

II

Con información y datos

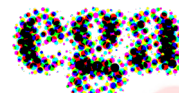
Diagramas, gráficas de datos, big data,
GIS, BIM, listas...

XXI Congreso Internacional de Expresión Gráfica Arquitectónica

Universitat Politècnica de Catalunya
Barcelona , 28, 29 y 30 de mayo de 2026



UNIVERSITAT POLITÈCNICA DE CATALUNYA
BARCELONATECH
Departament de Representació Arquitectònica





Con información y datos

Diagramas, gráficas de datos, big data,
GIS, BIM, listas...

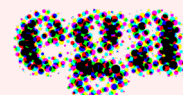
XXI Congreso Internacional de Expresión Gráfica Arquitectónica

Universitat Politècnica de Catalunya
Barcelona , 28, 29 y 30 de mayo de 2026



UNIVERSITAT POLITÈCNICA DE CATALUNYA
BARCELONATECH

Departament de Representació Arquitectònica



© Lluís Giménez (editor), 2026

© Los autores, 2026

© Iniciativa Digital Politècnica, 2026

Oficina de Publicacions Acadèmiques Digitals de la UPC

Jordi Girona 31,

Edifici Torre Girona, Plant 1, 08034 Barcelona

Tel.: 934 015 885

www.upc.edu/idp

E-mail: info.idp@upc.edu

ISBN: 979-13-88098-49-9

DOI: 10.5821/ebook-EGA.26.2.00



Los contenidos de esta obra están sujetos a la licencia de Creative Commons: [CC BY-NC-ND 4.0 Atribución/Reconocimiento-NoComercial-SinDerivados 4.0 Internacional](https://creativecommons.org/licenses/by-nc-nd/4.0/). Usted es libre de compartir y adaptar el contenido bajo los terminos de la licencia.

El Congreso EGA 2026 celebrado en Barcelona lleva un título-manifiesto: *Certezas e incertidumbre*. Los tiempos en los que se desarrolla nuestra docencia y nuestra investigación son inciertos, no solo por desastres naturales o acontecimientos provocados, sino porque la globalización hace que la incertidumbre se propague. El congreso de Barcelona en el año en que la ciudad es capital mundial de la arquitectura ha de servir para reflexionar sobre lo que hacemos y en el momento en que estamos.

Esta colección de 5 libros recoge lo que se ha presentado en las jornadas de Barcelona, recogiendo el testigo de Porto 2024. En esta ocasión, desde la convocatoria en que se recibieron 233 propuestas de comunicaciones, procedentes de 67 universidades de 16 países, 169 comunicaciones han superado dos rondas de revisiones por pares ciegos. Con lo que el congreso EGA se consolida como referente internacional y de calidad. Las cinco líneas temáticas en que se han organizado las comunicaciones dan pie a los cinco volúmenes que siguen.

Líneas temáticas

- I. Ante la enseñanza y el aprendizaje
- II. Con información y datos:
Diagramas, gráficas de datos, big data, gis, bim, listas...
- III. De dibujos, geometrías y trazos
Proceso creativo de la forma arquitectónica
- IV. Desde lo existente
Dibujar la realidad, levantamiento, simulación, análisis gráfico, conservación
- V. Hacia la sociedad
Comunicación, entorno social y natural

Comité organizador

- **Albert Sánchez Riera.** Universitat Politècnica de Catalunya
- **Bruno Seve.** Universitat Politècnica de Catalunya
- **Francesc Valls Dalmau.** Universitat Politècnica de Catalunya
- **Isabel Crespo Cabillo .** Universitat Politècnica de Catalunya
- **Isabel Zaragoza De Pedro.** Universitat Politècnica de Catalunya
- **Isidro Navarro Delgado.** Universitat Politècnica de Catalunya
- **Jesús Esquinas Dessy.** Universitat Politècnica de Catalunya
- **Jordi De Gispert Hernandez.** Universitat Politècnica de Catalunya
- **Josep Maria Fort Mir.** Universitat Politècnica de Catalunya
- **Lluís Giménez Mateu.** Universitat Politècnica de Catalunya
- **Manuela Ianni.** Universitat Politècnica de Catalunya
- **Marc Roca Musach.** Universitat Politècnica de Catalunya
- **Marilena Christodoulou.** Universitat Politècnica de Catalunya
- **Olga Guijarro Fayol.** Universitat Politècnica de Catalunya
- **Queralt Garriga Gimeno.** Universitat Politècnica de Catalunya
- **Renata de Mendonça Espinheira Gomes.** Universitat Politècnica de Catalunya
- **Salvador Gilabert Sanz.** Universitat Politècnica de Catalunya
- **Sandra Moliner Nuño.** Universitat Politècnica de Catalunya
- **Sebastian Harris.** Universitat Politècnica de Catalunya

Comité científico

- **Aitor Goitia Cruz.** Universidad CEU San Pablo
- **Albert Sánchez Riera.** Universitat Politècnica de Catalunya
- **Alberto Grijalba Bengoetxea.** Universidad de Valladolid
- **Andrés Abásolo Alcázar.** Universidad Europea de Madrid
- **Antonio Estepa Rubio.** Universidad de San Jorge
- **Carlos L. Marcos Alba.** Universidad de Alicante
- **Carlos Naya Villaverde.** Universidad de Navarra
- **Eduardo Antonio Carazo Lefort.** Universidad de Valladolid
- **Ernest Redondo Domínguez.** Universitat Politècnica de Catalunya
- **Flavio Celis D'amico.** Universidad de Alcalá
- **Francesca Fatta.** Università degli Studi Mediterranea di Reggio Calabria
- **Francisco Pinto Puerto.** Universidad de Sevilla
- **Íñigo Leon Cascante.** Universidad del País Vasco
- **Isabel Crespo Cabillo.** Universitat Politècnica de Catalunya
- **Javier Fco. Raposo Grau.** Universidad Politécnica de Madrid
- **Javier García-Gutiérrez Mosteiro.** Universidad Politécnica de Madrid
- **Jorge Gabriel Molinero Sánchez.** Universidad de Granada
- **Jorge Llopis Verdú.** Universitat Politècnica de València
- **José De Coca Leicher.** Universidad Politécnica de Madrid
- **Juan Serra Lluch.** Universitat Politècnica de València
- **Lluís Giménez Mateu.** Universitat Politècnica de Catalunya
- **Luís Agustín Hernández.** Universidad de Zaragoza
- **Luís Hermida González.** Universidade da Coruña
- **Manuel Alejandro Ródenas López.** Universidad Politécnica de Cartagena
- **Maria Amparo Bernal López-Sanvicente.** Universidad de Burgos
- **María Luisa Martínez Zimmermann.** Universidad de Las Palmas de Gran Canaria
- **Marina Sender Contell.** Universitat Politècnica de València
- **Ornella Zerlenga.** Università degli Studi della Campania 'Luigi Vanvitelli'
- **Pedro António Alexandre Janeiro.** Universidade de Lisboa
- **Pilar Chías Navarro.** Universidad de Alcalá
- **Roberta Spallone.** Politecnico di Torino
- **Salvador Gilabert Sanz.** Universitat Politècnica de Catalunya

Comité de revisores

- **Aitor Goitia Cruz.** Universidad CEU San Pablo
- **Albert Sánchez Riera.** Universitat Politècnica de Catalunya
- **Alberto Grijalba Bengoetxea.** Universidad de Valladolid
- **Alberto Sanjurjo Álvarez.** Universidad CEU San Pablo
- **Aldo Moccia.** Sapienza Università di Roma
- **Álvaro Moral García.** Universidad de Valladolid
- **Ana Abasolo Nicolás.** Universidad Europea de Madrid
- **Ana Torres Barchino.** Universitat Politècnica de València
- **Andrés Abásolo Alcázar.** Universidad Europea de Madrid
- **Ángel Allepuz Pedreño.** Universidad de Alicante
- **Ángel José Fernández Álvarez.** Universidade da Coruña
- **Ángel Martínez Díaz.** Universidad Politécnica de Madrid
- **Ángela Ruiz Plaza.** Universidad Europea de Madrid
- **Angélica Fernández Morales.** Universidad de Zaragoza
- **Antonio Estepa Rubio.** Universidad de San Jorge
- **Beatriz de la Puerta Gancedo.** Universidad Europea de Madrid
- **Bruno Seve.** Universitat Politècnica de Catalunya
- **Carlos L. Marcos.** Universidad de Alicante
- **Carlos Naya Villaverde.** Universidad de Navarra
- **Daniel López Bragado.** Universidad de Valladolid
- **David Marcos González.** Universidad de Valladolid
- **Daniel Vicente Martín Fuentes.** Universitat Politècnica de València
- **Daniele Colistra.** Università degli Studi Mediterranea di Reggio Calabria
- **Eduardo Antonio Carazo Lefort.** Universidad de Valladolid
- **Ernest Redondo Domínguez.** Universitat Politècnica de Catalunya
- **Fátima Sarasola Rubio.** Universidad CEU San Pablo
- **Fco. Javier Cortina Maruenda.** Universitat Politècnica de València
- **Fco. Javier González Pérez.** Universitat Politècnica de Catalunya
- **Fco. Javier Raposo Grau.** Universidad Politécnica de Madrid
- **Fernando Linares García.** Universidad de Valladolid
- **Fernando M. Alonso Pedrero.** Universidad de Navarra
- **Flavio Celis D'amico.** Universidad de Alcalá de Henares
- **Francesca Fatta.** Università degli Studi Mediterranea di Reggio Calabria
- **Francisco Pinto Puerto.** Universidad de Sevilla
- **Francisco Valls Dalmau.** Universitat Politècnica de Catalunya
- **Gonzalo Sotelo Calvillo.** Universidad Politécnica de Madrid

- **Héctor Mendoza Ramírez.** Universitat Politècnica de Catalunya
- **Hugo Barros Costa.** Universitat Politècnica de València
- **Ignacio Cabodevilla-Artieda.** Universitat Politècnica de València
- **Inés Pernas Alonso.** Universidade da Coruña
- **Iñigo León Cascante.** Universidad del País Vasco
- **Irene Benet Morera.** Universitat Politècnica de València
- **Irene de la Torre Fornés.** Universitat Politècnica de València
- **Isaac Mendoza Rodríguez.** Universidad de Valladolid
- **Isabel Crespo Cabillo.** Universitat Politècnica de Catalunya
- **Isabel Zaragoza de Pedro.** Universitat Politècnica de Catalunya
- **Janina Puig Costa.** Universitat Politècnica de Catalunya
- **Javier García-Gutiérrez Mosteiro.** Universidad Politécnica de Madrid
- **Jesús Esquinas Dessy.** Universidad Politècnica de Catalunya
- **Jordi de Gispert Hernández .** Universitat Politècnica de Catalunya
- **Jorge Gabril Molinero Sánchez.** Universidad de Granada
- **Jorge Llopis Verdú.** Universitat Politècnica de València
- **José de Coca Leicher.** Universidad Politécnica de Madrid
- **José Javier Pérez Martínez.** Universidad del País Vasco
- **Jose M. López Ujaque.** Universidad de Alicante
- **Josefina García León.** Universidad Politécnica de Cartagena
- **Juan L. Roquette Rodríguez-Villamil.** Universidad de Navarra
- **Juan Serra Lluch.** Universitat Politècnica de València
- **Licinia Aliberti.** Universidad Politécnica de Madrid
- **Lluís Giménez Mateu.** Universitat Politècnica de Catalunya
- **Luís Agustín Hernández.** Universidad de Zaragoza
- **Luis de Sobrón Martínez.** Universidad Politécnica de Madrid
- **Luís Hermida González.** Universidade da Coruña
- **Luís Navarro Jover.** Universidad de Alicante
- **Mª José Muñoz Mora.** Universidad Politécnica de Cartagena
- **Maialen Sagarna Aranburu.** Universidad del País Vasco
- **Manuel Castellano Román.** Universidad de Sevilla
- **Manuel Giménez Ribera.** Universitat Politècnica de València
- **Manuela Ianni.** Universitat Politècnica de Catalunya
- **Marc Roca Musach.** Universitat Politècnica de Catalunya
- **Maria Alexandra Salgado Ai Quintas.** Universidade de Lisboa
- **Maria Amparo Bernal López-Sanvicente.** Universidad de Burgos
- **María del Pilar Salazar Lozano.** Universidad de Navarra
- **María Josefa Agudo Martínez.** Universidad de Sevilla
- **Maria Senderos Laca.** Universidad del País Vasco

- **María Villanueva Fernández.** Universidad de Navarra
- **Marina López Sánchez.** Universidad de Sevilla
- **Marina Sender Contell.** Universitat Politècnica de València
- **Marinella Arena.** Università degli Studi Mediterranea di Reggio Calabria
- **Marta Quintilla Castán.** Universidad de Zaragoza
- **Miguel Sancho Mir.** Universidad de Zaragoza
- **Noelia Cervero Sánchez.** Universidad de Zaragoza
- **Omar Fabrisio Avellaneda López.** Universitat Politècnica de Catalunya
- **Ornella Zerlenga.** Università degli Studi della Campania Luigi Vanvitelli
- **Pablo Jeremías Juan Gutiérrez.** Universidad de Alicante
- **Pablo Rodríguez Navarro.** Universitat Politècnica de València
- **Patricia Wanderley Ferreira Lopes.** Universidad de Sevilla
- **Pau Natividad Vivó.** Universidad Politécnica de Cartagena
- **Pedro António Alexandre Janeiro.** Universidade de Lisboa
- **Pedro Marques de Abreu.** Universidade de Lisboa
- **Pedro Molina Siles.** Universitat Politècnica de València
- **Pedro Verdejo Gimeno.** Universitat Politècnica de València
- **Pilar Chías Navarro.** Universidad de Alcalá de Henares
- **Pilar Moya Olmedo.** Universidad Rey Juan Carlos Madrid
- **Placido Lizancos-Mora.** Universidade da Coruña
- **Queralt Garriga Gimeno.** Universitat Politècnica de Catalunya
- **Rafael Ortiz Martínez de Carnero.** Universidad de Sevilla
- **Raquel Álvarez Arce.** Universidad de Valladolid
- **Renata de Mendonça Espinheira Gomes.** Universitat Politècnica de Catalunya
- **Riccardo Montuori.** Universidad de Alicante
- **Roberta Spallone.** Politecnico di Torino
- **Roque Angulo Fornos.** Universidad de Sevilla
- **Salvador Gilabert Sanz.** Universitat Politècnica de Catalunya
- **Sandra Moliner Nuño.** Universitat Politècnica de Catalunya
- **Santiago Elía García.** Universidad de San Jorge
- **Sebastian Harris.** Universitat Politècnica de Catalunya
- **Sergio García Doménech.** Universidad de Alicante
- **Silvia Herrero Alonso.** Universidad Europea de Madrid
- **Vicente López Chao.** Universidade da Coruña
- **Víctor Antonio Lafuente Sánchez.** Universidad de Valladolid

II. Con información y datos:

Diagramas, gráficas de datos, big data, GIS, BIM, listas...

Volumen dirigido por Aldo Moccia

La evolución tecnológica nos ha proveído de nuevos recursos para el desarrollo de la expresión gráfica y ha provocado impulsos, no libres de discusiones sobre la conveniencia o no de su incorporación al trabajo gráfico. El diseño computacional y los motores de cálculo de inteligencia artificial generativa apuntan a otra revolución que debemos encarar, asumir y asimilar.

Además, gracias al manejo de esa tecnología hemos aprendido a dibujar lo que calculamos, a graficar de manera inteligible e inteligente los resultados de simulaciones, de mediciones, de datos que sería imposible manejar sin la computación. Lo más significativo es que nuestra habilidad demostrada en saber explicar cosas con dibujos ha aportado al mundo de la información la capacidad de hacer inteligibles los datos masivos. Convertir una información inabarcable en algo comprensible pasa por dibujar.

En los capítulos de este libro se desgrana el uso de la información para el diseño. Cada uno es una aportación sobre la creación, el análisis y la visualización de datos complejos relacionados con el contexto urbano, indicadores sociales, el rendimiento medioambiental, la eficiencia energética y otros aspectos de la arquitectura sostenible y resiliente. Se exploran las posibilidades del uso de datos para el diseño como el diseño paramétrico, generativo, algorítmico y evolutivo. Cómo trabajar el modelado de la información constructiva (BIM), cómo hacerlo con los sistemas de información Geográfica (SIG), qué derivas nos esperan en el terreno de la robótica, la fabricación digital y la IA.

Contenido del volumen

1. **Construir el dibujo de Arquitectura: una experiencia de innovación docente para la integración de metodologías BIM en la enseñanza de Dibujo de Arquitectura**
Constructing the drawing of Architecture: an educational innovation experience for integrating BIM methodologies into the teaching Drawing of Architecture
Ramos-Martín, Manuel; Landínez González-Valcárcel, David
2. **Conocimiento e incertidumbre en modelos HBIM: la definición diacrónica**
Knowledge and uncertainty in HBIM models: the diachronic definition
Castellano-Román, Manuel; Angulo-Fornos, Roque; Guerrero-Vega, José María
3. **Approcci di arricchimento semantico del modello informativo IFC per l'analisi archeologica**
Approaches to semantic enrichment of the IFC information model for archaeological analysis
Cera, Valeria; Canicattì, Luca; Scandurra, Simona
4. **Representación arquitectónica de la sostenibilidad: reutilización, expresión material y forma visual**
Architectural representation of sustainability: reuse, material strategies, and visual form
Bacheva, Tsvetelina Spasova
5. **Diseño de producto por arquitectos: análisis, representación gráfica y fabricación digital**
Product Design by Architects: Analysis, Graphic Representation, and Digital Fabrication
Lorenzo-Cueva, Covadonga
6. **Parametric Design and Geometric Optimization for a Deployable Arch Based on Asymmetric Hexagonal Modules**
Şahmetlioğlu Yilmaz, Ebru; Avellaneda Lopez, Omar Fabrisio
7. **Cartografía del Derecho a la ciudad en África Oriental. El caso de Inhambane (Mozambique)**
Mapping the Right to the city in Eastern Africa. Inhambane (Mozambique) as case study.
Moreno-Sanz, Joan; Solana-Arteche, Gorka; Márquez-Martin, Sara
8. **Arquitectura paramétrica avant la lettre: Ejemplos antes de la aparición del concepto**
Parametric architecture avant la lettre: Examples before the concept
Christodoulou, Marilena; Roca-Musach, Marc
9. **La representación gráfica en la salvaguarda del patrimonio inmaterial. Apuntes y debates**
Graphic representation for the safeguarding of intangible heritage. Notes and debates
Ferreira-Lopes, Patricia

- 10. Herramientas y metodologías emergentes para el estudio del patrimonio documental gráfico**
Emerging Tools and Methodologies for the Study of Graphic Documentary Heritage González Gracia, Elena; Ferreria-Lopes, Patricia; Pinto Puerto, Francisco
- 11. Traduzioni digitali di architetture perdute: Miguel Fisac Serna, Laboratori Jorba, Madrid**
Digital translations of lost architecture: Miguel Fisac Serna, Jorba Labs, Madrid
Cera, Simone; Argiolas, Raffaele; Bagnolo, Vincenzo
- 12. Modelli informativi integrati e BI per la governance digitale del patrimonio edilizio**
Integrated information models and BI for the digital governance of building heritage Antuono, Giuseppe; Scandurra, Simona; Galluccio, Giuliano
- 13. Del mapa al modelo: interoperabilidad entre BTA, BTU y CityGML en el marco de INSPIRE**
From maps to model: interoperability between BTA, BTU and CityGML within the INSPIRE framework
Bermúdez-González, Juan Luis; Fernández-Tapia, Enrique José; Martín-de Torres, Diego; Fernández-Trapa, Lucas
- 14. Dynamic mapping of seasonal landscape phenomena across Italy's inner areas**
Scandiffio, Alessandro
- 15. Trabajando con el ISOTYPE para la expresión gráfica arquitectónica**
Working with ISOTYPE in Architectural Graphic Expression
Bordes-Cabrera, Enrique; Bordes-de Santa Ana, Ignacio; De Sobrón-Martínez, Luis
- 16. El sueño de la razón produce ... Breve análisis de imágenes utópicas generadas por IA.**
The sleep of reason produces... Brief analysis of utopian images generated by AI.
Cortina-Maruenda, Javier; Llopis-Verdú, Jorge
- 17. Mapping adaptive capacity to extreme heat. A graphical approach**
Moccia, Aldo; Alonso-Montolío, Carlos; Coch, Helena

Dynamic mapping of seasonal landscape phenomena across Italy's inner areas

Scandiffio, Alessandro¹[0000-0001-9966-7523]

¹ Department of Architecture and Urban Studies, Politecnico di Milano, Milan, Italy.

alessandro.scandiffio@polimi.it

Abstract:

This contribution focuses on the mapping of seasonal landscape qualities across Italy's inner areas, by exploiting the potential of the integration of Remote Sensing (RS) and Geographic Information System (GIS), which can support interactive Web-based Map (WbM) applications with the main aim to provide firstly the knowledge of these territories and secondly support the engagement of new territorial development strategies oriented to sustainable tourism. Specifically, the research provides an overview of the Dynamic Mapping Methodology (DMM), which enables showing seasonal landscape phenomena both at large-scale and small-scale contexts, by exploiting the potential of multispectral satellite and UAV-based imagery acquisition. By considering that inner areas are largely defined by 'voids', extensive natural, semi-natural, and agricultural landscapes, this research seeks to uncover the hidden potential of these territories, resulting from seasonal landscape expressions derived from colour changes. Specifically, it aims to develop a visual tool which can support decision makers to establish strategies oriented to increase the attractiveness of some marginal places, promoting them as unconventional destinations to be experienced at specific times of the year. In this perspective, by exploring, at the national level, the landscape features across inner areas, the research shows some of the applications of DMM to different case studies, matching potentialities, limitations and future development.

Keywords: gis, inner areas, mapping, remote sensing, seasonal landscapes.

Thematic area: [II] ...with information and data.

1. Introduction

This contribution focuses on the mapping of landscape qualities of Italy's marginal areas, by exploiting the potential of the integration of Remote Sensing (RS) and Geographic Information System (GIS), which can support interactive Web-based Map (WbM) applications, with the main aim to foster knowledge of these territories and secondly support the engagement of new territorial development strategies oriented to sustainable tourism. Specifically, the research focuses on the so-called 'inner areas' (Agenzia Coesione Territoriale) of the country, where new visual tools are required to enhance the level of attractiveness of these places, which need to uncover their potentialities and better exploit the existing territorial assets. By considering that the landscape of those areas is mainly characterized by 'voids', extensive portions of natural, semi-natural, and agricultural lands, the research tries to explore the hidden

potentialities of these areas, which hold even strong potential in terms of aesthetics, especially if it is considered the visual perception of the landscape. In this perspective, the open spaces, which are commonly perceived as empty and uniform, can gain an added value by considering the landscape expressions resulting from natural phenomena and productive agricultural cycles from an aesthetic point of view. Particularly, the colour changes, which mark the places over the seasons, in terms of space and time, affect the overall character of the landscape, which can be recognized by communities even as a distinctive feature (Arriaza et al., 2004) (Stobbelaar, 2007) (a relevant example in this sense is well represented by the outstanding flowering of the lands in Castelluccio di Norcia, in the Umbria region in central Italy). These specific seasonal phenomena, mostly related to plant life cycle within agricultural production, which affect specific landscapes, have a short duration (a few weeks) and change quickly in terms of space and time (e.g., spring flowering,

the controlled floodings, the autumn leaves colouring) (fig.1-4), deserve special attention in terms of tourism opportunities, especially for marginal areas.



Fig. 1 Foliage across coniferous forest in the northern Alpine region. Val d'Ayas (Aosta Valley Region).

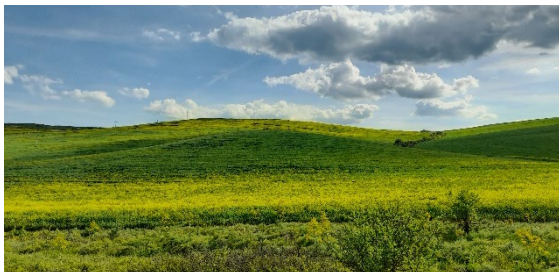


Fig. 2 Rapeseed spring blooming across an arable landscape in southern Italy (Basilicata region).



Fig. 3 Controlled flooding in the agricultural landscape of paddy-rice in between Piedmont and Lombardy regions.



Fig. 4 Daffodils summer blooming in the Alpine landscape at Oasi Zegna (Piedmont region).

In recent years, some of these places affected by seasonal phenomena have emerged as slow-tourism destinations, considering the opportunities to link them with the experiences of other related fields, such as local food and wine production, as well as the rediscovery of intangible heritage related to traditional and cultural practices and events. Nevertheless, there is a lack of visual tools to help decision-makers and visitors set site-specific experiences through the landscape. The specificity and temporality of these seasonal phenomena, which affect specific landscapes across Italy (Sestini, 1963), such as the ones of agricultural arable lands and croplands (e.g., paddy-rice fields, rapeseed fields, poppies), require the definition of a specific methodology and the adoption of dedicated mapping techniques able to capture both spatial and temporal data. In this framework, a great contribution is provided by Remote Sensing (RS) applications, which enable the observation of the landscape from a zenithally point of view and the collection of accurate spatial data. If the mapping target is centred on the scale of landscape, the detection can be managed by High-Resolution (HR) mapping techniques, such as those from satellites, which enable to capture of large portions of territories (e.g., one satellite tile covers an area of 100 km²). Whilst if the focus is on small areas and on smaller objects, such as flowers and leaves on the fruit groves, vineyards, grasslands with spontaneous species like daffodils and crocus, the mapping process requires the adoption of Ultra-High-Resolution (UHR) sensors equipped on Unmanned Aircraft Vehicles (UAVs), which enable the detection of objects at a finer scale (less than 10 cm) (Yao et al., 2019). Specifically, the research shows how the 'Dynamic Mapping Methodology' (DMM), based on the following workflow: acquisition of multispectral imagery (MI) through RS applications (Sentinel-2 mission by EU Copernicus Earth observation program or UAVs survey platform), GIS-based map processing and visualization of landscape phenomena by Vegetation Indices (VIs) computing, and interactive WbM visualization, which enables to share knowledge about these phenomena, and open to further research activities and related applications. By analysing some case studies, selected across inner areas

of the country, the research provides an overview of the application of the DMM at different scales of investigation, which enables the addition of a 'new layer' of spatial information to the existing ones. Specifically, by integrating heterogeneous layered spatial information, related to different categories such as the ones of minor heritage places, places related to food production, seasonal conditions of the landscapes, and underused infrastructure (minor railways, historical paths, minor roads, slow routes), that support the accessibility of the places, within a multisource geodatabase, new ways to use these places can be promoted according to the cycle of seasons, with the main aim of encouraging territorial rebalancing. The WbM, as a shared device that makes visible spatial information in a graphic support, on the one hand enables the improvement of users' interaction with places, both remotely and on-site by mobile devices, and other hand, can play a key role in increasing the level of awareness of the inhabitants of their landscape and territorial assets, which can support local actors in promoting sustainable development strategies.

2. Mapping seasonal landscapes across Italy's inner areas

Before overviewing the mapping methodologies and techniques that are useful to visualize the seasonal phenomena that affect specific landscapes, it is important to understand the 'where' these landscapes are localized across the country and 'what' their main spatial features are, so to plan dedicated territorial strategies. The mapping of Italy's inner areas potentially affected by seasonal landscape phenomena has been carried out by merging two different levels of investigation, which affect both the degree of marginalization of some areas of the country and their landscape features, which can be better enhanced through territorial strategies supported by visual devices. The first level has concerned the identification of the inner areas of the country according to the National Strategy of Inner Areas (SNAI). The second one was more about the analysis of their landscape features by considering the European mapping program named Corine Land Cover (CLC) (ISPRA). The

SNAI, which is an Italian placed-based policy for the territorial rebalancing and cohesion of marginalized territories, working in following period of time 2014-2020 and 2021-2027, has classified inner territories as the ones which are far away from the main urban centers, which supply the essential services in terms of mobility, education and health, so to concentrate major efforts and investments for the revitalization of local economies. In the current research, the inner areas are the ones classified and named by SNAI as "D-intermediate, E-peripheral, and F-ultra peripheral" areas. By selecting them and analysing their spatial features at the national level, it is visible that these territories cover about 58% of the Italian land surface and affect 48% of municipalities. By exploring the land cover features of inner areas classified as D, E and F, according to the CLC (the third level of information enables the identification of 44 land cover classes), it is visible that about 80% of their land cover is potentially affected by seasonal landscape phenomena. More in detail, seasonal landscape phenomena specifically refer to temporary landscape conditions, linked to certain times of the year, shaping their visual and aesthetic character, which are mainly perceivable throughout the colour changes or the presence of water, which profoundly affect the visual perception of these landscapes. Particularly, six different landscape phenomena have been identified by considering their outstanding visual features, their spatial patterns and their peak timing (seasonality). Precisely they are the so called 'foliage', autumn leaves colouring, which affect especially large portions of mountainous landscapes characterized by the presence of broad leaf, coniferous and mixed forests; the 'controlled floodings' of paddy rice-fields over the spring season, which radically change the appealing of this agricultural landscapes over the seeding stage; the 'spring flowering', which affect the productive landscapes characterized by fruit groves and complex cultivation patterns; the 'autumn colouring' of vineyard landscapes, which are also testimony of the cultural and historical values of their territories; the 'spring flowering' of productive landscapes characterized by arable lands, such as rapeseeds, wheat and poppies; the outstanding

spontaneous 'spring flowering' over the mountainous landscapes characterized by the presence of natural grasslands and pastures. The analysis of the CLC datasets makes evident that especially the landscapes characterized by 'forests' and 'arable lands', which are widely spread across the inner areas D, E and F of the country, by covering respectively 19% (27% of the Italy's land surface is the total covered by forests) and 17% (27% of the Italy's land surface is the total covered by arable lands) of Italy's overall land surface, can increase their level of attractiveness for sustainable tourism purposes, taking into account their potentialities related to seasonal phenomena, due to their large extensions. Within the inner areas already mentioned, even the landscapes characterized by 'fruit groves and complex cultivation pattern' and 'natural grasslands and pastures', which cover respectively 4% (9% of the Italy's land surface is the total covered by fruit groves and complex cultivation patterns) and 3% (4% of the Italy's land surface is the total covered by natural grasslands and pastures) of Italy's overall land surface, can be of interest for activating strategies for enhancing their specific landscape features, due to their medium extensions. Among the other seasonal phenomena which occur over the landscapes characterized by 'vineyards' and 'paddy-rice fields', which cover respectively 1% (2% of the Italy's land surface is the total covered by vineyards) and 0% (1% of the Italy's land surface is the total covered by paddy-rice fields) of Italy's overall land surface, only the vineyards, due to their territorial extensions, can be of interest for establishing territorial strategies, because half of the total surface at the national level of the vineyards lie in the inner areas. The spatial distribution of seasonal landscapes across the inner areas of the country is visible through the map (fig.5), whilst the corresponding statistical data are shown in the table (tab.1).

3. Dynamic Mapping Methodology

This paragraph reveals the main features of the Dynamic Mapping Methodology (DMM), which enables the visualization of how seasonal landscape phenomena change in terms of space and time by using the zenithally point of view, which is typical of maps. Once the potential locations of the landscapes affected by seasonal phenomena are known, the DMM enables the detection of their seasonal temporary conditions, by exploiting the potential of RS and GIS based applications which enable the processing of MI through which are computed the Vegetation Indices (VIs), which are proxies that can be used for detecting vegetation colour changes, beyond health and density vegetation. The DMM involves three different steps: the MI acquisition, the MI processing with GIS for VIs computing, and the visualisation of seasonal landscape phenomena by computing VI thresholds on maps. MI acquisition is related to the size and the spatial features of the landscapes. In this sense, different mapping techniques can be employed. When the target is centred on a large portion of landscape, for example 100 km² (e.g. forests, arable lands), MI is provided by satellites orbiting around the Earth. MI provided by Satellite are framed within the High-Resolution (HR) mapping techniques, whose spatial resolution is 10 m. In this case, the DMM is fed by a continuous flow of MI, provided by a Satellite orbiting around the Earth, which, every 3-4 days, at mid-latitude, provides updated information about the Earth's status. Nowadays, these kinds of spatial information are freely available through the European Program Copernicus, and specifically through the Sentinel-2 satellites (Fu et al., 2020) (European Space Agency). If the seasonal phenomena take place on small landscape portions (e.g. 1 km²) and result from small objects like flowers and leaves on the fruit groves, vineyards, grasslands with spontaneous species, the Ultra-High-Resolution (UHR) mapping techniques are required to detect smaller objects. In this second way, Unmanned Aircraft Vehicles (UAVs) equipped with a multispectral camera are required to record UHR MI, which enables the detection of objects at a finer scale.

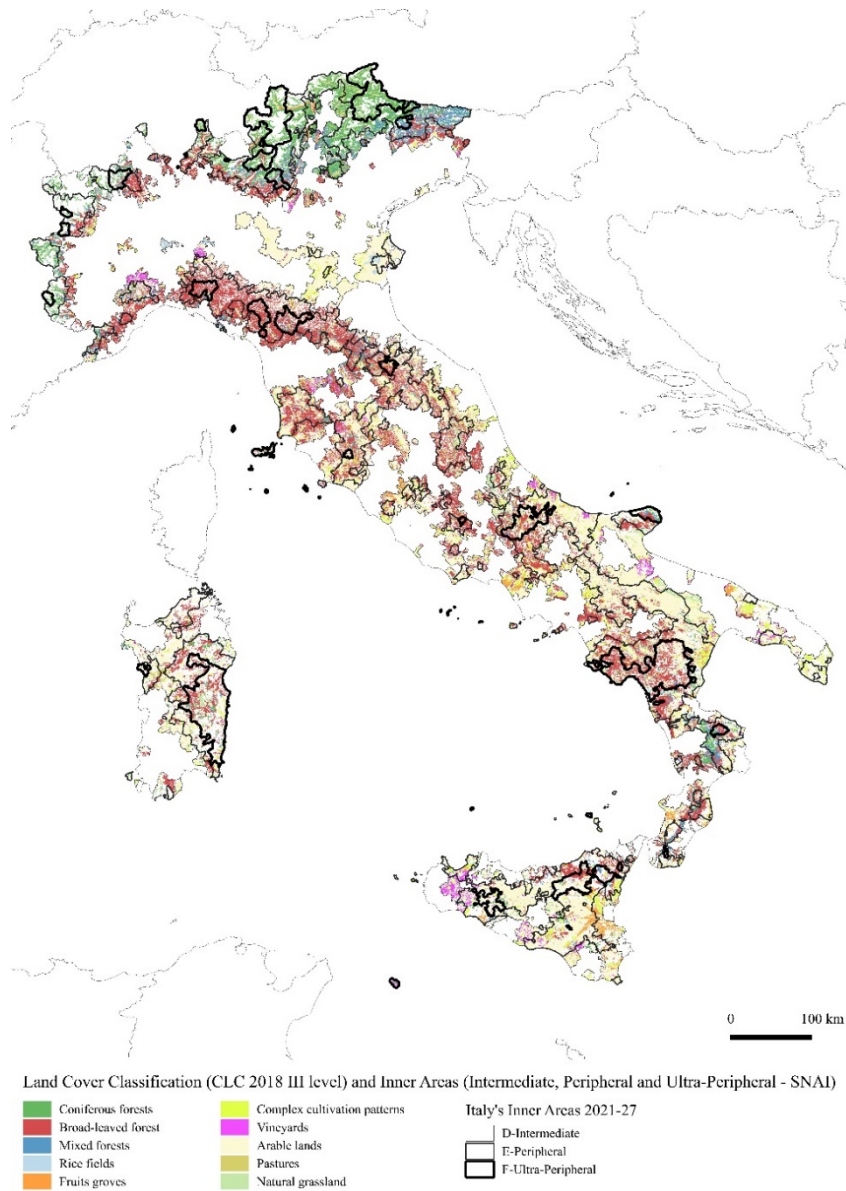


Fig. 5 Land Cover Classification of the potential seasonal landscapes across the Inner areas of the country according to SNAI 2021-2027 (map by author).

Tab 1. Statistical data related to CLC and Inner Areas (Intermediate, Peripheral Ultra-peripheral) SNAI 2021-2027.

Seasonal Phenomena	Land Cover - Landscapes	CLC 2018 Classes	Total Surface [km ²]	Surface [%]	Inner Areas [Intermediate] D [km ²]	Surface [%]	Inner Areas [Peripheral] E [km ²]	Surface [%]	Inner Areas [Ultra-Peripheral] F [km ²]	Surface [%]	Total Surface Inner Areas D+E+F [km ²]																											
Foliage	Broad leaf, Coniferous, Mixed Forests	311-312-313	80.714	27%	21.223	7%	27.447	9%	8.395	3%	19%																											
Controlled floodings	Paddy rice fields	213	2.943	1%	261	0%	81	0%	2	0%	0%																											
Spring flowering	Fruit groves and complex cultivation patterns	222-242	25.953	9%	6.977	2%	3.973	1%	533	0%	4%																											
Autumn coloring	Vineyards	221	6.269	2%	1.691	1%	744	0%	77	0%	1%																											
Spring flowering	Arable lands	211-212	80.962	27%	20.361	7%	24.102	8%	7.450	2%	17%																											
Spring flowering	Natural Grasslands and Pastures	231-321	12.219	4%	2.753	1%	4.225	1%	1.840	1%	3%																											
			209.059	69%	53.266	18%	60.572	20%	18.297	6%	44%																											
<table><tr><td colspan="3">Seasonal Landscapes D/Tot D [%]</td><td colspan="3">Seasonal Landscapes E/Tot E [%]</td><td colspan="3">Seasonal Landscapes F/Tot F [%]</td></tr><tr><td colspan="3">75.550 82%</td><td colspan="3">78.838 77%</td><td colspan="3">22.272 82%</td></tr><tr><td colspan="3">Tot land surface D</td><td colspan="3">Tot land surface E</td><td colspan="3">Tot land surface F</td></tr></table>												Seasonal Landscapes D/Tot D [%]			Seasonal Landscapes E/Tot E [%]			Seasonal Landscapes F/Tot F [%]			75.550 82%			78.838 77%			22.272 82%			Tot land surface D			Tot land surface E			Tot land surface F		
Seasonal Landscapes D/Tot D [%]			Seasonal Landscapes E/Tot E [%]			Seasonal Landscapes F/Tot F [%]																																
75.550 82%			78.838 77%			22.272 82%																																
Tot land surface D			Tot land surface E			Tot land surface F																																
* Italy's land surface 302.073 km2																																						

* Italy's land surface 302.073 km²

The MI processing is managed by GIS, for satellite imagery, or by Metashape combined with GIS, for UAV-based data acquisition, which enables the computation of VIs by combining multispectral bands through dedicated algorithms. The VIs result from the combination of the reflectance values of light recorded on the different bands of the electromagnetic spectrum collected through MI (Tucker, 1979). Each seasonal landscape phenomenon requires the computation of specific VIs, in relation to their features (e.g., detection of colour nuances, water). The last step concerns the visualization of seasonal landscape phenomena by computing VIs thresholds, which enable showing the landscape phenomenon occurring in a certain area and in a certain period. By reiterating the same workflow for different time MI acquisition is possible to visualize dynamically the spatial-temporal evolution of the landscape phenomena. Whilst the high-temporal resolution of satellite MI acquisition, which follows the revisit time of each mission, enables the DMM to work with a huge amount of data worldwide, in a semi-automatic way, the UAV-based MI acquisition can be reiterated over time, but requires dedicated site visits and surveys with human surveillance, with great efforts in the data acquisition and processing.

4. Application of DMM to different case studies

This section provides some insights into the application of DMM, targeting different case studies across Italy's inner areas, which reveal the applicability of the methodology and the potential of MI acquisition through satellite and UAVs. The investigation of seasonal landscape phenomena, such as the foliage in the forests, the controlled flooding in the paddy-rice fields, and the spring flowering of rapeseed in the arable lands, which affect large-scale landscape contexts, requires the application of DMM based on satellite MI acquisition. Once the satellite imagery has been acquired in a specific time interval and with a low cloud-cover percentage, it is necessary to compute VIs by combining different spectral bands within specific algorithms to map the searched seasonal phenomenon.

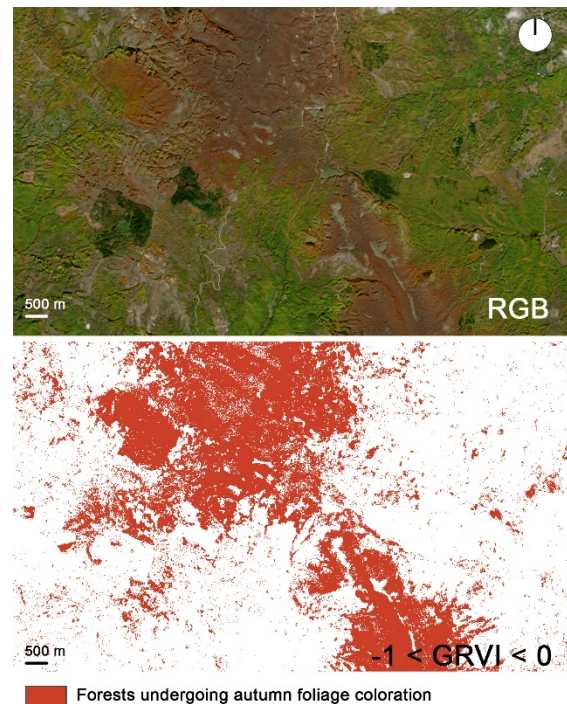


Fig. 6 Mapping foliage across the beech forest in the Lucanian Apennines in the Potenza province. Comparison between Sentinel 2A image RGB (2025 November 4th) and negative values of GRVI.

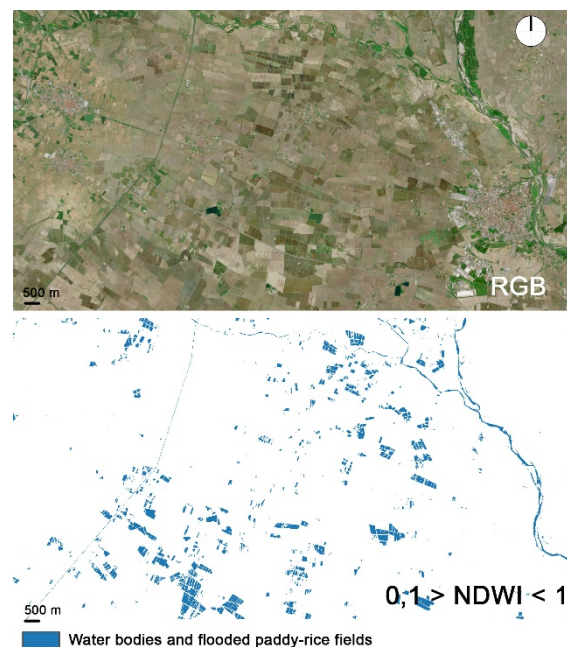


Fig. 7 Mapping the water bodies and the controlled floodings in the agricultural landscape of paddy-rice fields between Piedmont and Lombardy region. Comparison between Sentinel 2A image RGB (2025 May 15th) and positive values of NDWI.

For instance, the detection of foliage phenomenon across the landscape characterised by beech forests in central and southern Italy is first visible by observing the true colour (RGB) imagery acquired by satellite, and then it is detectable in an accurate way by processing the Green Red Vegetation Index (GRVI), which combines the green and red spectral bands. Specifically, the GRVI index enables the distinction of the green surfaces from those in colour (Motohka et al., 2010). More in detail, by computing GRVI and then setting a specific threshold to select negative values, it is possible to visualize and highlight only the areas affected by the autumn colouring phenomenon and analyse its temporal evolution (fig.6). The DMM can also be applied for mapping other seasonal landscape phenomena, such as controlled flooding on paddy-rice fields or the flowering of rapeseed over the spring season, which affect large landscape portions. The applicability of DMM to other case studies requires that the VIs processing be adapted to the vegetation and crop types, as in the case of paddy-rice fields, which are filled with water over the seeding stage in the spring season (e.g. application of Normalized Difference Water Index – NDWI) (fig.7). The landscape mapping at a finer scale can be based on UAV system, that can be used to get more accurate spatial data (Colaceci et al., 2022). Precisely, seasonal landscape phenomena, that need to be analysed at the scale of flowers or leaves within smaller areas, as in the case of spontaneous daffodils summer blooming across the grasslands in the mountainous landscapes, require to be mapped through UHR MI by dedicated UAV survey. In this case, the spatial resolution of MI, about 2-3 cm/px, enables to distinction of small flowers, like the ones of white daffodils widespread in the grasslands, from the other objects (fig.8).

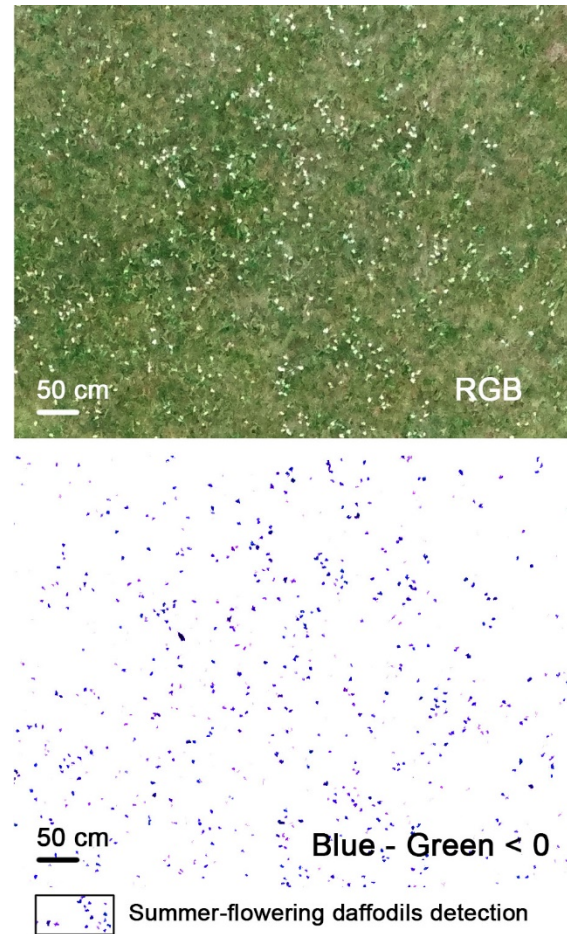


Fig. 8 UHR Multispectral imagery acquired by UAV survey (DJI Matrice 300 RTK equipped with Micasense Altum Multispectral camera 2.26 cm/px). Comparison between RGB and threshold negative values computed by the difference between Blue – Green spectral bands (image by author).

Table 2 shows the main differences between satellite and UAV-based data acquisition and their potential application to different landscape scales, by matching spatial and temporal resolution, number of bands, acquisition procedures, processing, and visualization.

Tab 2. Comparative analysis between Satellite and UAV-based data acquisition, processing and visualization.

	Landscape scale	Multispectral Camera	Bands	Image Resolution Typology	Spatial Resolution	Temporal Resolution	Data Acquisition	Data Processing	Data Visualization
Satellite Sentinel-2	Large/Medium	X	12	High-resolution imagery (HR)	10 m/pixel 20 m/pixel 60 m/pixel	3-5 days	automatic	GIS	GIS-based map
UAV	Small	X	6	Ultra-High-resolution imagery (UHR)	Flight altitude (less than 10 cm/pixel)	on-site survey	user-controlled	Metashape/GIS	GIS-based map 3D model

In this sense, the proposed case study of summer daffodils flowering, localized in the north-western area of Piedmont region at Oasi Zegna in the Biella province, shows the applicability of DMM by recording MI by UAVs. In this specific case, image processing and Vegetation index computation were performed by an integrated Metashape-GIS workflow. The detection of summer flowering of daffodils seems to be effective by computing negative values within the difference between blue and green spectral bands.

5. Discussion, Conclusion and future developments

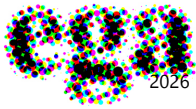
This contribution has shown that at the national level, large portions of the landscape and open spaces within the inner areas of the country can potentially be affected by seasonal phenomena, which can play a key role for improving tourism attractiveness. At methodological level, the research has shown the applicability of DMM as a tool for mapping the seasonal landscape phenomena across Italy's inner areas, by focusing on the integration of RS and GIS, which enable processing MI from satellites and UAVs. Specifically, the DMM seems to be flexible in the adaptability and replicability to the different landscape contexts, and to different data acquisition modes (satellites and UAVs). However, further investigations need to be undertaken to fix more accurate VIs' thresholds for the different seasonal phenomena, whose appearance is also linked to many unpredictable climatic factors (e.g., temperature, sunlight exposure, water provision) and human interventions linked to crop rotation.

Beyond the VIs optimization, the future developments of this work should be addressed to make a more effective output map related to each data acquisition, more easily accessible to end-users (decision makers and visitors), within interactive WbM applications with the integration of navigation services to effectively support the fruition of the places. Some limitations of the overall method concern the cloud-cover factor, which affects the satellite MI acquisition and the weather conditions in the UAV survey, which can negatively affect the

imagery performance and prevent the VIs processing. In this perspective a future development of this research could concern a deeper analysis of the accessibility of the potential locations of seasonal landscape phenomena within Italy's inner areas, so to select only the places that can actually be reached by visitors. This would provide insights and more accurate route analysis and processing about how easily these places can be reached, ultimately supporting the development of more targeted and effective territorial strategies. In this perspective, the dynamic mapping of seasonal landscape phenomena could play an interesting role, if the territorial strategies across the Italy's inner areas will take into account, in a more integrated vision, even the enhancement of the other territorial assets, as the ones of natural and built heritage, the ones of traditions and events, the ones related to food and gastronomy, but also the infrastructural accessibility, which enable visitors to get unconventional destinations. In this perspective, some places can be revitalised across Italy's inner areas, making new alternative destinations to the most frequented ones, acting as a territorial rebalance. From a visual representation perspective, the DMM provides a further layer of investigation into landscape features, enriching traditional static representations by integrating both spatial and temporal dimensions. This enables the tracking of the evolution of landscape phenomena through the seasons, making updated information about the places available.

6. Bibliography

- Agenzia per la Coesione Territoriale.
«Strategia nazionale aree interne». Accessed October 29, 2025.
<https://www.agenziacoesione.gov.it/strategia-nazionale-aree-interne/?lang=en>.
- Arriaza, Manuel, Cañas-Ortega, J. F., Cañas-Madueño, J. A., Ruiz-Avilés, P. 2004.
«Assessing the Visual Quality of Rural Landscapes». *Landscape and Urban Planning* 69 (1): 115–125.
<https://doi.org/10.1016/j.landurbplan.2003.10.029>.



Colaceci, Sara, Chiavoni, Emanuela, Ciani Maria Grazia. 2022. «UAVs and GIS Models for Landscape Representation». *Disegnarecon* 15 (29).
<https://doi.org/10.20365/disegnarecon.29.2022.10>.

De Rossi, Antonio (ed). 2018. *Riabitare l'Italia: Le aree interne tra abbandoni e riconquiste*, Roma: Donzelli.

Fu, Wenxue, Ma, Jianwen, Chen, Pei, and Chen, Fang. 2020. «Remote Sensing Satellites for Digital Earth». In *Manual of Digital Earth*, edited by Guo, Huadong, Goodchild, Michael F., and Annoni, Alessandro. 55–123. Singapore: Springer.
https://doi.org/10.1007/978-981-32-9915-3_3.

Istituto Superiore per la Protezione e la Ricerca Ambientale (ISPRA). «Corine Land Cover». Accessed October 27, 2025.
<https://www.isprambiente.gov.it/it/attivita/suolo-e-territorio/suolo/copertura-del-suolo/corine-land-cover>.

Motohka, Takeshi, Kenlo Nishida, Nasahara, Oguma, Hiroyuki and Tsuchida, Satoshi. 2010. «Applicability of Green-Red Vegetation Index for Remote Sensing of Vegetation Phenology». *Remote Sensing* 2 (10): 2369–87.
<https://doi.org/10.3390/rs2102369>.

European Space Agency (ESA). «Sentinel-2. Color vision for Copernicus». Accessed November 5, 2025:
https://www.esa.int/Applications/Observing_the_Earth/Copernicus/Sentinel-2

Sestini, Aldo. 1963. *Il Paesaggio. Conosci l'Italia*. 9–12. Milano: Touring Club Italiano.

Stobbelaar, Derk Jan, Hendriks, Karina. 2007. «Seasonality of Agricultural Landscapes: Reading Time and Place by Colours and Shapes». In *Seasonal Landscapes*, edited by Palang, Hannes, Sooväli, Helen and Printsmann, Anu. 103–26. Dordrecht: Springer.

Tucker, C. J. 1979. «Red and Photographic Infrared Linear Combinations for Monitoring Vegetation». *Remote Sensing of Environment* 8: 127–50.

Yao, Huang, Qin, Rongjun, Chen, Xiaoyu. 2019. «Unmanned Aerial Vehicle for Remote Sensing

Applications – A Review». *Remote Sensing* 11 (12): 1443. <https://doi.org/10.3390/rs11121443>