADANO VALLEY AND ALTA MURGIA

The study area is centred on the northern section of the Bradano valley along the border between Basilicata and Apulia (fig.2), which is characterized by a geological depression named 'Fossa Bradanica' in between the Lucanian Apennines and Alta Murgia plateau, with the predominance of clay and sandy soils (Sestini, 1963). This area is characterized by a

complex hilly landscape, where natural components, historical urban settlements, and widespread built heritage mostly related to farming activities are interconnected through a system of historical infrastructure and a network of minor roads that offer valuable opportunities for promoting slow tourism and improving accessibility of these heritage-rich places (fig.3).

The landscape is mainly characterized by high-quality open spaces, marked by the presence of a network of waterways, among them the Bradano and Basentello are the main rivers, flowing in the north-west/south-east direction, from the mountains of the Apennine chain to the plain area along the Ionian Sea. Along these rivers are located even artificial lakes, as those of Acerenza and San Giuliano, along the Bradano river, and the Serra del Corvo Lake along the Basentello river, which are water reservoirs of this territory. From west to east, the morphology of this area shifts from the mountainous slopes of the Apennines to smoother hills, then gradually flattens into plains and valleys, extending till the borders of the Alta Murgia plateau [5] (Regione Basilicata, 2023). The waterways network and the artificial lakes create a balanced system to support the agricultural activities, which are mostly devoted to arable lands, especially to wheat and corns, which ensure high-quality productions. The distinctive

Fig. 1 - Comparison between the maps of National Strategy for Inner Areas dated back to 2014 and 2020. The maps highlight the study area of Alto Bradano valley as 'peripheral' area of the country (image by author).

A - Poles
B - Inter-municipal poles
C - Urban belts
D - Intermediate
E - Peripheral
F - Ultra-peripheral
Regional borders
Study area

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character of this landscape lies in the 'voids', in the uniform extension of arable lands, occasionally broken by patches of woodlands and mosaics of crops (vineyards, fruit groves, olive groves, and orchard), typically inserted on the slopes near urban settlements, which increase a bit the diversity of the landscape. In this sense the perception of this landscape is strongly influenced by the agricultural life cycle of the plants over the seasons, which determines different scenic configurations, due to color change [6] (Arriaza et al., 2004) (Stobbelar et al., 2007) of vegetation (the wheat fields change from green of the spring to the gold of summer, to brown of autumn and winter). Within the agricultural patterns is still recognizable the network of paths used for the movement of livestock over the transhumance (listed as intangible heritage by UNESCO), named 'tratturi', which are elements that historically defined this landscape, as an area of crossing between the Apennines and the plain area of the Ionian Sea, which has influenced the cultural identity of these places. The main one is the 'Tratturo regio Melfi-Castellaneta', to which are interconnected also other secondary branches, along with are localized minor built-heritage such as fountains, chapels, drinking troughs, small huts and villages, which are the signs of the agro-pastoral landscape [7] (Mininni et al., 2020). Another dominant feature of this agricultural landscape is the presence of scattered farmhouses and rural settlements, such as Taccone and Santa Maria d'Irsi villages, in the territory of the Irsina, which were built with the Italian Agrarian Reform of 1950, centred on Southern Italy. This reform was aimed at contrasting social and economic inequalities in the agricultural sector by focusing on land redistribution, primarily from large estates to landless peasants, to create employment and increase agricultural efficiency. Furthermore, the agricultural character of this landscape is marked by the presence of ancient rural settlements, named 'masserie', which are a tangible heritage of the historical presence of agricultural and breeding activities, before the Agrarian Reform. Sometimes, they appear as fortified settlements, with tower and walls, which contributed to the control and defence of the territory with castles, or as a productive centre connected to the abbeys. The uniformity of the landscape is broken
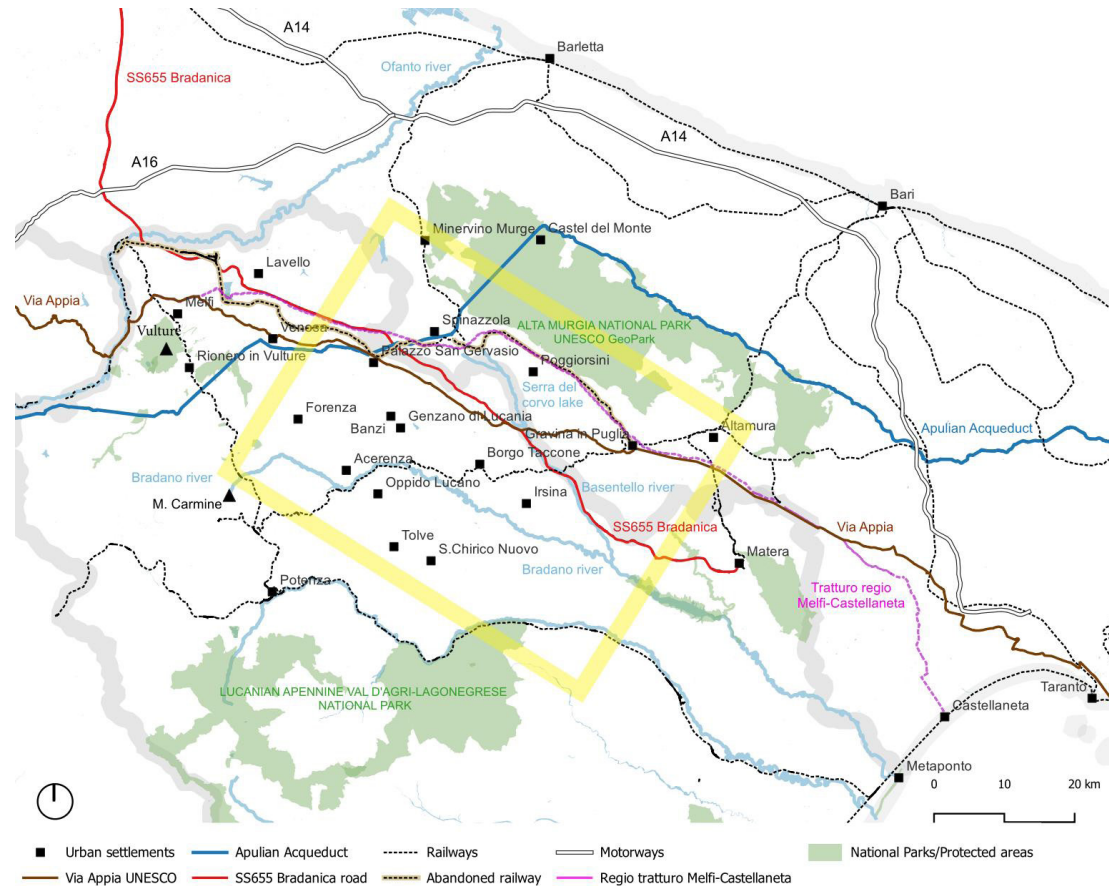

Fig. 2 Map of the inner area of the Bradano valley, along the border between the Apulia and Basilicata regions (image by author).
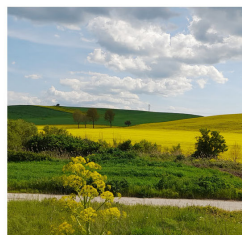
by the urban settlements, which are mainly localized on the top of the hills as landmarks which are perceivable from the valleys, connected one to each other, by an intervisibility network of belvedere points.
Along the Bradano Valley are located the towns belonging to the Basilicata region: Irsina, Genzano di Lucania, Banzi, Tolve, Oppido Lucano, San Chirico Nuovo, Acerenza, Forenza, and Palazzo San Gervasio. On the opposite side, along the western border

of the Apulia region, are located the towns of Minervino Murge, Spinazzola, Poggiorsini, and Gravina in Puglia, whose territory overlaps partially with the Alta Murgia National Park, recognized in the list of Global GeoParks Network by UNESCO in 2024. All of them are characterized by an historical urban fabric, with small streets and traditional architecture, enriched by noble palaces, churches and small squares, which deserve to be visited. Among them, the ones

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NATURE AND OPEN SPACES

Arable lands and Croplands

Rapeseed spring blooming

Bauxite quarries - Spinazzola

Monumental oak - Forenza

BUILT HERITAGE

Agrarian Reform village of Taccone

Monte Serico castle

Historical farmhouses

Agricultural archaeology
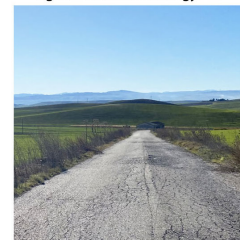
INFRASTRUCTURE

The Apulian Aqueduct

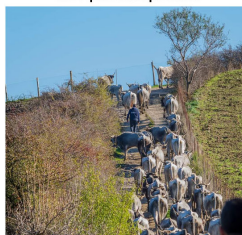Dismissed railway Melfi-Gioia del Colle

Cycle and pedestrian routes

Historical and minor roads network

INTANGIBLE HERITAGE

UNESCO - Transhumance

Religious procession S.Rocco - Tolve

Historical reenactment event - Banzi

Local food and Enogastronomy

Fig. 3 The set of landscape heritage qualities that characterizes the Alto Bradano valley and the Alta Murgia inner areas beyond towns: open spaces, built heritage, infrastructure, and intangible heritage (image by author).

that deserve special attention are the historical settlements of Acerenza, known as 'the cathedral city', for the presence of the huge Romanesque cathedral dating back to the XI century, and Irsina, whose historic urban fabric is enriched by the presence of the baroque cathedral of Madonna dell'Assunta. Both villages are listed among the most beautiful villages in Italy. Nevertheless, all villages, historically, established a strong relationship with the surrounding countryside, which was for many people the place of working activities, but also as the setting to celebrate some traditional religious rituals. These ceremonies, identifiable as intangible heritage, are often marked by processions to churches, monasteries, and sanctuaries scattered across the territory, reflecting a deep popular devotion and a strong sense of belonging to the community. One notable example of this is the celebration of 'Madonna della Pietà e Pizzicantò' in Irisina, during which the community journeys from the rural church of 'Madonna della Pietà' to the cathedral in the historic city centre, an event that weaves together tradition, spirituality, and culture.

The accessibility of this area is ensured by a network of historical and contemporary infrastructures, which in a different way, can be better exploited for slow tourism purposes, by providing access to the minor heritage widespread over the territory such as, roman archaeological sites, rural villages, historical farmhouses, agricultural archaeology, churches and sanctuaries, but also, monumental trees, agricultural fields with their related productions. The main infrastructure which traverse this area are: a branch of the ancient 'via Appia, Regina Viarum', inserted in the UNESCO WHL in 2024, which crosses the whole Bradano valley area from Melfi to Gravina in Puglia in the north-west/south-east direction; the main canal of Apulian Aqueduct which traverses the valley from west to east, touching Palazzo S. Gervasio and Spinazzola, that can be experienced through a linked cycle path; the minor Apulian-Lucanian FAL railway connecting Bari, Altamura and Potenza, passing through Gravina in Puglia, Irsina and Taccone village; the abandoned branch of national railway between Melfi and Gioia del Colle; the 'Bradanica' statal road 665 Matera-Foggia; the network of cultural routes named 'Cammino Materano' which include the via Sveva (connecting Trani, Spinazzola and Matera), and the

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via Daunia (connecting Termoli, Spinazzola and Matera), and the 'Sentiero Italia', which enable the crossing of this landscape in a slow way. This network is a great source for this territory, because it traverses this area in different directions, offering visitors the chance to get an immersive experience at different speeds, passing through the open spaces and the widespread built heritage that defines the unique character of the Bradano Valley.

METHODOLOGY: STATIC AND DYNAMIC MAPPING OF LANDSCAPE HERITAGE QUALITIES BY GIS AND RS

The comprehension of a complex territorial system, particularly focusing on the analysis oriented to planning and management strategies related to landscape and open spaces, relies mainly on the mapping process [8] (Corner, 1999) (Abrams et al., 2006) and on the making of visual devices which enable the spatialization of information. Among them the maps enable the visualization of spatial elements in a graphic form by using a codified representation language (Cicalò et al., 2021) by adopting a critical and selective interpretation of reality [9], based on the definition of the geographical context and the selection of the relevant components (Pandakovic, 2007).

Mapping of landscape heritage qualities, at the territorial level, requires the integration of specific tools (Colaceci et al., 2022), such as GIS and RS applications, which enable the collection, management, processing, and visualization of geospatial information within a layered structure. While the use of GIS, from the collection of the geodatabases to the map-making, follows a well-established and codified graphic framework that supports territorial planning strategies, the integration of geospatial information from RS applications introduces a new layer of knowledge that highlights the 'temporal' dimension. In this sense, the research, which focuses on the inner areas of Bradano valley and Alta Murgia, shows how this methodology can be applied for mapping both static and dynamic information related to landscape heritage features of this area. Firstly, the mapping process requires to define the geographical context, by identifying the structural components that shape the landscape, such as the Bradano river, which defines its valley through its watershed; or by considering a
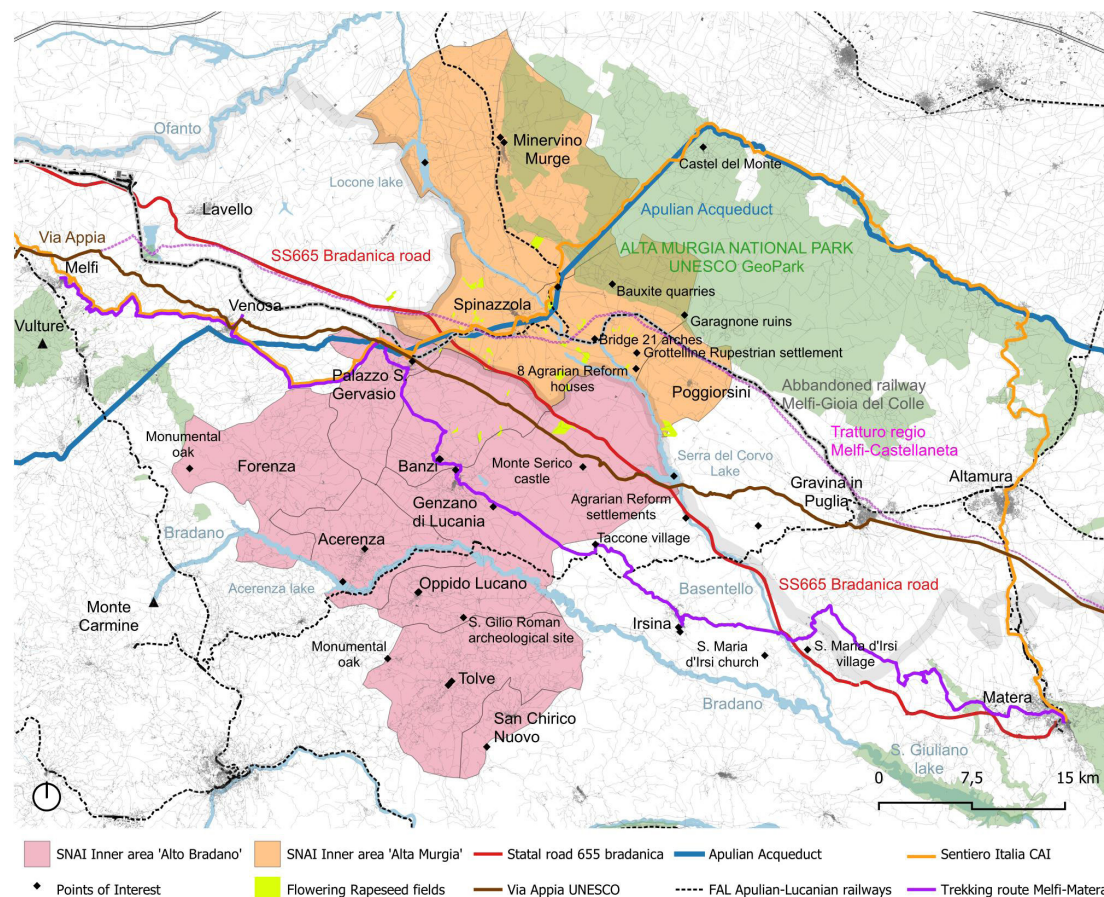

Fig. 4 GIS-based map of landscape heritage qualities across 'Alto Bradano' and 'Alta Murgia' by the integration of geospatial data retrieved from Geoportals and Satellite Imagery (image by author).

portion of territory that presents homogeneous and distinctive characteristics, considering physiographic setting [10] and land cover pattern that, in the case of Bradano valley, are described, at the national scale, as 'hilly, terrigenous landscape with tablelands' (Amadei et al., 2003). To this level which is based on the physical components of the landscape, overlaps even the administrative level (municipal and regional) and the national policy level introduced by SNAI, which

has identified two different strategic inner areas named 'Alto Bradano' and 'Alta Murgia', to concentrate major efforts and investments for the revitalization of local economies. Getting more in detail, the mapping of landscape heritage components, on the one hand, follows the standard way, concerning the making of a multisource geo-database with the collection of layered spatial information to which are linked spatial attributes that define their meaning [11]; They are

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fed by the great amount of geo-database available on the web (Institutional Geoportals, Google Maps, Open Street Map, users' generated content shared by outdoor activities portals), accessible through GIS (fig.4). Specifically, the research has used the open-source software QGIS 3.40.12 'Bratislava' (long-term release), which can take advantage of the potential of many plug-ins created by the community of developers to investigate specific topics. The geodatabase has been structured according to the ESRI shapefile standard format, by layering spatial information among point, line, and surface entities, which enable to represent the main landscape features. The ESRI shapefile format supports the storage of alphanumeric information in attribute tables, allowing it to be displayed in both static and web-based interactive maps, thanks to the interoperability with other file formats (e.g., KML, GPX). To the first group of information, shaped through a points of interest layer, belong the natural and built heritage widespread across the study area, such as monumental trees, artificial lakes, rural villages, historical and modern farmhouses, churches, monasteries, archaeological sites, castles, bridges, caves, quarries, agricultural archaeologies. To the line layers, belong even the infrastructures such as the ancient path of 'via Appia, Regina Viarum', the historical network of 'trattu-ri', the main canal of Apulian Aqueduct, the modern and contemporary road and railway infrastructures, and the network of slow routes. The system of open spaces, particularly relevant in this specific case for the large extension of arable lands and croplands, has been mapped firstly in a static form through a surface layer, by using land-cover information, and secondly, in a dynamic form, by using multi-temporal series of satellite imagery, continuously orbiting around the earth (satellite imagery by ESA Sentinel-2 are available every 3-4 days at mid-latitudes). The large number of satellite observations, freely available through the ESA Copernicus geoportal, enables the exploration of landscape changes through the seasons. Specifically, across the Bradano valley, the scenic phenomenon of rapeseed blooming, over the spring season, which affects large portions of intense yellow fields contrasting with the green of wheat fields or with the red of poppy fields, can become a further territorial asset, becoming a potential travel
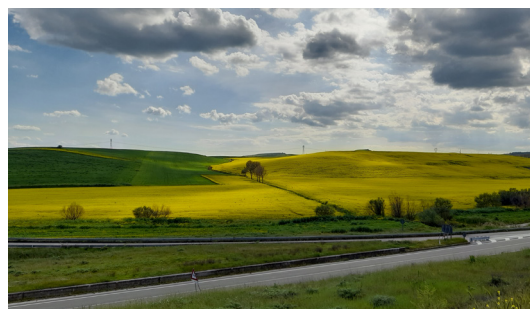

Fig. 5 The phenomenon of the spring blooming of the rapeseed fields along the state road Bradanica 655 connecting Matera to Foggia, April 2023, 28. (image by author).
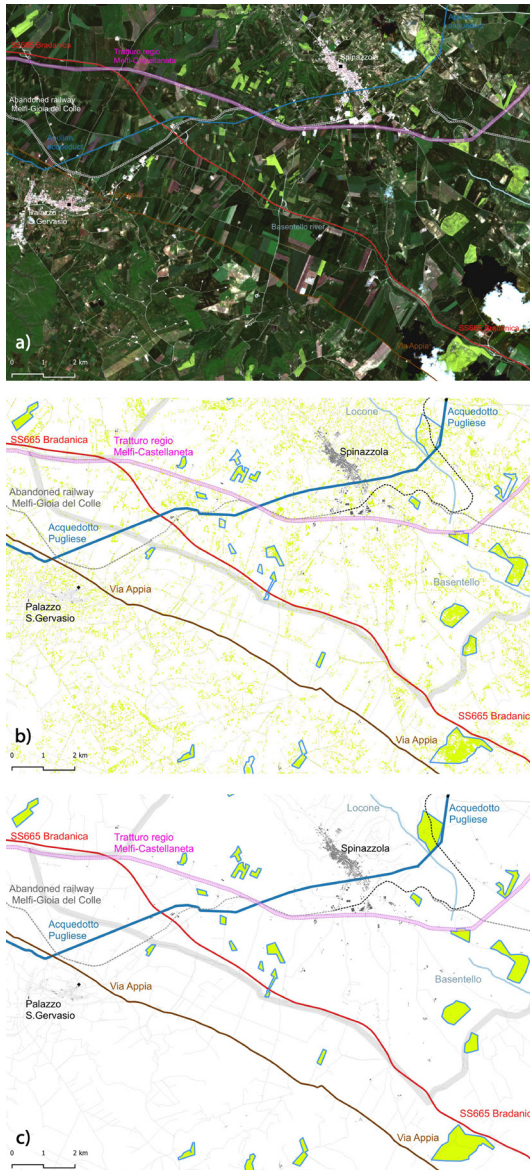

Fig. 6 The phenomenon of the spring blooming of the rapeseed fields across the Bradano Valley (image by author).

Fig. 7 The phenomenon of the spring blooming of the poppy fields and wheat across the Bradano Valley (image by author).

destination for both inhabitants and visitors over the spring. The scenic phenomenon, due to the rapeseed plantation for agricultural purposes related to crop rotation, can add further value to the landscape of this area if it is analysed not as a single agricultural field, but rather, at the landscape scale, as a transformation of the character of the entire Bradano valley, which assumes an outstanding aspect over the spring season (fig.5,6,7).

In this specific case, the blooming of rapeseed fields has been mapped in the area in between Irsina, Banzi, Genzano di Lucania, Palazzo S. Gervasio and Spinazzola, along the state road 665. The mapping of this temporary condition of the landscape, which last few weeks over the spring, require to understand the 'where' and 'when' it takes place with high accuracy, so to suggest the best period to visit. The dynamic mapping of this seasonal phenomenon can be obtained by using RS satellites applications (Fu et al., 2020), and specifically by processing the time series of Multispectral Satellite Imagery (MSI), available through the Copernicus program by the European Space Agency (ESA) for Earth Observation by Sentinel-2 [12], by integrating the Semi-Automatic Classification Plug-in (SCP) (version 8.5.0 - infinity) (Congedo, 2021) available in QGIS. The dynamic mapping methodology comprises three main steps: MSI acquisition from the Sentinel-2 satellite, MSI processing in QGIS for computing Vegetation Indices (VIs), and the visualisation on maps of areas affected by seasonal landscape phenomena by computing VIs thresholds.

The MSI acquisition is managed by the SCP plug-in within QGIS. It enables the collection of MSI (raster images layered into 13 spectral bands - 1 tile covers 100 km^2) that record for each selected date Earth's object reflectance in the visible and near-infrared to shortwave infrared ranges, with different spatial resolutions (10 m, 20 m, and 60 m). In this case, 10 m resolution bands (Blue, Green, Red, and Near-infrared) have been used for the testing of VIs, which can be considered as proxies for monitoring the health status of the plants, but that can be also used to extrapolate of the areas that are affected by the rapeseed blooming, in a semi-automatic way, by integrating them in a map-based visualization. The rapeseed flowering fields have been identified by using the Green-Red Vegetation Index (GRVI) (Motohka et al.,

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2010), which distinguishes the green surfaces from those in colour by using a combination of green and red bands [13]. Specifically, the research has found a good match of the positive values of GRVI, within the interval of 0.07 to 0.12, for mapping rapeseed flowering fields. These steps related to the acquisition of satellite imagery (fig. 8a), its interpretation using VIs (fig.8b), and finally its integration into map-making (fig.8c), can be reiterated for different dates, with the aim of showing the spatio-temporal evolution of the blooming phenomenon. In this sense, the continuous flow of updated geo-spatial information can support end-users in choosing the best time to visit the places and experience this site-specific aesthetic condition of the landscape [14], by showing spatial information within a routing-based system (Scandiffio, 2021) (Rolando et al., 2023). The comparison of the blooming condition of the rapeseed fields can be carried out by matching pictures taken from the zenithally point of view from satellite in April 2023, 27 (fig.8a) and from the ground level April 2023, 28 (fig.5). This last step is fundamental for validating the methodology because it enables comparison between the interpretation of satellite imagery and the real situation on the ground level. Nevertheless, some limitations affect the presented methodology; the first concerns the cloud-cover factor in satellite acquisitions, which can degrade the image readability and prevent the correct processing of VIs. The second one concerns the definition of VIs thresholds, that sometimes appear uncertain, requiring multiple tests and further processing of additional masks to delete non-congruent objects.

A WEB-BASED INTERACTIVE MAPPING SYSTEM TO VISUALIZE, COMMUNICATE AND SHARE LANDSCAPE HERITAGE QUALITIES SUPPORTING SUSTAINABLE TOURISM STRATEGIES

The enhancement of landscape and cultural heritage in a sustainable tourism perspective firstly requires actions oriented to getting physical and visual accessibility of places, to foster their knowledge (Ba-

Fig.8 Dynamic mapping of rapeseed fields blooming by satellite observation across the Bradano valley. a) RGB Satellite imagery - April 2023, 27. b) Image processed by the GRVI Vegetation Index. c) Integration of geospatial information related to rapeseed blooming within the GIS system. (image by author).

lestrieri et al., 2020). The development of knowledge, as a basis for establishing protection and enhancement landscape strategies, can be supported nowadays by a 'web-based interactive mapping system', which enables to display and to interact with places, by seeing them in their real territorial context and by providing users accurate georeferenced information about places. Within this system, the places are visible on an overall dynamic map, and users can interact with them by getting information and directions to reach the places, both remotely and on-site. The interactive map of the Alto Bradano valley and Alta Murgia reveals how static spatial information, mostly related to landscape and cultural heritage, and temporary information related to seasonal landscape phenomena and traditional events, can coexist, by supporting users to choose the best time to visit the places. The web-based interactive map, at the same time, becomes a visual device for narration and experience the territory, playing a significant role in sharing knowledge and for the fruition of the places, but also as a base for planning future strategies (fig.9). Interoperability between the GIS-based map and the interactive map, based on the U-map system, is ensured by the common layered structure and by the compatibility of KML and GPX files with the two systems, which can be easily exported by QGIS and embodied within U-map, holding their spatial features and their related attributes. This combined map-based approach is sometimes missing, especially in inner areas, and could enable users to interact with places more effectively by providing accurate location details and related information. Within this landscape heritage-rich context, which needs to be revitalized, the interactive map can be considered as the base for implementing an overall territorial vision which considers both the whole Bradano valley and the Alta Murgia as a unique area, overcoming the rigid administrative boundaries, both at municipal and regional level, and broadening the relationships with the main urban settlements, Matera, Gravina in Puglia and Altamura, but also with National Alta Murgia Park, recently recognized as UNESCO GeoPark, especially exploiting the potential of existing infrastructural networks. Specifically, a sustainable oriented tourism strategy based on the enhancement of 'slow' and 'fast' infrastructures, joined with the provision

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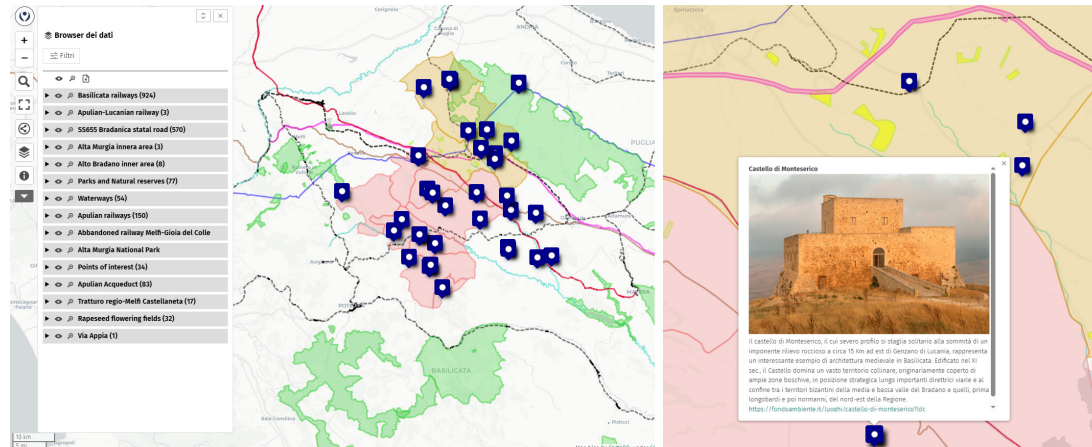
Fig.9 The web-based interactive map of the Alto Bradano Valley and Alta Murgia, which shows landscape heritage qualities. The map is based on the free-access web portal U-Map (image by author).

of digital and physical tourism services, can enable a better visibility and accessibility of the widespread minor heritage.

While the process of recognition of landscapes and heritage of outstanding beauty is almost automatic by the local community, the attribution of value, both to the minor single heritage, both to the site-specific landscape feature (e.g. the blooming of rapeseed fields), can be reached by considering them as part of a broader system, such as linear infrastructure or slow routes, that holds all of them together.

In this sense three main actions, specifically related to the infrastructural network, can be developed to foster the revitalization of this area:

· the reactivation of the abandoned railway Melfi-Gioia del Colle and its related artifacts would enable a better accessibility of Alto Bradano and Alta Murgia by train, improving the connections, on the west side, with the railway Spinazzola-Barletta and the Adriatic coastline, and on the east side with Altamura, important node to reaching Bari, Potenza, Taranto and Matera.

· the enhancement of the network of slow routes which innervates this territory (the UNESCO Via Appia regina viarum, the network of tratturi, the Cammino Materano routes network, the Sentiero Italia, the cycle path along the main canal of Apulian Aqueduct) by incorporating minor heritage places. The routes should be promoted as a way for experiencing, in a transversal way, heterogeneous places related to nature, history, culture, agriculture, gastronomy, religion, ensuring intermodal accessibility with train, bicycle and cars, and reporting the best time to visit according to the seasonal phenomenon occurring over the landscapes.

· the enhancement of the Bradanica state road 655, which is the major crossing infrastructure through this valley connecting Matera and Foggia, in a tourism perspective, by adding equipped rest areas to frame the landscape, promoting stops and alternative detours in the surrounding areas, according to heritage locations, and the best seasonal landscape conditions.

CONCLUSIONS AND FUTURE DEVELOPMENTS

The research has shown how the map-based visual devices can play a key role both in the process of analysis and knowledge of landscape heritage qualities in the inner territories (GIS and RS), and in the process of communication and fruition (Web-based Interactive Map). Most of all, the research has shown how the GIS tools are valuable tools for reading complex territorial systems and supporting spatial planning strategies (fig.10), passing through the process of data acquisition, data processing, and data visualization, even if the automatization of the workflow, from RS to GIS and from GIS to U-map, would need further optimizations to make the process more fluent, and manteneinng the data flow updated for long run.

Specifically the GIS, by displaying spatial information at a territorial scale, especially improves the visibility of the so-called 'minor heritage places' spread throughout the territory, whose accurate location is often not even traceable (where they are), but also for showing the hidden potential of the 'voids', open spaces mostly devoted to agricultural production,
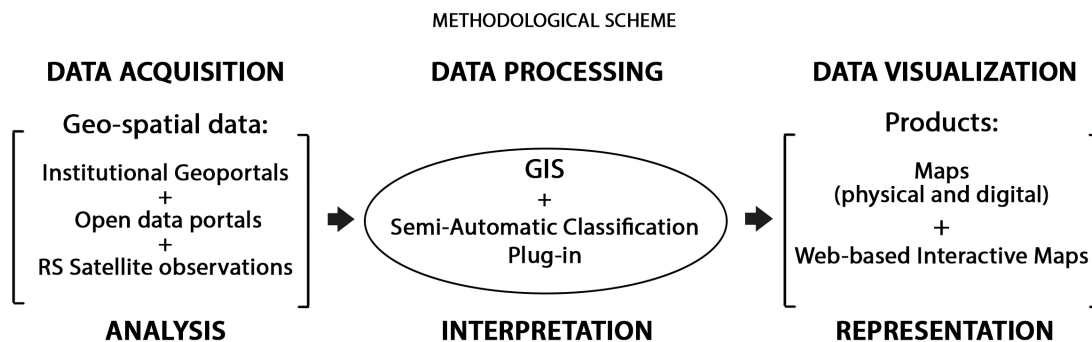
METHODOLOGICAL SCHEME

DATA ACQUISITION   **DATA PROCESSING**   **DATA VISUALIZATION**

Geo-spatial data: Products:

Institutional Geoportals   GIS   Maps
          +   +   (physical and digital)
   Open data portals   Semi-Automatic Classification   +
          +   Plug-in   Web-based Interactive Maps
RS Satellite observations

ANALYSIS   **INTERPRETATION**   **REPRESENTATION**

Fig.10 Methodological scheme summarizing the key role of GIS in the process of mapping, between analysis, interpretation, and representation.

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which can gain an aesthetic added value with specific seasonal phenomenon (e.g. spring flowering), emerging as potential slow-tourism destinations. In this sense, the complex process of attributing value to minor heritage places and seasonal landscapes by the communities passes through the essential stage of knowledge, led by the mapping process which not only enables to get the spatial feature of the single heritage place, but, most of all, enables understanding its mutual relationships with other surrounding territorial entities, opening new opportunities to spatial planning strategies. In this perspective, the knowledge of places moves from mapping single entities toward exploring broader systems, extending beyond the physical domain of each place to embody related fields of investigation, such as culture, eno-gastronomy, tourism, and agriculture, thus allowing for a more transversal interpretation of places. By considering the large extension of inner areas across Italy, further developments of the research can be addressed to check the scalability and replicability of this methodological approach to other territorial contexts, to test the effectiveness and adaptability of the mapping techniques to different landscape patterns and sizes. In this perspective, a deeper GIS-based analysis of landscape-heritage qualities of inner areas at the national level could provide a broad knowledge framework to support further applications of this methodology.

NOTE

[1] For the first time these territories in Italy start to be seen not as a 'problem' but as an 'opportunity'. De Rossi, 2018, pp.3-17.

[2] Especially in the inner areas, due to the distance from main urban centers, tourism can activate local community creativity, which can generate benefits for other sectors like agriculture and craftsmanship. Cavuta, G., & Ferrari, F. 2018, pp.21-26.

[3] Main overtourism impacts concern the environment, economic, and socio-cultural aspects. Overtourism definition, causes, threats, and impacts for cultural heritage across Europe have been analysed by European Parliament, 2018, pp.15-40.

[4] The SNAI is an innovative place-based policy for the territorial rebalancing and cohesion, addressed to the marginalized areas of the country, to concentrate major efforts and investments for the revitalization of local economies. Inner areas are identified as territories which are far away from the main urban centers which supply the essential services in terms of mobility, education and health. They cover about 60% of the national surface, host 22% of the whole population, which is distributed across 52% of the Italian municipalities. The policy was supported by a complex and extensive process of mapping, based on the measurement of the 'level of peripherality' of each municipality from the main urban settlements, which provide the essential services in the fields of mobility, education, and health. Agenzia per la Coesione Territoriale, 2025. Retrieved June 18, 2025, from https://www.agenziacoesione.gov.it/strategia-nazionale-aree-interne/?lang=en.

[5] The study area overlaps partially to the landscape area, defined as 'the Bradano hills and terraces' by the Basilicata Regional Landscape Plan. Regione Basilicata, 2023.

[6] The changing of colours in the landscape is a relevant aspect for reading places through time. Landscapes can be characterized and recognized by their expression of the seasons. Stobbelaar & Hendriks, 2007, pp.103-126.

[7] The improvement of slow mobility through the enhancement network of tratturi and historical infrastructure is a great potential also for systematizing minor heritage places across the Basilicata region. Mininni et al., 2020, pp.115-127.

[8] The mapping refers more to a 'creative process' than a mere reproduction of reality, enabling to show hidden potentials. Corner, J. 1999. p.213.

[9] The cartographic representation leads to the knowledge of open spaces, as well as it happens with architectural survey, with the knowledge of buildings. Pandakovic, 2009, pp. 217-221.

[10] Referring to the 'Carta dei Tipi e delle Unità Fisiografiche dei Paesaggi Italiani' which, at the scale 1:250.000, enables the identification of 37 landscape types at the National level. Amadei et al., 2003.

[11] GIS enables the reading of multiple spatial features through their linked attributes within a database. Cicalò et al. 2021, p.20.

[12] Sentinel-2 is a mission under the Copernicus program of the European Union, consisting of two satellites, Sentinel-2A and Sentinel-2B. https://www.copernicus.eu/en/copernicus-documents-library/copernicus-sentinel-2-overview

[13] GRVI = 0 is the threshold for separate green vegetation and other types of the ground covers. GRVI turned from negative to positive values at the beginning of leaf green-up. Motohka et. al., 2010.

[14] Other scenic phenomena of interest to the tourism sector that can be mapped at the landscape scale, following the dynamic mapping method, include the controlled flooding of paddy-rice fields and autumn-coloring fall foliage in woodlands and vineyards. Scandiffio, 2021, 1374 – 1391. Rolando et al., 2023, 89-98.

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